A Dynamic General Equilibrium Model for Malaysia:
Labour Market and Trade

by

Ju-Ai Ng

A thesis submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy

A Dynamic General Equilibrium Model for Malaysia: Labour Market and Trade

ERRATA

p4 line 4: delete "important" and read "Tariffs played a role in..."

p26 line 23: delete "at the World Bank and" and read "...used widely in America..."

p50 line 19: replace "marginal" with "margin" and read "...of margin industries..."

p48 fourth last line: delete "is" and read "...although easier..."

p48 second last line: delete "as" and read "...well as less..."

p127 footnote 15: replace "mean" with "means".

p51 line 13: replace "...which advanced over..." with "...which are advances over..."

p51 line 15: replace "Building in..." with "Building on..."

p225 line 1: replace "So why does..." with "So why do..."

ADDENDUM

p3 line 2: add "real" and read "the impact on real wages and ..."

p3 lines 9-13: read " My Malaysian version of this specification has seven parts: (i) Workers are categorized into nine different occupational groups; three skilled occupations (Legal senior office managers, Professional or Technical associate professional); five semi-skilled occupations (Clerical, Service&sales, Skilled agriculture and fishery worker, Craft and trades or Plant machine operator) and one unskilled occupation (Elementary occupation);..."

p257 line 7: add sentence after "...illegal immigration." Additional sentence reads "Consequently, their categories included the dimensions legal/illegal and domestic/foreign as well as the labour-force function dimension."

pxi line 7: add footnote at labour market. Footnote reads "I investigate the effects of a 5% tariff cut. However, sensitivity analysis presented in chapter 6 shows that the effects of a much larger tariff cut can still be considered small".

p37 line 20: Modify to read "...dynamic variables (Tobin's Q and aggregate capital K) are needed...".

p153 line 2: Modify to read " The input-output (I-O) data for the base year which is 2005, ..."

p208 line 5: Add footnote at the end of the line. Footnote reads: "Equation 6.18 leaves out the effect on revenue of the change in import volume, but this left out effect is negligible."

p200: Footnote to be added below Figure 6.6: Footnote reads: "Positive movements in the real exchange rate (blue line) denote real devaluation.

To my family for all their support and encouragement

TABLE OF CONTENTS

CHAPTER 4

CHAPTER 5

CHAPTER 6

CHAPTER 7

REFERENCES

LIST OF FIGURES

LIST OF TABLES

SUMMARY

This thesis investigates the effects of trade on the labour market in Malaysia. Specifically, we study the impact of a tariff cut in the motor vehicle industry on the different occupational wages and employment. Tariffs played an important role in Malaysia's economic development; from an import-competing economy to an export-oriented economy. The literature on trade, wages and employment for Malaysia is limited because of inadequate occupational data to carry out econometric analysis. To fill this gap, we use a dynamic computable general equilibrium (CGE) model for the Malaysian labour market, MyAGE_LM to analyze the effects of a reduction in motor vehicle tariffs. CGE models have theoretical rigour and extensive analytical capabilities for carrying out policy analysis.

This thesis contributes to the literature by (i) Introducing labour supply with nine different occupational groups into the dynamic CGE model for Malaysia and (ii) Analyzing a reduction in the motor vehicle tariff rate in Malaysia. The policy simulation is a 5 per cent cut in the motor vehicle tariff rate. To facilitate the analysis of the tariff cut, the MyAGE_LM model incorporates the labour market mechanism similar to that of Dixon and Rimmer (2003; 2008). The simulation results for the impact of the tariff cut on macroeconomic indicators, sectoral outputs and nine categories of occupational wages and employment are presented. The results are analyzed in terms of major model mechanisms.

The macroeconomic results of the tariff cut indicate that in the short run, with the government aiming for revenue neutrality through increased labour taxes, there would be a small welfare gain. We also found that in the short run, exports fell despite real devaluation. So, the export sectors do not benefit in the short run. In the long run, aggregate real wages increase, and there is an economy-wide gain in GDP and aggregate consumption. The sectoral results revealed that most export-oriented industries would experience an increase in output.

There are some evident effects on occupational wages and employment. The occupational group that stands out is the semi-skilled occupational group, SklAgriFish. This occupational group experienced the biggest decrease in vacancies. SklAgriFish occupations do well because no workers in this occupation are employed in the motor vehicle industry. Also, a

significant proportion of SklAgriFish workers are hired in the export-oriented Agriculture industry, and the Agriculture industry sells to FoodBevTob (which does well in the long run because of real devaluation). The PlantMachOpr occupation does relatively well because a high proportion of these workers is employed in OthMachEquip industry (export-oriented and a winner from tariff cut in the long run).

In general, from the MyAGE_LM policy simulation, we find that the tariff cut did not have a significant impact on the labour market. There are only small changes in average real wages and employment. We find damped labour supply effects in both the short and the long run. Semi-skilled occupations gain relative to skilled and unskilled workers. Skilled workers do not do well. They are mainly hired in non-traded industries that scarcely use imported motor vehicles

STATEMENT OF AUTHORSHIP

This thesis contains no material that has been accepted for the award of any other degree or diploma in any university or equivalent institution, and to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

……   ……………….

Ju-Ai Ng

ACKNOWLEDGEMENT

CHAPTER 1

INTRODUCTION

1.1   Statement of Issues and Motivation

Wage inequality between skilled and unskilled workers is an important area of discussion among labour and trade economists. A substantial amount of research has been carried out to determine the causes of inequality (Freeman 1995; Sachs & Shaz 1994; Leamer 1996, 1994; Wood 1997; Bhagwati and Dehejia 1994). Fundamentally, the argument has been about whether trade[1] (reflected in trade volume, prices, measures of protection and globalization) or technological change (which includes de-industrialization and productivity growth) is the key determinant.

The importance of the two competing views (trade or technology) has been highlighted through numerous theoretical and empirical studies. Some of these have demonstrated that a more open trade regime decreases the relative wages of skilled workers in developing countries through the Stolper-Samuelson effect (Berman et al. 1994; Leamer 1994). Other studies show that the recent wave of labour-saving technological innovations has had a strong impact on the structure of labour demand, particularly on unskilled workers (Acemoglu 1998, 2002; Katz & Murphy 1992; Berman et al. 1994 and Haskel & Slaughter 2001). Technological progress generally favours the use of skilled labour, therefore increasing skilled employment relative to unskilled employment, which leads to larger wage and employment disparities between the two groups.

This thesis looks at only one side of the debate: the effect of trade liberalization on wages and employment. Trade theory tells us that international trade brings gains to a country. However, trade theory also says that there will be winners and losers from a country opening up to international trade. Empirical evidence shows a relationship between an increase in international trade and wage inequality, which has led several economists to conclude that the

---

[1] An in-depth survey on empirical literature on the effects of trade (trade volumes, factor prices and measures of trade protection) on wages can be found in Deardorff and Hakura (1994).

recent globalization of economies contributed to the increase in the inequality of wages (Wood 1997). This proposition is sustained by the Heckscher-Ohlin model and its supporting theorem; Stolper-Samuelson.

According to the Heckscher-Ohlin-Samuelson (H-O-S) framework, based on the assumptions of similar technology levels, constant returns to scale and a given factor intensity relationship between final goods, a country would tend to export more of the goods that use the factor of production that is relatively abundant, while importing goods that intensively use the scarce factor of production (Burtless 1995). Therefore, with trade, the demand for the abundant factor increases due to the contraction of import-competing effects on factor prices. In the case of developing countries, the abundant factor would be unskilled workers, while skilled workers are assumed to be the scarce factor. When the economy opens up to trade, this tends to decrease the wages and employment of the skilled workers and increase the wages and employment of unskilled workers, thereby decreasing the difference in wages between the two groups. However, there has been much debate among economists about the impact of trade liberalization in developing countries, especially the effects on wages and employment. The assumptions underlying the H-O-S framework may be too restrictive to form the basis for reliable predictions about the effects of trade liberalization. Indeed, in this thesis I find that trade liberalization has relatively little effect on wage inequality.

Trade liberalization considerably alters the policy environment of a country; for example, the labour market. Consequently, an appropriate measurement of the effects of such a policy requires a comprehensive framework to investigate the interaction between the different economic agents in the market. A dynamic computable general equilibrium (CGE) model provides a strong foundation for investigating the short and long run effects of trade on Malaysia's labour market. This is because CGE models have computational rigour and extensive analytical capabilities. They have become a popular tool for carrying out policy analysis in the investigation of the impact of policy shocks to the economy. Computable general equilibrium (CGE) models represent the principles behind general equilibrium theories in their depiction of the whole economy and explore the different interactions among economic agents making decentralized decisions (Khor 1982). CGE models have been developed to address a series of theoretical questions and empirical/policy issues in different fields such as macroeconomics, international trade and environmental issues. The aim of this thesis is to use a dynamic CGE model to investigate the impact of trade liberalization on the

Malaysian economy. More specifically, we want to study the effects of a cut in motor vehicle tariffs on the labour market in Malaysia, i.e., the impact on wages and employment, as well as the labour supply.

1.2   Main Contributions

This thesis contains two extensions to the existing pool of research. They are:

(i)   Introduction of the Labour Supply with Nine Different Occupational Groups

I extend the dynamic computable general equilibrium (CGE) framework for Malaysia (the MyAGE model) to study the labour market in the Malaysian economy by modifying the labour market specification of Dixon and Rimmer (2003; 2008). My Malaysian version of this specification has seven parts: (i) Workers are categorized into nine different occupational groups; three skilled occupations (LegSenOffMan, Professional or TechAssProf); five semi-skilled occupations (Clerical, ServiceSales, SklAgriFish, CraftTraders or PlantMachOpr) and one unskilled occupation (ElementOcc); (ii) The labour force is divided into categories at the start of each year to reflect workforce functions in the previous year, (iii) Workforce activities are defined as what workers do during the year, (iv) Labour supply is generated from each category to each activity by solving optimization problems describing the behaviour of workers in each category, (v) Labour demand for workers in each activity is generated by solutions to optimization problems describing the behaviour of firms, (vi) Wage adjustment processes are specified reflecting both the demand and supply of labour; and (vii) A process is described to determine everyone's activity, i.e., who gets the jobs and what happens to those who do not. In Dixon and Rimmer (2003; 2008), the labour market is modelled to investigate the effects of reducing illegal immigrants. In the dynamic CGE model for the Malaysian labour market, MyAGE_LM, I assume that there are no illegal immigrants and everyone is a Malaysian citizen. The labour force specification in MyAGE_LM is a simplified version of the model specification by Dixon and Rimmer (2003) and Dixon et al. (2010).

(ii) The Analysis of a Reduction in Motor Vehicle Tariffs in Malaysia

Malaysia is a small open economy. The effects of a reduction in tariffs on the labour market, i.e., occupational wages and employment are investigated using the MyAGE_LM model. Tariffs played an important role in Malaysia's economic development; from an import-substitution economy towards the direction of industrial development, which depended on the expansion of export-oriented activities (Athukorala and Menon 1999). Literature studying the impacts of trade, wages and employment for Malaysia is very limited. This is because of the inadequacy of occupational data for carrying out any substantive analysis to show the impact of a tariff reduction. Hence, using econometric techniques to investigate the impact of tariffs on occupational wages and employment would not be sufficient to generate sensible results. Fortunately, the dynamic CGE model provides a strong foundation for investigating the short and long run effects of trade, wages and employment.

However, we need to note that the main focus of this thesis is not the impact of trade on wage inequality and employment per se, but rather how a tariff cut affects the Malaysian labour market in general. In addition to looking at the effects on occupational wages and employment (demand side), we investigate what happens to the labour supply. We present detailed simulation results at both the macro and industry levels. To the best of my knowledge, no study on wages and employment has been carried out using a dynamic CGE approach to analyze the impact of a reduction in motor vehicle tariffs in Malaysia.

1.3   Outline of Thesis

This study contains seven chapters (including the Introduction and Conclusion chapters) and three appendices. The current chapter introduces the topic under investigation by providing a statement of issues and motivations. It also outlines the main contributions of the study.

Chapter 2 provides an introduction and an overview of the Malaysian economy, as well as the evolution of its trade policy since independence. The trends in Malaysia's wages and employment are highlighted. In addition, this chapter reviews the main features of computable general equilibrium (CGE) models and the technical aspects of CGE modelling to illustrate why I have chosen this approach for investigating trade policy in Malaysia.

Chapter 3 introduces the dynamic CGE model for the Malaysia, MyAGE, and explains the labour market extension made for this study. The extended version is referred to as the MyAGE_LM model. MyAGE and MyAGE_LM are single country models of the Malaysian economy based on the MONASH-style dynamic Applied General Equilibrium model. The chapter begins by deriving a group of model equations from optimization problems (cost minimization, utility maximization, etc.) which underlie the behaviour of economic agents in the economy based on neoclassical microeconomic theory. Details on the labour market extension are given in the later part of this chapter.

Chapter 4 documents the construction of the MyAGE_LM database. This includes input-output data and other parameters and coefficients that are used for the successful implementation of the MyAGE_LM model for investigating the impact of the motor vehicle tariff reduction on the labour market in Malaysia.

Chapter 5 provides a detailed discussion on the closures used in the MyAGE_LM model; the historical, forecast and policy closures and how they are applied in the GEMPACK (General Equilibrium Modelling Package) version of MyAGE_LM described in Chapter 3.

In Chapter 6, I provide a description of how the MyAGE_LM tariff cut policy simulation is set up. This chapter also provides a detailed analysis of the macro results using a back-of-the-envelope (BOTE) model developed for this purpose. Results at the industry and occupational levels are analyzed using regression techniques.

Chapter 7 concludes and provides a discussion of results, along with direction for future research from the development of MyAGE_LM.

CHAPTER 2

OVERVIEW OF THE MALAYSIAN ECONOMY AND COMPUTABLE GENERAL EQUILIBRIUM (CGE) MODELS

2.1 Introduction

This chapter presents an overview of the Malaysian economy by highlighting Malaysia's growth trends and economic development. The evolution of Malaysia's trade liberalization is discussed, along with the presentation of wage and employment trends of skilled, semi-skilled and unskilled workers. We illustrate how CGE models are useful in carrying out policy-induced analysis.

The chapter is organized as follows. Section 2.2 provides an overview of Malaysia's growth performance, which makes it an interesting case study to investigate the effects of tariffs on occupational wages and employment. Section 2.3 illustrates Malaysia's economic development since gaining independence, while Section 2.4 highlights Malaysia's tariff policy experience. The discussion of the basic features, performance and trade policy of the Malaysian economy provides the framework for the analysis of the effects of a reduction in motor vehicle tariffs on the labour market. The trends for selected occupational wages and employment in Malaysia are presented in Section 2.5. Due to data limitations, only selected occupational data in the manufacturing industry from 1985 to 2005 is presented. Section 2.6 introduces computable general equilibrium (CGE) models. Section 2.7 discusses the technical aspects of CGE modelling in detail. This section highlights the solution methods, dynamics and regional extensions of CGE modelling. Section 2.8 concludes.

2.2 Brief Overview of the Malaysian Economy

Malaysia is a country in South East Asia, consisting of thirteen states and three Federal Territories. Located between 2 and 7 degrees north of the Equator, Peninsular Malaysia is

separated from the states of Sabah and Sarawak by the South China Sea. To the north of Peninsular Malaysia is Thailand while its southern neighbour is Singapore. Sabah and Sarawak are bounded by Indonesia while Sarawak also shares a border with Brunei. Malaysia has a total land area of 329,847 square kilometres and population of around 28 million (Malaysia Department of Statistics (DOS) 2011). Malaya (current Malaysia) was a British colony from 1874 to 1946. It was occupied by Japan from 1942 to 1945. The British-ruled territories on the Malaya Peninsula formed the Federation of Malaya in 1948 and gained independence on the 31st August 1957. In 1963, the Federation of Malaya merged with other former British colonies to form Malaysia. Since then, Malaysia has moved from an agriculturally based economy to a more diversified and export-oriented economy along with a high trade/GDP ratio. Figure 2.1 shows the growth rate in the Malaysian economy from 1970 to 2010.

Figure 2.1   Real GDP Growth Rate (%) in Malaysia from 1970-2010
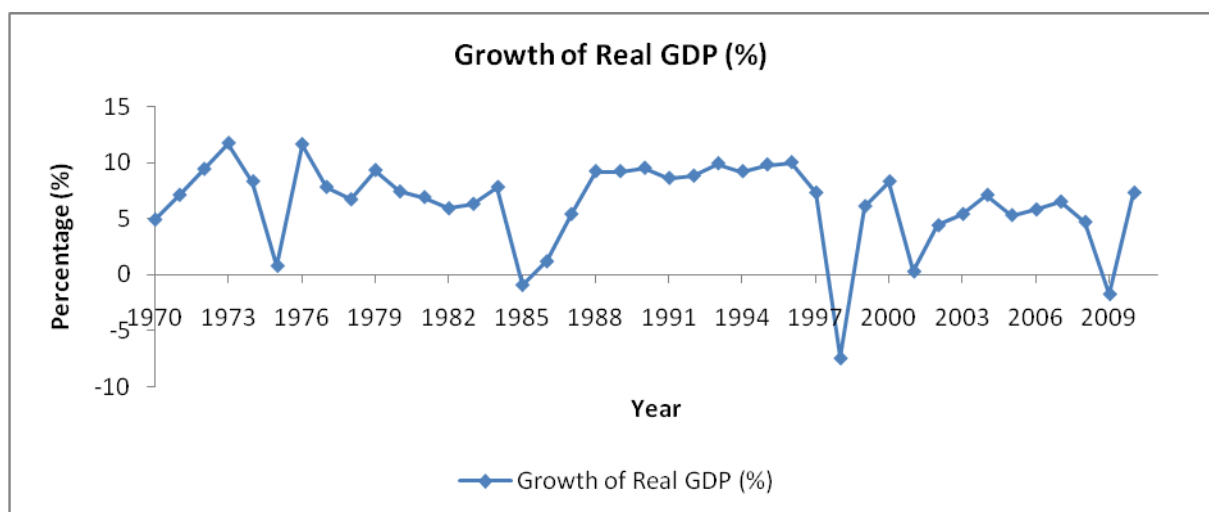
Source: IMF World Economic Outlook (WEO) Database

In the early 1970s, there was a shortage of capital in Malaysia, resulting in a low capital-labour ratio and slowing rates of technological improvement. During this period, the main economic activity was in agriculture and other labour intensive industries such as textiles and garments and electrical machinery. Labour intensive industries were able to exploit the abundance of cheap labour. Most of the output produced was exported to industrialized countries such as the US and Japan. In the mid-1970s, there was a clear improvement in Malaysia's performance in its manufacturing industry because of significant investment in

machinery and equipment facilitating the adoption of more advance technologies. The high rate in the accumulation of capital, coupled with the increase in skill development led to an improvement in labour productivity which averaged 3.6 per cent a year from 1970 to 1980 (Yusoff et al. 2000). Also, during this period, the manufacturing sector experienced an annual growth rate of 22.9 per cent. This was sparked by the boom in export-orientated and labour intensive industries, such as electronics, textiles, and wool products. Another factor contributing to this impressive performance was the efforts of the Malaysian government in attracting and promoting export-orientated industries through the establishment of free-trade zones (FTZs) in the early 1970s. During that period, economic growth was on average 7.9 per cent due to strong performance of the manufacturing industries.

The global recession in 1975 following the oil shock crisis saw the growth of real GDP drop from 8.3 per cent in 1974 to only 0.8 per cent in 1975. Due to the sharp decline in the growth rate, the Malaysian government responded by significantly increasing spending on public investment projects. By 1979, real GDP growth rebounded to 9.3 per cent as a result of the increase in public investment spending in helping spur economic recovery. Because of the prolonged global economic recession in the early 1980s, real GDP growth averaged only 6 per cent.

Malaysia fell into another recession in 1985, with an annual growth rate of -0.9 per cent. This was caused by the collapse in the prices of several of the main export commodities. As a result, total exports decreased by 1.6 per cent in 1985 and 6.2 per cent in 1986. Following the improvement of external conditions that led to an improved performance in the export sector, the Malaysian economy recovered and managed to achieve an annual growth rate of 9.3 per cent during the period 1988 to 1990. In addition, a second round of export-orientation was initiated in the late 1980s. There was substantial growth in the Malaysian economy in the 1990s, where the annual average growth rate was 9.4 per cent during the period 1991 to 1996. This strong growth was mainly due to active promotion of the private sector as the main driver of economic development.

In 1997, Malaysia was badly affected by the Asian financial crisis and real GDP growth dipped significantly to -7.4 per cent. From 1997 to 2003, the economy recorded an average growth rate of only 3.5 per cent. Various macroeconomic and financial sector policies were established to tackle the crisis, which managed to help the economy recover in 1999 (growth

of real GDP of 6.1 per cent). Nevertheless, growth faltered to a mere 0.3 per cent in 2001 during the world trade recession. The Malaysian economy recorded an average growth rate of 5.6 per cent from the years 2002 to 2005.

In 2007, GDP grew by 6.5 per cent because of the growth of both foreign and private investments in the economy. This included the implementation of major projects such as the Penang Second Bridge and the Southern Johor Economic Region projects. GDP growth in Malaysia remained positive until 2009. In 2009, GDP growth dipped to -1.71 per cent, caused by the financial crisis in 2008. Despite experiencing negative growth, Malaysia's economy managed to bounce back and grow by 4.5 per cent in the first quarter of 2010. Overall GDP growth in 2010 was 7.3 per cent.

Over the past 40 years, despite going through three recessions, one Asian and one global financial crisis, Malaysia still managed to achieve sustainable economic growth from 1970 to 2010, with an average growth rate of around 6.5 per cent. A key aspect to the main success for Malaysia is the growth in the manufacturing industry. In 2003, the contribution of manufacturing products to total exports increased from 22 per cent in 1980 to 82 per cent. The most dynamic sector is the electronics sector, with Malaysia now one of the world's major exporters of semi-conductors and electronics components. According to Dollar and Kraay (2004), Malaysia was quoted as one of the world's 24 post 1980 'globalizes'.

Malaysia's growth performance makes it an interesting case study with regards to the impact of a reduction in tariffs on the labour market. As seen from Table 2.1, the country has good macroeconomic management, with low levels of inflation and unemployment since the 1980s. The only exception is the high unemployment rate of 6.9 per cent between 1986 and 1990 caused by world recession.

Table 2.1   Inflation Rates and Unemployment Rates (%), 1981-2010

Period	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2010
Inflation (% per annum)	3.2	1.4	3.6	3.6	1.9	3.6
Unemployment (% per annum)	3.3	6.9	3.4	2.9	3.5	4.2

Source: International Monetary Fund (IMF), International Financial Statistics (IFS) Yearbook (various issues).

Table 2.2   Exports and Goods and Services, Malaysia (1970-2010)

Variable	1970	1980	1990	2000	2010
Exports of goods and services*	5389	30676	88675	427004	639428
Imports and goods and services*	4888	29342	8624	358530	529195
GDP at purchaser's price	11829	53308	119081	343215	559554
Exports of goods as % of GDP	45.6	57.5	74.5	124.4	114.3
Imports of goods as % of GDP	41.3	55	72.4	104.5	94.6
Total % of GDP	86.9	112.5	146.9	228.9	208.9

Source: UNDP (2006); Malaysia DOS
* RM Million

The trade liberalization process in Malaysia has been linked with the increase in trade flows. The share of foreign trade (exports and imports) to GDP increased from 86.9 per cent in 1970 to 208.9 per cent in 2010 (Table 2.2). Malaysia is one of the most open economies among developing countries. As a percentage of GDP, exports of goods and services increased from around 46 per cent in 1970 to 114 per cent in 2010. Over the same period, the share of imports as a percentage of GDP increased from 41 per cent to 95 per cent. Export shares increased relatively higher than that of import shares. This improved the balance of trade on goods and services in Malaysia. The sharp increase in export shares over the four decades stem from Malaysia's growth from import-substitution industrialization (ISI) towards the direction of industrial development, which depended on the expansion of export-oriented activities.

Tariffs played an important role in Malaysia's economic development from import-substitution towards the direction of industrial development. Simulations with a model of the type developed in this thesis could potentially influence future policy making by the Malaysian government with regards to tariffs.

2.3   Malaysian Economic Development (1965-Present)

Before discussing Malaysia's tariff policy experiences, this section highlight's Malaysia's economic development from the time of independence to the present.

2.3.1 Post Independence to Riot Phase (1965-1969)

Before gaining independence, Malaysia specialized in the production and export of processed rubber and tin, in return for the imports of food and manufacturing goods. Thus, during the time of independence, the country was heavily dependent on rubber and tin exports. By the late 1960s, Malaysia moved from the stage of import-substitution towards the direction of industrial development, which depended on the expansion of export-oriented activities (Athukorala and Menon 1999). Among the investment incentives provided by the Malaysian government in the move towards industrialization were: (1) The Investment Incentives Act (1968), where tax holidays were granted to pioneer status firms, based on the nature, content of the product and location.

2.3.2 The New Economic Policy Phase (1970-1990)

There was already diversification in the agricultural industry, where in addition to timber and palm oil being important export commodities, the production of crude petroleum began to gain significance. However, the New Economic Policy (NEP) was implemented in 1970 following the racial riots on May 13th 1969. The basic philosophy of the NEP was to maintain national unity through two main objectives; (1) Eradicating poverty through an overall development strategy by emphasizing export-oriented industrialization and (2) Restructuring of the society, where long-term targets were established to increase the ownership share of capital in limited companies for the Malays, as well as increasing the share of Malays

employed and holding managerial positions in the manufacturing industry (Athukorala and Menon 1999). Under the NEP policy, the government aimed to increase Malay share in corporate assets from 2 per cent in 1970 to 30 per cent in 1990. The participation of the Malays in business was encouraged in two ways: (i) Through the expansion of the public sector, most of the key positions were held by the Malays and (ii) By providing Malays with privileged access to share ownership and business opportunities in the private sector. In 1975, an Industrial Coordination Act (ICA) was enacted to increase Bumiputera participation at the enterprise level, by imposing licensing on both small and medium scale enterprises.

Throughout the 1980s, economic diversification, along with deregulation and financial liberalization helped transform Malaysia into a middle-income emerging market by the end of the decade. In 1983, the prolonged world recession following the second oil shock in 1979 caused a slowdown in the country's growth. The Malaysian government responded by instituting structural adjustment during 1984 to 1990, which included restraining public sector expenditure to reduce budgetary deficits, adopting a private sector growth strategy, introducing deregulation and improving investment policies and incentives to promote private sector participation, as well as privatizing public sector enterprises. In 1987, the economy recovered, with a surplus in the balance of payment of RM6.6 billion. Also, the manufacturing sector accounted for 22.6 per cent of GDP, surpassing the agriculture sector for the first time. In addition, by 1989, Malaysia transitioned from a public sector economy to a private sector driven economy as private sector growth exceeded that of the public sector.

2.3.3 From NEP to the National Development Policy (NDP) (1991-2000)

The NEP came to an end in 1990, replaced by the National Development Policy (NDP), which involved the removal of some of the strict investment requirements under the NEP. New dimensions were added to the NDP, which included the shift in focus on anti-poverty towards the eradication of hard core poverty, and at the same time decreasing relative poverty, emphasizing the increase in employment, greater reliance on the private sector in the restructuring objective and the development of human resources to promote labour force productivity. In 1986, the Promotion of Investment Act was introduced to promote more private investors, as well as reducing some of the strict ethnic requirements of the NEP (Ching 2008). There was also a relaxation in the foreign equity participation requirements as

well as allowing up to 100 per cent foreign ownership of export-oriented companies. To further encourage more foreign investment, work permit requirements for foreign employees of companies with foreign-paid up capital of US$ 2 million and above were relaxed.

Prior to the Asian Financial crisis in 1997, Malaysia sustained a strong economic performance. This period was viewed as the golden age of economic growth for Malaysia. There was a reduction in the current account deficit, unemployment was below 3 per cent, inflation rate was at 3.5 per cent and exchange rate was stable at RM 2.5 per USD. The sustained economic growth was caused by technological innovation and positive external forces.

Malaysia went into recession following the Asian Financial crisis. Market confidence shrank with the rest of the region's members. The drop in the ringgit led to a fall in investor confidence, as it was believed that all major Malaysian companies were likely to go bankrupt and small and medium enterprises would not survive the crisis (Noordin 1998 cited in Yusoff et al. 2000). The crisis caused a dramatic depreciation of the ringgit by over 35 per cent against the US dollar. The contraction in economic growth was accompanied by a high increase in the cost of borrowings and the withdrawal of bank lending and credits. The initial response was to increase interest rates and to tighten fiscal policy in order to build market confidence.

To tighten the control on capital mobility, the Malaysian government implemented capital control on the 1st of September 1998. The aim was to restrain non-residents from speculating on capital transactions by eliminating ringgit-based transactions outside of Malaysia. This implied that the ringgit had no value outside of Malaysia. One of the hoped for benefits of such constraints was increased efficiency of capital allocation and prevention of external capital transactions from affecting the domestic economy. Non-residents were required to gain permission in order to transfer capital between their accounts and the use of money owned was only limited to purchasing assets in Malaysia. These measures undertaken by the government managed to ease the liquidity problem as ringgit denominated assets outside Malaysia would have to flow back home. On the 2nd of September 1998, the Malaysian government announced a fixed exchange rate system with a fixed rate of RM3.8 per USD.

By 1999, Malaysia's economy started to recover. The gradual easing of capital controls helped promote investor confidence. The improved economic conditions, coupled with an increase in world demand for electronics and the imports of intermediate goods enabled the build-up of international reserves, decreased unemployment and lowered the inflation rate. In the later part of 2000, the heavy dependence on electronic exports made Malaysia very sensitive to the global slowdown in information technology. In May 2003, to stimulate the economy's growth, the Malaysian government introduced the Package of New Strategies, aimed at increasing private sector investment, strengthening the country's competitiveness, developing new sources of growth and improving the efficiency of the delivery system.

2.3.4 National Vision Policy (NVP) (2001-Current)

The National Vision Policy (NVP) incorporates the main strategies of NEP and NDP as well as encapsulating new policy dimensions. The new dimensions focused on the development of Malaysia into a knowledge-based economy, generating endogenously-driven growth and achieving at least 30 per cent of Bumiputera[2] participation (corporate equity ownership and preference accorded to Bumiputera companies in relation to the grant of permits or licences or business under Article 153(6) of the Federal Constitution) by 2010. Also, an Investment Tax Credit was implemented, where those who were not qualified for entrepreneur status were given tax exemption on a certain percentage of investment expenditure. The aim was to encourage an increase in private spending, as well as encourage an increase in the construction sector to build up the tourism industry. Table 2.3 provides a summary of the major economic policies set out by the Malaysian government in the developing planning horizon for Malaysia.

---

[2] Bumiputeras and Malays are used interchangeably without any loss in meaning.

Table 2.3   Summary of Economic Policies in Malaysia

Period	Policy	Focused Issue
1957 – 1970	Post-independence	Laissez-faire/Export-Orientated Economic and Rural Development
1971 – 1990	New Economic Policy (NEP)	Growth with Equity
1991 – 2000	National Development Policy (NDP)	Balanced Development
2001 – 2010	National Vision Policy (NVP)	Building a Resilient and Competitive Nation
2011 - 2020	Vision 2020	Total Development

Source: Ching (2008)

2.4   Tariff Policy in Malaysia

Having highlighted Malaysia's growth and economic development over the past forty years, we now look at the tariff policy. Major policies related to economic liberalization and structural adjustment were carried out post-independence. These policies were generally linked with supply side oriented policies. Malaysia started its industrial transformation by adopting an import-substitution strategy in order to encourage the growth of domestic industries that produced simple consumer goods. The nominal average tariff rates in Malaysia from 1965 to 2009 are shown in Figure 2.2 below.

Figure 2.2   Average Nominal Tariff Rate (1965 – 2009)
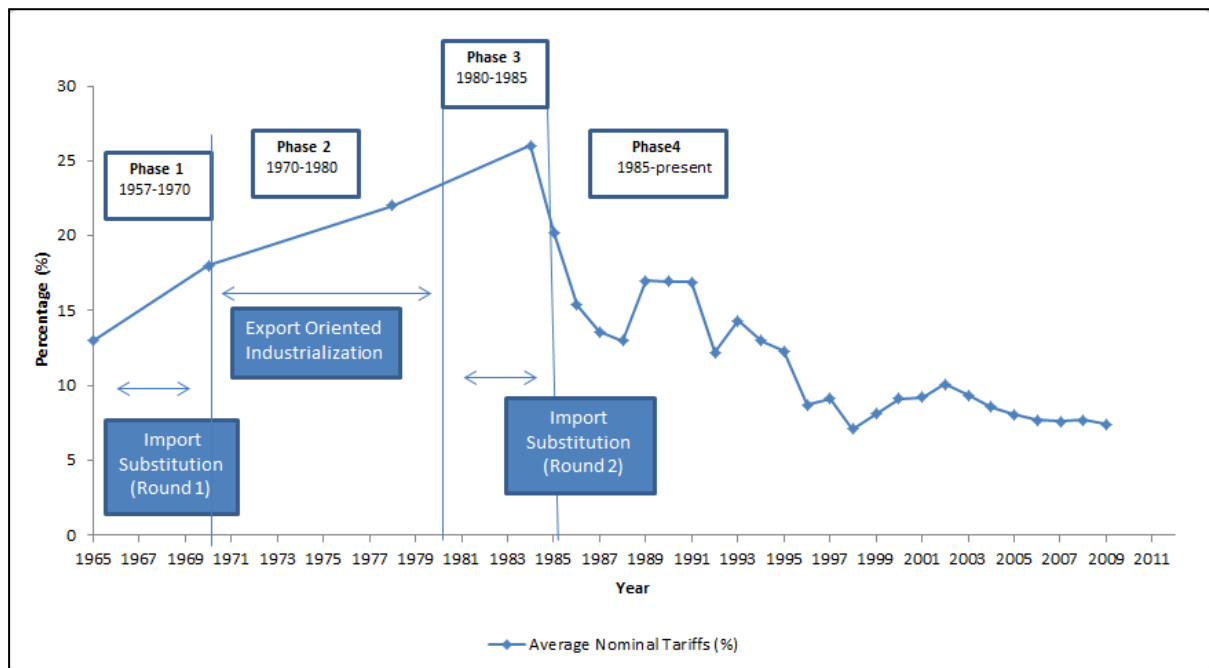
Sources: Athukorala (2001, 2005), UNDP (2006) and the author's calculations, where missing values were calculated by taking the average value of data for the year before and the year after.

From Figure 2.2, it can be seen that through its open and export-orientated economy, Malaysia has progressively liberalized its trade as the economy shifted away from a reliance on the export of primary commodities. From the years 1986 to 1990, the average tariff rate was 15 per cent. Over the periods of 1996 to 2002, the average tariff rate fell to 9 per cent, similar to that of Korea and Taiwan. Being a member of ASEAN and under the ASEAN Free Trade Agreement (AFTA), import tariffs were significantly decreased. Malaysia's trade liberalization policies have given preference to intra-ASEAN trade, and are divided into four key phases, discussed below:

Phase I (1957-1970)

Before gaining independence, Malaysia exported primarily processed rubber and tin and imported food and manufactured goods. Tariffs were imposed to protect selected infant industries producing consumer goods. The import-substitution industrialization (ISI) during the 1960s focused on tariff protection, import restriction and investment incentives to facilitate industrial development. In 1965, the average tariff rate in Malaysia was 13 per cent

(Athukorala 2005). In that period, very few quantitative restrictions were used to limit the quantity of imports.

Phase II (1970-1980)

From 1970 to 1980, export-oriented industrialization was introduced, with the establishment of free trade and export processing zones. The protectionism measures implemented during the import-substitution phase were mild, and this made the transformation to an export-oriented industry relatively smooth. Incentives were provided to encourage the exports of manufactures. However, as part of a heavy industrialization move by the government, average nominal tariffs on manufactured goods increased from 22 per cent in 1978 to 26 per cent in 1984 (Athukorala 2005). Also, following the May 13 riots in 1969, some elements in the implementation of the New Economic Policy (NEP) ran counter to the country's commitment to attracting foreign investors. These included increasing the share of native Malays in the corporate sector, to reserve certain percentage of employment in foreign ventures for these people and a ceiling of 30 per cent on foreign ownership in businesses operating in Malaysia. Nevertheless, the Malaysian government did take steps to improve the adverse effect of these measures on the strictures on export-oriented activities. One of the incentives granted to encourage export performance is the establishment of free trade and export processing zones.

Phase III (1980-1985)

A second round of import-substitution measures for heavy industries were introduced by the Malaysian government from 1980 to 1985, which included the automobile, petrochemical, iron and steel, and cement industries. Under this policy, high protection was given to the chosen industries in the form of high import duties, or import restrictions for competing products. This policy is best illustrated by the tariff structure of the automotive industry. With the advent of the first national car, Proton, the import of completely built cars was limited by a predetermined number. Also, the import duty of completely knocked down (CKD) parts (main components imported and assembled locally) for non-national cars was raised, while the national car manufacturers enjoyed a lower duty for similar imports. CKD tariffs on a

wide range of manufactured goods increased substantially in the early 1980s as a part of a move towards heavy industrialization (UNDP 2006).

Phase IV (1985-present)

Major reforms were carried out in the late 1980s following the economic crisis during the periods from 1985 to 1987, which was caused by the combination of budget deficits due to the heavy industrialization move and trends in Malaysia's major export prices,. Among measures undertaken were the introduction of a structural adjustment reform package, including significant tariff reductions and the removal of quantitative restrictions. There was also a second round of export-orientation through a cluster-based approach. The post 1985 recession resulted in a significant reduction in the average tariff rate of the manufacturing industry to below 30 per cent. Because the protectionist policies implemented during the import-substitution phase was not as significant, by 1986, tariff rates in Malaysia decreased to 15.4 per cent. The government provided improved export incentives to encourage manufactured exports, as well as promotional and publicity efforts to attract foreign investment (Ching 2008). From the late 1980s and in the 1990s, a decrease in tariffs was further implemented as part of the Common Effective Preferential Tariff (CEPT) of the ASEAN Free trade Agreement (AFTA) and the commitments made to the WTO for greater liberalization. By 2005, there were only limited restrictions being applied in Malaysia's trade policy.

Malaysia experienced significant trade liberalization in phase IV. After gaining independence, import-duties were imposed mostly as a revenue-raising measure. During the 1960s and 1970s, more import tariffs were imposed in order to protect the emerging import-substituting industries. Tariffs were particularly high in the early 1980s as a part of a move towards heavy industrialization but gradually decreased in the late 1980s, especially with the launching of AFTA and commitments to WTO.

The decrease in the average tariff rates varied according to sectors. In the agricultural sector, Malaysia's tariff rates are less than 5.5 per cent, while the tariff rates for live animals are less than 4 per cent. Also, rates for fats and oils, mineral products, chemicals, as well as wood and wood articles do not exceed 2 per cent. Optical and precision instruments also attracted tariff

rates that were less than 2 per cent while fruits and vegetables have rates of around 2 per cent (UNDP 2006).

Tariff rates are particularly high in textiles and apparel (17 per cent); prepared foodstuffs (11 per cent); plastics (15 per cent) and footwear (19 per cent). For the purpose of this thesis, in the simulation carried out in Chapter 6, the tariff rate for motor vehicles is 11.4 per cent. This percentage is significantly lower than the motor vehicle tariff rate of 53 per cent mentioned in UNDP (2006). This is because the import duties for motor vehicles in the MyAGE_LM database include the import duties of passenger cars, commercial vehicles, busses, trolley busses and coaches (Malaysia Standard Industrial Classification 2008; Malaysia Ministry of Finance 2007; CoPS 2010). The duties also include the duties for intermediate inputs in the production of the components of the motor vehicle parts. Import duties vary significantly across the different categories of motor vehicle imports, from very high rates to duty-free. The rate of 11.4 per cent used in this thesis is the trade-weighted average tariff rate[3]. In future work, I would like to experiment with different weighting schemes as described in Anderson et al. (2012).

Overall, Malaysia's tariff rate is relatively low. Malaysia has a long-standing commitment to maintaining a trade-liberalized and an open-investment policy regime. The main industry policies are listed in table 2.4:

Table 2.4   Summary of Incentives Provided by the Malaysian Government

Incentive	Description
Export Promotion Incentive	Those who intended to expand their facilities were entitled to this incentive
Free Trade Zone	Firms that built within the free trade zones were tax exempted
Subsidies, Tariff and Non-Tariff Protection	The Tariff Advisory Board, which was established to enhance import-substitution strategy, was abolished in 1970 and the task was taken over by the Federal Industrial Authority

Source: Ching (2008)

---

[3] Calculation of the 11.4 per cent motor vehicle tariff rate is found in Appendix A.6.

There are however some noteworthy anomalies in the structure of Malaysia's protection policy that encourage the channelling of resources into unproductive enterprises and projects. Specifically, the protection structure is characterized by a dualistic pattern where an export-oriented industrialization strategy under a free trade regime takes place together with a predominantly domestic market-oriented production assisted by tariff protection (Athukorala and Menon 1999). Also, Malaysia's trade policy includes very high tariff rates for a few product lines; e.g., certain automobiles, while tariff rates for other product lines are either non-existent or very low. This significant variation in tariff protection across sectors/industries implies sufficient room for future policy consideration.

2.5   Occupational Wages and Employment in Malaysia: Manufacturing

In this section, we highlight some trends and salient facts on occupational wages and employment in Malaysia from 1985 to 2005. Unfortunately, the only sector for which time series data is available is manufacturing.

Two different types of wage differentials are shown for manufacturing: the wage gap and wage ratio. The wage gap is the difference between wages of skilled, semi-skilled and unskilled workers, while the wage ratio is the ratio of the different skilled wages. Skilled, semi-skilled and unskilled workers are classified based on occupations (Masco 2008). Based on the definition and functions of workers in the selected occupation (due to unavailability of data), it is assumed that (Professionals and Non-Professionals[4]) and Tech and Supervisory occupations are skilled occupations. Clerical is assumed to be a semi-skilled occupation while (Driver and General) is the unskilled occupation. The annual occupational wage and employment data are obtained from the Malaysian Department of Statistics (DOS) based on the Malaysia Standard Classification of Occupation 2008 (Masco 2008) publication.

The average weekly wage rate is obtained by dividing the annual wages with the total number of people employed in each occupation and then dividing by the number of weeks in a year

---

[4] In this chapter, we use the term "non-professionals" based on the earlier occupational classification given by the Malaysian Department of Statistics. In the 2008 occupational classification and in the MyAGE_LM model, "non-professionals" can be classified as "Legislators, Senior Officials and Managers (LegSenOffMan)".

(52 weeks). The average weekly real wages for selected occupations in Malaysian manufacturing from 1985 to 2005 is shown in Figure 2.3.

Figure 2.3   Wage Gap, Malaysian Manufacturing (1985 – 2005)
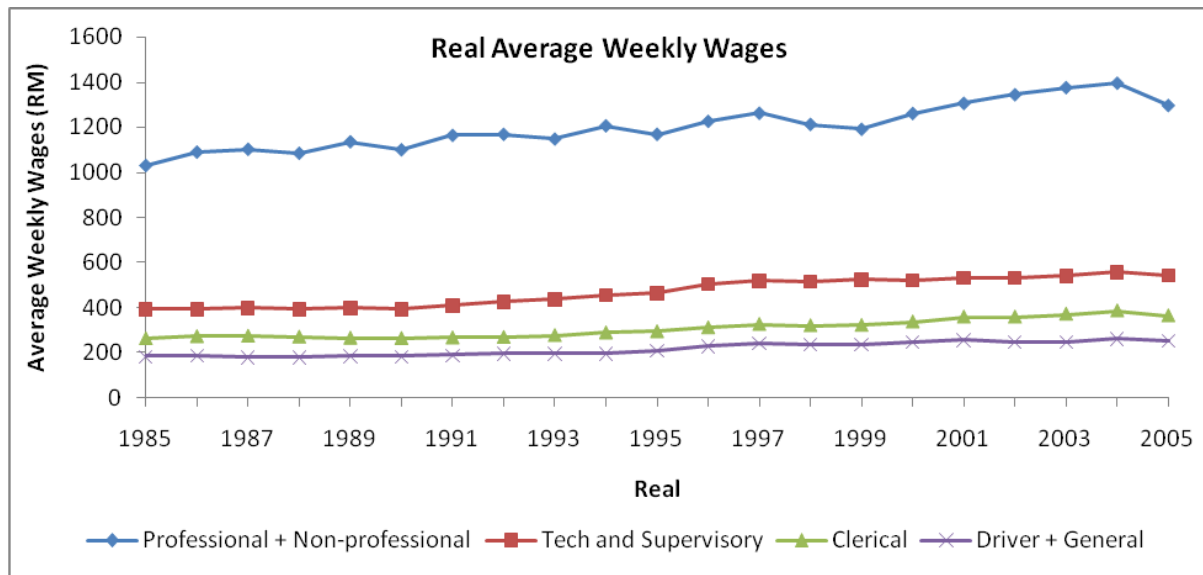
Source: Malaysia Department of Statistics (DOS)

From Figure 2.3, it can be seen that wage gap between skilled wages with semi and unskilled wages is fairly consistent throughout the years from 1985 to 2000. The wage gap increased slightly from 2000 to 2004 before decreasing in 2005. We can also see that there is a consistent difference in the wages within the skilled occupations, where the average weekly real wages for Professionals and Non-Professionals are around 2.5 times higher than the wages in Tech and Supervisory occupations.

In addition, it can be seen that the average weekly wages for Clerical, Technical and Supervisory and General workers do not show much growth over the decades, compared to the wage rates for workers in the Professional and Non-Professionals occupations.

Figure 2.4   Selected Occupational Wage Ratios, Malaysian Manufacturing (1985-2005)
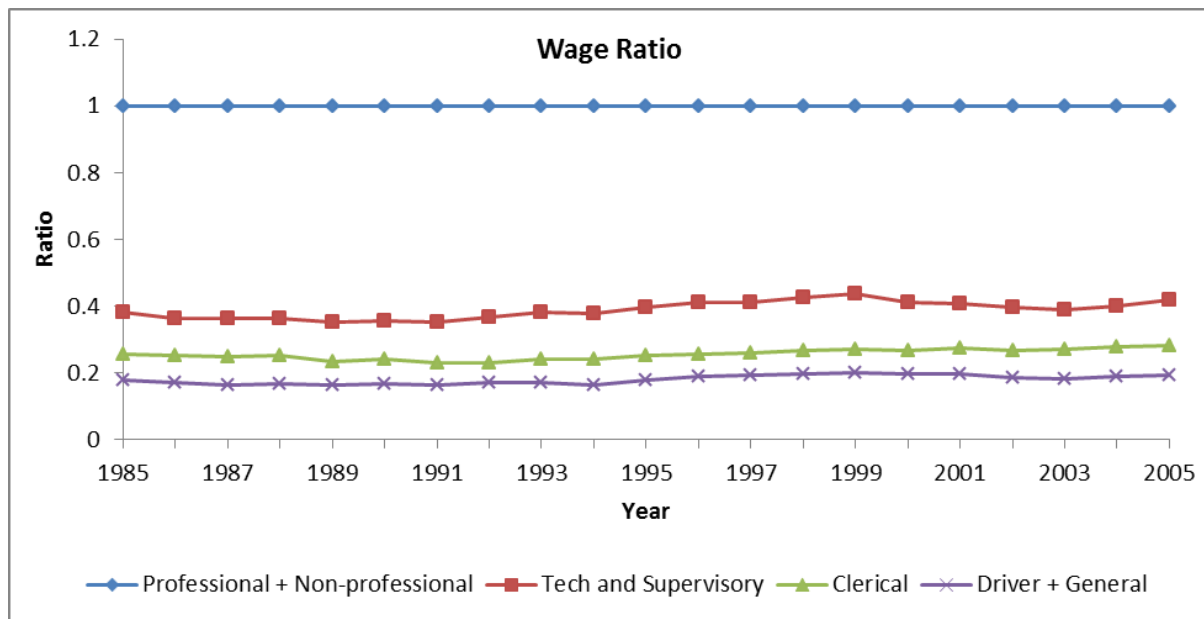
Source: Malaysia Department of Statistics (DOS)

Figure 2.4 shows the ratios of average weekly wages of skilled, semi-skilled and unskilled to the wages of Professionals and Non-Professionals for Malaysian manufacturing from 1985 to 2005. Wage inequality between Tech and Supervisory and Professionals and Non-Professionals decreased slightly from 1995 to 1999 before increasing again, while inequality remained fairly stable between the wages of Supervisory and Professionals with semi and unskilled wages. It is worth noticing that in the period where Malaysia experienced significant trade liberalization, with reductions in import tariffs (Figure 2.2) there was no significant changes in inequality. We can see that wage inequality is relatively steady despite Malaysia's continued process of trade liberalization.

Figure 2.5   Selected Occupational Employment, Malaysian Manufacturing (1985 – 2005)
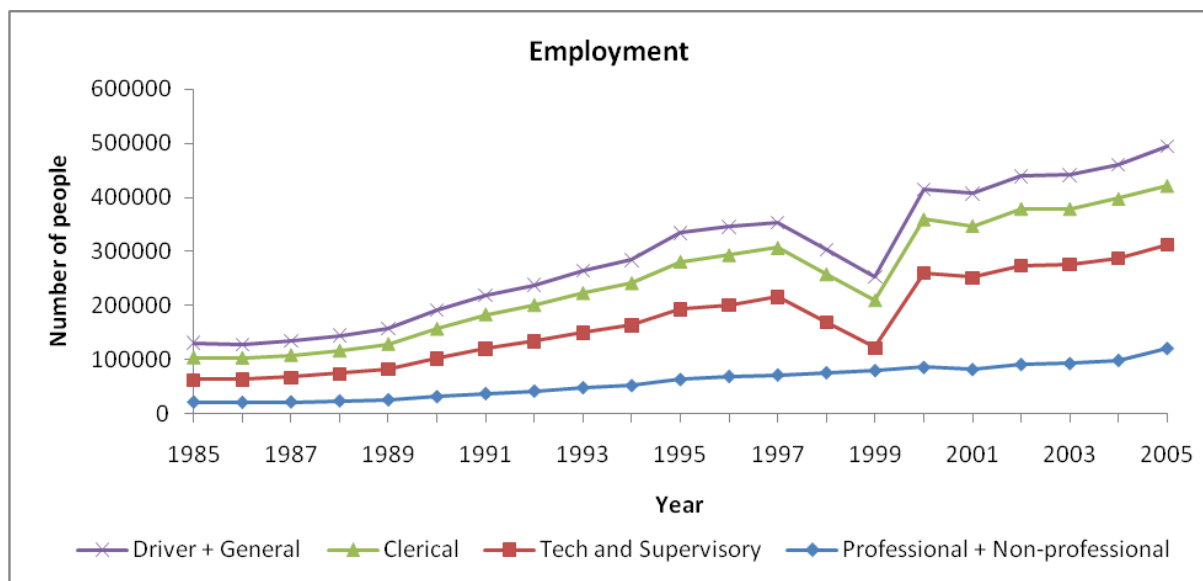
Source: Malaysia Department of Statistics (DOS)

Figure 2.5 shows a steady increase in employment for all occupations from 1985 up to 1997. The number of people employed as Drivers and General workers, Clerical and Tech and Supervisory dropped significantly in 1998 and 1999. This was caused by the Asian Financial Crisis in 1997 which badly affected Malaysia. In 2000, the Malaysian economy recovered and employment for workers in those occupations increased steadily over the years. The trend for employment of Professionals and Non-Professionals (skilled occupations) shows a steady increase despite the Financial Crisis in 1997. Even though the manufacturing industry was hit hard during the crisis, there was still an increase in demand for Professionals and Non-Professionals workers in this sector.

Figure 2.6   Selected Occupational Employment Ratios, Malaysian Manufacturing (1985 – 2005)
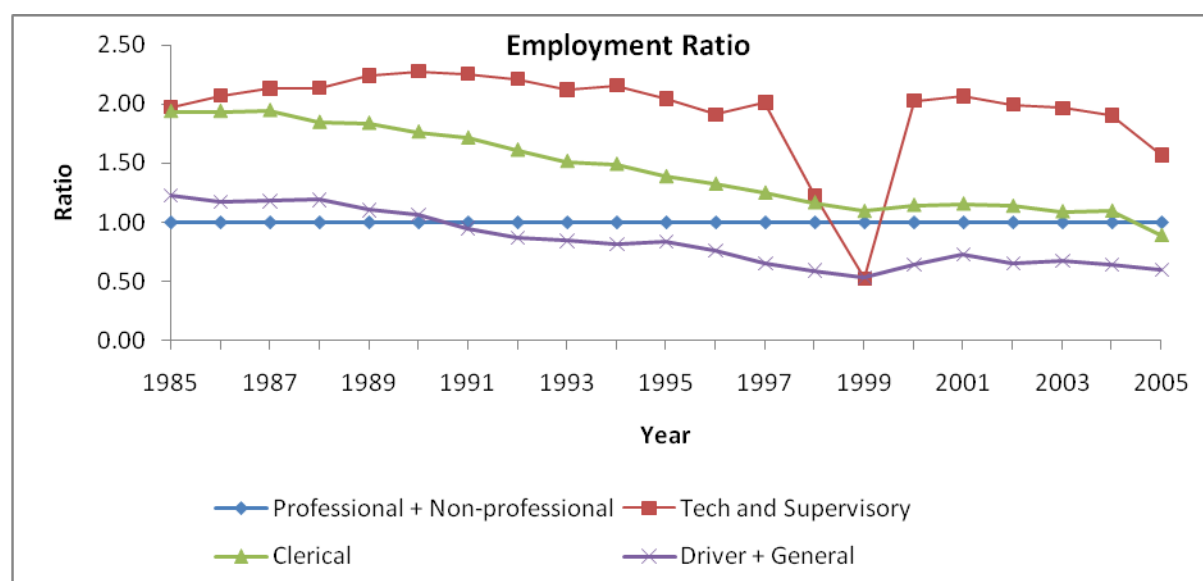
Source: Malaysia Department of Statistics (DOS)

Figure 2.6 shows the ratios of skilled, semi-skilled and unskilled employment to employment of Professionals and Non-Professionals in Malaysian manufacturing from 1985 to 2005. Firms in the manufacturing industry are employing less semi-skilled (Clerical) and unskilled (Drivers and General) workers, relative to more skilled workers (Professionals and Non-Professionals). This is shown by the downward trend in employment for the semi-skilled and unskilled occupations. As discussed in Section 2.4, Malaysia underwent a second round export-oriented phase in 1985. Hence, there would be an increase in the demand for more skilled workers in the manufacturing industry. Workers in the Tech and Supervisory occupational groups experienced a significant drop in employment during the Asian Financial Crisis even though they are considered skilled occupations (although less skilled in comparison to Professionals and Non-Professionals). As Malaysia recovered from the crisis, employment for workers in Tech and Supervisory occupational groups increased relative to Professionals and Non-Professional in 2000, but decreased in the following years. This shows a shift towards more capital intensive (skilled workers) industries within the manufacturing sector.

2.6 Features of a Computable General Equilibrium (CGE) Model

As illustrated in Section 2.5, there are limitations in the availability of occupational data for wages and employment in Malaysia. With the occupational data only available for the years 1985 to 2005 (and only for selected occupations in manufacturing), it is not possible to carry out policy analysis using econometric approaches. This section introduces the key features of CGE models and how they are used to address data limitations, as well as being used as a powerful tool for carrying out policy analysis.

Computable general equilibrium (CGE) models represent the principles behind general equilibrium theories in their depiction of the whole economy and explore the different interactions among economic agents making decentralized decisions (Khor 1982). General equilibrium theory and modelling have been developed to address a series of theoretical questions and empirical/policy issues in different fields such as macroeconomics, international trade and environmental issues. In the economy, prices, outputs and incomes are endogenously determined by the interaction of optimizing units of production and consumption.

One of the key features of CGE models, as compared to econometric models is that, while econometric models tend to be statistical, CGE models are more theoretical by unequivocally incorporating households and firms optimizing behaviour. Households decide on the demand for commodities and the supply of their endowments in order to maximize their utility, while firms choose the demand for inputs and decide on the supply of outputs in their profit maximizing decisions. These optimizing behaviours can be used to highlight the role of commodity and factor prices which influences the decisions made by firms and households, as well as to describe the behaviour of governments. In other words, they are *general* (Dixon 2008).

CGE models also describe the supply and demand decisions made by the economic actors in the economy, which determines the prices of commodities and factors. For each commodity and factor, equations are included such that the total demand in the economy does not exceed the total supply. This shows that the economic agents utilize market *equilibrium* assumptions.

CGE models also produce ***computable*** results, where coefficients and parameters in equations are estimated by reference to a numerical database. This allows the simulation of changes in policy and responses to exogenous shocks in the economy as well as the forecasting of macroeconomics variables (Chumacero & Hebbel 2004). CGE models are suitable to simultaneously carry out policy experiments for many countries, as well as capturing inter-sectoral linkage effects. In addition, CGE models are also able to address the issues of offsetting effects of trade liberalization working through inter-sectoral shifts, factor price adjustments and exchange rate changes which are not addressed by partial equilibrium models.

Another unique feature of CGE models is the data requirement, where basic national accounts for a single year are used. Generally, the estimation of econometric models require time series data, which may be a problem when studies are carried out for developing counties that do not have long historical times series data. Thus, CGE models provide a powerful tool for carrying out empirical analysis when faced with such limitations.

2.7   Technical Aspects of CGE Modelling

In this section, we look at three technical aspects of CGE modeling: solution methods, dynamics, and regional extensions.

2.7.1 Solution Methods

Many of the equations in CGE models are non-linear. We can solve CGE models using a levels approach in which the equations in their original non-linear forms are presented to the computer. Another approach involves presenting the equations to the computer as a system of linear equations in percentage changes and changes of the variables. The former approach is used widely at the World Bank and in America, as well as in Europe. It is often implemented with the GAMS (General Algebraic Modelling System) software. The second method of solving CGE models is common in Australia, and is now applied in Asian countries (China, the Philippines, Pakistan, Indonesia, Thailand and Malaysia). The percentage change approach is usually implemented with the GEMPACK (General Equilibrium Modelling

Package) software. In this thesis, I rely on the percentage change approach implemented in GEMPACK. Consequently, I will confine my discussion of solution methods to that approach. For a very detailed CGE model, the number of variables (n) and equation (m) can be very big. To avoid the computational problems in solving a large non-linear system, Johansen (1960) developed a system of linear equations to study the economy of Norway. This involves firstly converting the system of non-linear equations into a system of linear equations by taking total differentials of each equation.

For example, instead of writing the equation in the model as:

$$Y = K^{\alpha}L^{\beta} \tag{2.1}$$

where

- Y is output;
- K is capital;
- L is labour; and
- α and β are positive parameters summing to 1. Johansen writes this equation in a linearized form as:

$$y = \alpha k + \beta l \tag{2.2}$$

where

- *y, k* and *l* are the percentage changes in Y, K and L.

The Johansen-style model can be represented as:

$$Av = 0 \tag{2.3}$$

where
- A is an m x n matrix of coefficients and v is a n x 1 vector of percentage change or change variables.

The number of variables n is always greater than the number of equations m. Then, the linearized version of the m equations is solved in order to generate the effects of changes in the (n-m) exogenous variables on the m endogenous variables.

We can demonstrate Johansen's percentage-change approach in a simple example from Dixon et al. (1992).

We start with a system of equations represented as:

$$F(V) = 0 \tag{2.4}$$

where

- F is a vector function of m equations and V is a vector of variables in levels form.

Let (2.4) be represented by a system of two equations and three variables given as:

$$V_1^2 V_3 - 1 = 0 \tag{2.5a}$$

$$V_1 + V_2 - 2 = 0 \tag{2.5b}$$

where

- V_1 and V_2 are endogenous variables and V_3 is exogenous.

The Johansen approach uses an initial solution, V^I. The initial solution that I will adopt to satisfy equations (2.5a) and (2.5b) is $V_1^I = 1$, $V_2^I = 1$ and $V_3^I = 1$.

Assume that we want to find the effects on V_1 and V_2 from a shift in V_3 from 1 to 1.1. In this trivial example, it is easy to find these effects exactly:

$$V_1 = \left(\frac{1}{V_3}\right)^{1/2} \tag{2.5aa}$$

$$V_2 = 2 - \left(\frac{1}{V_3}\right)^{1/2} \qquad (2.5bb)$$

Substituting the required value for V_3 into (2.5aa) and (2.5bb) gives new values for V_1 and V_2 of 0.9535 and 1.0465 respectively. Hence, a 10 per cent increase in V_3 causes a 4.65 per cent reduction in V_1 and a 4.65 per cent increase in V_2.

The Johansen approach applied to this simple example is as follows. To solve a linearized version of (2.4) in a Johansen-style computation, we can express the changes or percentage changes in the endogenous variables as linear functions of the changes in our exogenous variables of the form:

$$A_1 y + A_2 x = 0 \qquad (2.6)$$

where

- y is a vector of percentage changes in the endogenous variables;
- x is the vector of percentage changes in the exogenous variables;
- A_1 has dimensions of m x m; and
- A_2 has dimensions of m x (n-m).

In order to solve the effect for changes in the exogenous variables on endogenous variables, we use an inverse matrix derive from (2.6):

$$y = -A_1^{-1}.A_2 x \qquad (2.7)$$

We can show the derivation of (2.6) and (2.7) using our example in equations (2.5a) and (2.5b).

Differentiating equation (2.5a):

$$\frac{\partial\left(V_1^2 V_3\right)}{\partial V_1}dV_1 + \frac{\partial\left(V_1^2 V_3\right)}{\partial V_2}dV_2 + \frac{\partial\left(V_1^2 V_3\right)}{\partial V_3}dV_3 = 0 \tag{2.5*aa}$$

$$\Rightarrow\ 2V_1 V_3 dV_1 + V_1^2 dV_3 = 0 \tag{2.5`aa}$$

Differentiating equation (2.5b):

$$\frac{\partial\left(V_1 + V_2\right)}{\partial V_1}dV_1 + \frac{\partial\left(V_1 + V_2\right)}{\partial V_2}dV_2 + 0 = 0 \tag{2.5*bb}$$

$$\Rightarrow\ dV_1 + dV_2 = 0 \tag{2.5`bb}$$

Writing (2.5`aa) and (2.5`bb) in matrix form:

$$\begin{bmatrix} 2V_1 V_3 & 0 & V_1^2 \\ 1 & 1 & 0 \end{bmatrix}\begin{bmatrix} dV_1 \\ dV_2 \\ dV_3 \end{bmatrix} = 0 \tag{2.8}$$

Converting (2.8) into percentage change gives:

$$\begin{bmatrix} 2 & 0 & V_1/V_3 \\ V_1/2 & V_2/2 & 0 \end{bmatrix}\begin{bmatrix} 100\left(dV_1\right)/V_1 \\ 100\left(dV_2\right)/V_2 \\ 100\left(dV_3\right)/V_3 \end{bmatrix} = 0 \tag{2.9}$$

With V_3 exogenous, using the initial solution with $V = V^I = (1,1,1)$, equation (2.9) can be written in a form corresponding to (2.6) as:

$$\begin{bmatrix} 2 & 0 \\ 0.5 & 0.5 \end{bmatrix}\begin{bmatrix} v_1 \\ v_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix}v_3 = 0 \tag{2.10}$$

Now we can proceed to the solution corresponding to (2.7) as:

$$\begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = - \begin{bmatrix} 2 & 0 \\ 0.5 & 0.5 \end{bmatrix}^{-1} \begin{bmatrix} 1 \\ 0 \end{bmatrix} v_3 \qquad (2.11)$$

$$\Rightarrow \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = \begin{bmatrix} -0.5 \\ 0.5 \end{bmatrix} v_3 \qquad (2.12)$$

where

- v_1, v_2 and v_3 can be interpreted as a vector of percentage changes away from the initial solution (1,1,1). With v_3 being 10, equation (2.12) gives v_1 as -5 and v_2 as +5. In other words, the Johansen solution suggests that a 10 per cent increase in V_3 causes a 5 per cent decrease in V_1 and a 5 per cent increase in V_2. This can be compared with the real solution obtained from equations (2.5aa) and (2.5bb), where the 10 per cent increase in V_3 causes a 4.65 per cent decrease in V_1 and a 4.65 per cent increase in V_2. These actual values differ from the percentage-change approach. This illustrates the linearization error. Linearization errors can be significantly reduced by breaking the changes in the exogenous variables into smaller steps. We can demonstrate this in the following example:

Consider the effects on V_1 and V_2 from a shift in V_3 from 1 to 1.2. Using equations (2.5aa) and (2.5bb), with $V_1^I = 1$, $V_2^I = 1$ and $V_3^I = 1.2$, we find that the real solution for V_1 and V_2 are 0.9129 and 1.0871 respectively. This suggests that a 20 per cent increase in V_3 causes an 8.71 per cent reduction in V_1 and an 8.71 per cent increase in V_2. Using the Johansen solution, from equation (2.12), with v_3 being 20, we find a 20 per cent increase in V_3 causes a 10 per cent decrease in V_1 and a 10 per cent increase in V_2. Instead of using a one-step Johansen procedure, we break the change in V_3 into smaller steps by using a 4-step Johansen procedure.

We start with:

$$\begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = B(V)v_3 \qquad (2.13)$$

where

- v_1, v_2 and v_3 are percentage changes in V_1, V_2 and V_3 and

$$B(V) = -\begin{bmatrix} 2 & 0 \\ V_1/2 & V_2/2 \end{bmatrix}^{-1} \begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} -0.5 \\ 0.5V_1/V_2 \end{bmatrix} \qquad (2.14)$$

The four-step procedure is as follows:

Step 1: Increase V_3 from 1 to 1.05 where $V_1 = 1$ and $V_2 = 1$

$$\begin{bmatrix} v_1 \\ v_2 \end{bmatrix}_{1,4} = B(V^1) * 5 \qquad (2.15)$$

$$= \begin{bmatrix} -0.5 \\ 0.5V_1/V_2 \end{bmatrix} * 5 \qquad (2.16)$$

$$= \begin{bmatrix} -0.5 \\ 0.5*1/1 \end{bmatrix} * 5 = \begin{bmatrix} -2.5 \\ 2.5 \end{bmatrix} \qquad (2.17)$$

where

- $(V)_{r,s}$ represents the rth step of the s-step procedure.

The new levels values for V_1 and V_2 are:

$$1*(1-0.025) = 0.975 \quad \text{and} \quad 1*(1+0.025) = 1.025 \qquad (2.18)$$

giving

$$(V)_{1,4} = (0.975,\ 1.025,\ 1.05)$$ (2.19)

From equation (2.19), we can see that the values of V_1, V_2 and V_3 has moved from $(1,1,1)$ to $(0.975,\ 1.025,\ 1.05)$.

Step 2: Increase V_3 from 1.05 to 1.1 where $V_1 = 0.975$ and $V_2 = 1.025$

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix}_{2,4} = B\left(V^I\right) * 4.762$$ (2.20)

$$= \begin{bmatrix} -0.5 \\ 0.5 * V_1/V_2 \end{bmatrix} * 4.762$$ (2.21)

$$= \begin{bmatrix} -0.5 \\ 0.5 * 0.975/1.025 \end{bmatrix} * 4.762 = \begin{bmatrix} -2.381 \\ 2.265 \end{bmatrix}$$ (2.22)

giving

$$(V)_{2,4} = (0.9518,\ 1.048,\ 1.10)$$ (2.23)

Step 3: Increase V_3 from 1.10 to 1.15 where $V_1 = 0.9518$ and $V_2 = 1.048$

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix}_{3,4} = B\left(V^I\right) * 4.545$$ (2.24)

$$= \begin{bmatrix} -0.5 \\ 0.5 V_1/V_2 \end{bmatrix} * 4.545$$ (2.25)

$$= \begin{bmatrix} -0.5 \\ 0.5 * 0.9518/1.048 \end{bmatrix} * 4.545 = \begin{bmatrix} -2.273 \\ 2.064 \end{bmatrix}$$ (2.26)

giving

$$(V)_{3,4} = (0.930, 1.07, 1.15) \tag{2.27}$$

Step 4: Increase V_3 from 1.15 to 1.2 where $V_1 = 0.930$ and $V_2 = 1.07$

$$\begin{bmatrix} v_1 \\ v_2 \end{bmatrix}_{4,4} = B(V^I) * 4.348 \tag{2.28}$$

$$= \begin{bmatrix} -0.5 \\ 0.5 V_1 / V_2 \end{bmatrix} * 4.348 \tag{2.29}$$

$$= \begin{bmatrix} -0.5 \\ 0.5 * 0.930/1.07 \end{bmatrix} * 4.348 = \begin{bmatrix} -2.174 \\ 1.89 \end{bmatrix} \tag{2.30}$$

giving

$$(V)_{4,4} = (0.91, 1.09, 1.2) \tag{2.31}$$

A comparison of the solutions for V_1 and V_2 obtained from V_3 shifting from 1 to 1.2 using the different solution methods are summarized in Table 2.5 below:

Table 2.5   Solutions for V_1 and V_2 when V_3 shifts from 1 to 1.2: True Solution versus the Johansen 1-Step Procedure and Euler Method

Endogenous Variables	$V_1 (\%)$	$V_2 (\%)$
Initial values	1	1
Estimated values after an increase in V_3 from 1 to 1.2		
True solution*	-8.71	8.71
Johansen 1-Step Procedure**	-10	10
Euler 4-step Method***	-9	9

*   Calculated from equations (2.5aa) and (2.5bb).
**   Calculated from equation (2.12).
*** Calculated from equations (2.13) and (2.14).

Table 2.5 compares the true solutions for V_1 and V_2 when there is a move in V_3 from 1 to 1.2 with solutions obtained using the 1-step Johansen procedure and the Euler method. In equation (2.31), from the four-step Johansen procedure, a 20 per cent increase in V_3 induces a 9 per cent decrease in V_1 and a 9 per cent increase in V_2. This is compared with the real solution from equations (2.5aa) and (2.5bb), where the 20 per cent increase in V_3 causes a 8.71 per cent decrease in V_1 and a 8.71 per cent increase in V_2. In contrast, using the 1-step Johansen procedure, from equation (2.12), we find V_1 decreases by 10 per cent and V_2 increases by 10 per cent. This shows that breaking the change in V_3 into smaller steps reduces the linearization error as compared to using a one-step approach. This technique is known as the Euler method, that is, the process of using differential equations to move from one solution to another. This method is the simplest form of several techniques of numerical integration. We can show the benefits of using this multi-step technique in Figure 2.6 by contrasting the 1-step Johansen procedure and the 3-step solution path.

Figure 2.7   Single Step Johansen versus Multi-Step Euler Solution Method
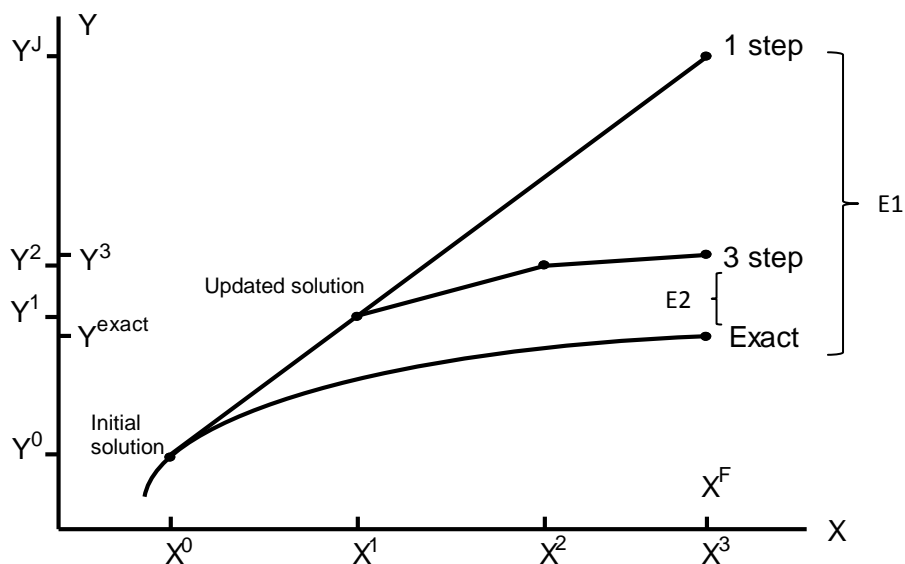
Source: Horridge (2003)

From Figure 2.7, using the Johansen 1 step method gives a linearization error of E1. In contrast, we can reduce the linearization error with the 3 step Euler method, which reduces the error from E1 to E2.

2.7.2   Dynamics

2.7.2.1   Intertemporal CGE Models

For intertemporal models, current decisions made by economic agents depend on information about the future. These kinds of models cannot be solved one period at a time. The agents in intertemporal CGE models have perfect foresight (rational expectations). An intertemporal CGE model is characterized by:

$$F_{1t}(Z_t) = 0$$

.
.
.

$$F_{ht}(Z_t) = 0$$
.... $$(t = 1,...,T)$$

$$F_{h+1}(Z_0, Z_1..., Z_{T+1}) = 0$$

.
.
.

$$F_{h+m}(Z_0, Z_1..., Z_{T+1}) = 0 \qquad (2.32)$$

The functions $F_{it}(i = 1,...,h)$ and $F_{h+j}(j = 1,...,m)$ are $h + m$ differentiable functions, of which some or all may be non-linear. The first h of these functions represents the atemporal equations which inter-relate Z, the variables, at the same point in time, that is, single CGE sub-models (Malakellis 2000). The m functions characterize the intertemporal functions that link variables at different points in time, i.e., linking the single-period CGE sub-models through time.

For intertemporal models with a system such as equation (2.32), forward looking behaviour complicates the solution because the values of certain variables in the current period are determined by the values of variables in the future. In order to solve models where some variables in the current period depend on future periods, terminal period values (i.e., terminal conditions) must be specified for those variables for which initial period values are not available (i.e., initial conditions). An equation system with these types of boundary condition (i.e., some which hold in the initial period and some which hold in the terminal period) is typically treated as a *two-point boundary problem*. It is harder to solve problems with two-point boundary conditions compared to initial value problems because obtaining a steady state is not as straight-forward.

In a non-linear system with a two-point boundary condition, variables that do not have a fixed initial value jump discontinuously in order to take the system to a new steady state path. In general, when solving a two-point boundary problem for intertemporal CGE models, the jumping variable would be Tobin's Q of investment, since the current value of Q is determined by the future value of Q. For the simple intertemporal model in this section, the jumping variable is investment, I. Similar to Tobin's Q, investment exhibits discontinuities and jump in response to a relevant shock. Capital is not used as a jumping variable because generally, most stock variables are continuous (Schmidt 2003).

Thus, in order to solve the simple theoretical model numerically, numerical paths for the dynamic variables (Q and K) are needed (Dixon et al. 1992). Once these are known, the paths of other variables can be obtained using equations from the model. As finding a numerical solution to the model requires solving the model's equations of motion which are a set of simultaneous differential equations, the model is solved using numerical integration. These equations would be easy to solve if the initial values of Q and K were known. One method commonly used is the Euler's method (Press et al. 1986).

However, initial post-shock values of the "jumping" variable (in this model; investment) will usually be unknown. Investment (I) may jump initially, taking on a new value which cannot be determined without solving the entire model. This leaves the model without enough boundary conditions to determine the solution. Thus, if I(0) is not known, there is no way to determine where the system will be immediately after the shock.

This is why two-point boundary problems are much harder to solve than initial value problems. The two main numerical methods used for solving such problems are shooting (pure and multiple) and finite differences methods. The next section demonstrates how pure and multiple shooting methods are used to solve an artificial society represented by a simple intertemporal model.[5]

2.7.2.1(a)   Pure Shooting Method

The algorithms used in pure shooting method uses initial value methods to integrate the equation system from the initial to the terminal period. The values of some of the time dependent variables are known in the initial period (i.e., from the database) while the remainder is known as the terminal period (i.e., exogenously specified or implied by theory). In order to use initial value methods to integrate the equation system forward through time, a trial solution which consists of the values of all time dependent variables must be specified in the first period. The values of variables for which initial conditions are unavailable must be guessed.

Starting from the trial solution, the equation system is integrated forward one period at a time in a recursive manner. As the boundary condition of some variables would be known before the integration, a solution is obtained when there are no significant discrepancies between the previously known and the computed terminal condition for those variables. However, if there are intolerable discrepancies, then the guessed values in the first period of the simulation must be revised and the procedure repeated until the system hits a steady state path when integrated forward. These guesses are called "*shooting*".

A finite intertemporal model example is illustrated below.

---

[5]An indepth discussion of these methods for solving intertemporal CGE models is found in Dixon et al. (1992).

Finite Time Horizon (3 Periods)

The firm maximizes an objective function given as:

$$\sum_{t=1}^{3}\left(\frac{1}{1+r}\right)^{t}C_{t} + P_{4}K_{4} \tag{2.33}$$

by choosing $\quad C_{t}, I_{t} \qquad t = 1, \ldots, 3$ (2.33a)

$\qquad\qquad\quad K_{t} \qquad\quad t = 2, \ldots, 4$ (2.33b)

subject to $\quad C_{t} = K_{t}^{\alpha}L_{t}^{1-\alpha} - I_{t} - \frac{\Phi}{2}\left(\frac{I_{t}}{K_{t}}\right)I_{t},\qquad\qquad t = 1, \ldots, 3$ (2.34)

$\qquad\qquad K_{t+1} = K_{t}\left(1-\delta\right) + I_{t},\qquad\qquad t = 1, \ldots, 3$ (2.35)

Equation (2.33) shows the society's objective function, which is the present discounted value of consumption. The parameters r and P_{4} are the interest rate and the value per unit of terminal capital stock, C_{t} is consumption at time t, I_{t} is investment at time t, L_{t} is labour at time t, α is a parameter with value between 0 and 1, and Φ is the firm's adjustment cost parameter. Equation (2.35) is the capital accumulation equation, with K_{t} as capital stock at time t and δ the depreciation rate of capital. Using equations (2.33) to (2.35), the Lagrangian function is written in the form of equation (2.36):

$$\text{Lagrangian} = \sum_{t=1}^{3}\left(\frac{1}{1+r}\right)^{t}C_{t} + P_{4}K_{4}$$

$$-\sum_{t=1}^{3}\Lambda_{t}\left[C_{t} - K_{t}^{\alpha}L_{t}^{1-\alpha} + I_{t} + \frac{\Phi}{2}\left(\frac{I_{t}}{K_{t}}\right)I_{t}\right]$$

$$- \sum_{t=1}^{3} \rho_{t+1} \left[K_{t+1} - K_t (1-\delta) - I_t \right] \qquad (2.36)$$

The first order conditions for the Lagrangian are as follows:

Differentiating the Lagrangian with respect to (C_t) gives the following:

$$\left(\frac{1}{1+r} \right)^t - \Lambda_t = 0 \qquad\qquad t = 1, \ldots, 3 \qquad (2.37a)$$

The term Λ_4 is defined as:

$$\left(\frac{1}{1+r} \right)^4 - \Lambda_4 = 0 \qquad (2.37b)$$

Differentiating the Lagrangian with respect to (I_t), (K_t) and (K_4) gives the following equations respectively:

$$- \Lambda_t \left[1 + \Phi \left(\frac{I_t}{K_t} \right) \right] + \rho_{t+1} = 0 \qquad\qquad t = 1, \ldots, 3 \qquad (2.38)$$

$$\Lambda_t \alpha \left(\frac{L_t}{K_t} \right)^{1-\alpha} + \Lambda_t \left(\frac{\Phi}{2} \right) \left(\frac{I_t}{K_t} \right)^2 + \rho_{t+1}(1-\delta) - \rho_t = 0 \qquad t = 2, \ldots, 3 \qquad (2.39a)$$

$$-\rho_4 + P_4 = 0 \qquad (2.39b)$$

Let Q_t be defined as:

$$Q_t = \frac{\rho_t}{\Lambda_t} \qquad\qquad t = 2, \ldots, 4 \qquad\qquad (2.40)$$

Using (2.37a) and (2.40), equation (2.38) is written as:

$$-\left[1 + \Phi\left(\frac{I_t}{K_t}\right)\right] + \left(\frac{1}{1+r}\right)Q_{t+1} = 0 \qquad\qquad t = 1, \ldots, 3 \qquad\qquad (2.41)$$

Similarly, using (2.37a) and (2.40) and substituting Q_{t+1} from (2.41), equation (2.39a) can be re-written as:

For period 2:

$$\alpha\left(\frac{L_2}{K_2}\right)^{1-\alpha} + \left(\frac{\Phi}{2}\right)\left(\frac{I_2}{K_2}\right)^2 + \left(\frac{1-\delta}{1+r}\right)Q_3 - Q_2 = 0, \qquad\qquad (2.42a)$$

$$\Rightarrow \alpha\left(\frac{L_2}{K_2}\right)^{1-\alpha} + \left(\frac{\Phi}{2}\right)\left(\frac{I_2}{K_2}\right)^2 + \left(\frac{1-\delta}{1+r}\right)\left\{(1+r)\left[1 + \Phi\left(\frac{I_2}{K_2}\right)\right]\right\} - Q_2 = 0 \qquad\qquad (2.42aa)$$

For period 3:

$$\alpha\left(\frac{L_3}{K_3}\right)^{1-\alpha} + \left(\frac{\Phi}{2}\right)\left(\frac{I_3}{K_3}\right)^2 + \left(\frac{1-\delta}{1+r}\right)Q_4 - Q_3 = 0, \qquad\qquad (2.42b)$$

$$\Rightarrow \alpha\left(\frac{L_3}{K_3}\right)^{1-\alpha} + \left(\frac{\Phi}{2}\right)\left(\frac{I_3}{K_3}\right)^2 + \left(\frac{1-\delta}{1+r}\right)\left\{(1+r)\left[1 + \Phi\left(\frac{I_3}{K_3}\right)\right]\right\} - Q_3 = 0 \qquad\qquad (2.42bb)$$

From equations (2.37b) and (2.40), equation (2.39b) becomes the *terminal condition* given in the following equation:

$$Q_4 = P_4 (1+r)^4 \tag{2.43}$$

In this model example, there are:

12 equations: (2.33a), (2.33b) and (2.40).

12 variables: K_2, K_3, K_4, I_1, I_2, I_3, C_1, C_2, C_3, Q_2, Q_3, Q_4 .

The way in which this finite model is solved and how pure shooting is implemented is as follows:

Given ("shooting") the value of I_1,

$$(2.41) \Rightarrow Q_2$$

$$(2.35) \Rightarrow K_2$$

$$(2.42aa) \Rightarrow I_2$$

$$(2.35) \Rightarrow K_3$$

$$(2.41) \Rightarrow Q_3$$

$$(2.42bb) \Rightarrow I_3$$

$$(2.41) \Rightarrow Q_4$$

With the values of P_4 and K_1 known, and guessing the value of I_1, equations (2.41) and (2.35) can be used to determine the values of Q_2 and K_2 respectively. Then, using equation (2.42aa), the value of I_2 can be obtained given the values of Q_2 and K_2, which then enables

the model to solve for K_3 using back equation (2.35). The known values of I_2 and K_2 are also used to obtain Q_3 using equation (2.41), which is then used to solve for the value of I_3 using equation (2.42bb). Lastly, with the known values of K_3 and I_3, the value of Q_4 can be obtained using equation (2.41). The values of C_1, C_2 and C_3 are solved simultaneously in the model in conjunction with solving the I_t, K_t and Q_t values.

However, the value of Q_4 is already given in equation (2.43), which is the terminal condition. Thus, if the guessed value of I_1 is incorrect, then when equation (2.41) is used to solve for Q_4, the system will not hit the terminal condition and there is a contradiction with equation (2.43). The process discussed above would have to be repeated all over again with a new guessed value of I_1.

2.7.2.1(b)   Multiple Shooting

The pure shooting method described above is prone to numerical instability. A small error in the trial values assigned to the unknown initial conditions can result in very large and uncontrollable errors after integrating over a small number of periods. One method of overcoming explosive results from trial value errors is to use multiple shooting. In multiple shooting, the period in which the model is to be integrated forward is divided into a smaller number of sub-periods. Pure shooting is then used to integrate the model over these smaller sub-periods.

However, the benefit of numerical stability from the multiple shooting method comes at the cost in terms of a lot of computing time (Dixon et al. 1992). For example, if the model is integrated over 30 periods, the atemporal equations of the model must be solved at least that many times because there will be as many sets of trial values of the unknown initial conditions as there are sub-periods (Malakellis 2000). Thus, the revision of any of the trial values requires the model to be integrated over 30 periods again, hence requiring the atemporal core of the model to be solved another 30 times. Assuming the 30 period time horizon is divided into 5 even sub-periods, then each revision of the five sets of trial values of the unknown initial conditions would require the atemporal core of the model to be solved

150 times. Also, this method is not suitable for solving large intertemporal models because it requires solving the intra-period part of the model thousands of times in the course of obtaining a full intertemporal model.

To illustrate how multiple shooting works, the same finite example for pure shooting is used. Instead of guessing only I_1, the value of I_2 is guessed as well. The way in which this finite model is solved using the multiple shooting method is as follows:

Given ("shooting") the value of I_1,

$$(2.41) \Rightarrow Q_2$$

$$(2.35) \Rightarrow K_2$$

$$(2.42aa) \Rightarrow I_2 \text{ (Achieved)}$$

$$(2.41) \Rightarrow \text{(Update } Q_2 \text{ using the value of } I_2 \text{ (guessed) and achieved } K_2 \text{ from (2.35))}$$

$$(2.41) \Rightarrow Q_3 \text{ (Using guessed value of } I_2 \text{ and achieved } K_2)$$

$$(2.41) \Rightarrow Q_3$$

$$(2.42bb) \Rightarrow I_3$$

$$(2.41) \Rightarrow Q_4$$

With the values of P_4 and K_1 known, and guessing the value of I_1, equations (2.41) and (2.35) can be used to determine the values of Q_2 and K_2 respectively. In the case of pure shooting, using equation (2.42aa), the value of I_2 can be obtained given the values of Q_2 and K_2, which is then used to solve for K_3 using back equation (2.41). With multiple shooting, instead of using the "*achieved*" value of I_2 found using equation (2.42aa), the "*guessed*" value of I_2 and the value of K_2 are used to revise the value of Q_2 using equation (2.42aa). The main difference between pure shooting and multiple shooting is that the guessed value of I_2 is used to integrate the system forward instead of the achieved value of

I_2 (Dixon et al. 1992). Then, with the guessed value of I_2, the achieved value of K_2 (from 2.41), the value of K_3 is obtained. Since multiple shooting in this example is only for I_1 and I_2, the system is integrated forward using the same method as described in the pure shooting example to obtain the values of Q_3 , I_3 and Q_4. Note that the value of I_3 used to solve for Q_4 is the achieved I_3, and not the guessed I_3. Also, the values of C_1, C_2 and C_3 are solved simultaneously in the model in conjunction with solving the I_t, K_t and Q_t values.

As with pure shooting, the value of Q_4 is already given in equation (2.43), which is the terminal condition. Thus, if the guessed value of I_1 is incorrect, when equation (2.41) is used to solve for Q_4, the system will not hit the terminal condition and there is a contradiction with equation (2.43). Instead of just guessing the initial shock to I_1, the shock to I_2 is also guessed in order for the system to hit a steady state path. The whole process discussed above would have to be repeated all over again with new guessed values of I_1 and I_2. The intuition behind a few guessed values of investment is such that if there is a huge error in the guessed value of I_1, explosive results can be avoided by having another guess at investment because errors of guesses prevent explosive results compared to having just one guessed shock to investment as in the case of pure shooting.

2.7.2.1(c)   Finite Differences

In addition to the pure and multiple shooting methods, another method that is commonly used to solve two-boundary condition problems is the finite-differences method (Dixon et al. 1992). Finite-differences differ from shooting methods, such that the difference equations for all periods are solved simultaneously, and requires as many independent equations in the model as there are endogenous variables. Compared to shooting methods, the finite difference method does not function by guessing the initial value of the variable and integrating forward to see whether the boundary condition is satisfied.

For finite differences, at each point in time, a guessed solution of the values of every variable is iteratively revised until all equation in the model (which includes all the difference equations and boundary conditions) are satisfied. Models that are continuous in time are

firstly solved by replacing the differential equations with finite difference equations. Then, a grid is defined, dividing the time horizon of interest into intervals of time where the finite difference equations are assumed to approximate the original variables at each grid point. An example of using this method to solve for a small intertemporal CGE model is found in Dixon et al (1992). As the endogenous variables for all periods are solved simultaneously, the finite differences method allows complete freedom in the structure of intertemporal links, that is, the end point conditions will appear explicitly as a part of the equations system. Hence, the initial and terminal conditions will be satisfied and unlike the shooting methods used in this chapter, the algorithm for finite differences is not prone to numerical instability.

However, Press et al. (1986) states that using the finite differences method is very inefficient for solving systems of non-linear simultaneous equations, especially for very large intertemporal CGE models. This is because of the difficulty in providing a trial solution, i.e., the guesses of time paths for all endogenous variables that is closest to the true solution and then having to revise it iteratively. There is always the temptation of keeping the model small to minimize the number of intertemporal linkages.

Intertemporal CGE models have become very popular for analyzing tax policy issues (Pereira and Shoven 1988). Most of the tax models are highly aggregated. Summers (1981) used an intertemporal CGE model with one productive sector to analyze the steady-state effects of capital taxes in the US. Dynamics in the model is introduced using an overlapping generations (OLG) life cycle model of savings. The model is not used to trace out the transition path of the economy from the initial steady state to the new steady state. Another study carried out to investigate the impacts of the US tax policy on the efficiency of capital accumulation is by Jorgensen and Yun (1986), where the authors used a CGE model with a single productive sector and a forward-looking, infinitely-lived representative consumer.

Bovenberg (1988) used a two sector (corporate and non-corporate) intertemporal growth model to study the effects of differential taxation of capital income. The main focus was to compare a model that takes into account adjustment costs on investment that gave rise to imperfect sectoral capital mobility with a model that assumes perfect capital mobility. Both investment and the decisions made by the representative household to save by the two sectors are forward looking. In Bovenberg's model, the structural equations are modelled in a log-linear form. A similar CGE tax policy model is used by Goulder and Summers (1989) to

analyze the disaggregated industry effects using an integrated treatment of short and long run adjustments to policy initiatives. Their model differs slightly to Bovenberg's, such that five sectors are used instead of two, and the model is not expressed in a log-linear form.

Intertemporal CGE models that are not used mainly on tax policy analysis are generally less aggregated. Jorgensen and Wilcoxen (1990) used an intertemporal CGE model to analyze the impacts of US environmental regulation identifies 35 productive sectors. A single capital stock, which is perfectly malleable and mobile among the sector, is assumed and the investment decisions made by producers are forward looking. Also, the total supply of capital in each period is assumed to be fixed by past investments and there are no investment adjustment costs. Households are forward looking with full consumption allocated across time by maximizing their utility. In contrast, both government budget and current account are balanced and assumed to be exogenous. In contrast to the usual parameters in CGE models being calibrated, the parameters of the model used by Jorgensen and Wilcoxen (1990) are estimated econometrically. Usually, the intertemporal benchmark solution of an intertemporal CGE model is constructed to exhibit steady state growth. A pioneering aspect of the model by Jorgensen and Wilcoxen (1990) is that the intertemporal control solution only exhibits steady-state growth in the long run.

Another example of CGE models used for policy making is by Devarajan and Go (1996), where a simple intertemporal dynamic economy-wide CGE model was used to look at the effects of shocks on tariffs and terms of trade on different economic variables in the economy such as consumption, investment and capital for the Philippines. Also, a multi-region dynamic CGE model by Bayar et al. (2000) was used to investigate issues of agricultural trade liberalization (gains from increased bilateral trade), growth and capital accumulation in the South Mediterranean countries, Turkey and the European Union.

Diao et al. (2002) investigated the effects of learning-by doing and growth process in Thailand. Based on simulation results, they showed how economic growth was prolonged by multisector productivity and investment dynamics, along with structural shifts from agriculture sectors to exportable sectors. They conclude that protectionism is a barrier and holds back growth on productivity spillover in the Thai economy. Khonder et al. (2008) looked at the effects on welfare from Bangladesh's trade liberalization from alternative trade policy scenarios (full, partial and gradual trade liberalization in the form of tariff reductions).

Intertemporal CGE models are also used to carry out the analysis of the effects of tax policy changes on consumption decisions in the US economy (Joint Committee on Taxation 2006), and the effects of trade liberalization on welfare and growth (Piazolo 2005; Toan 2005).

A multi-regional intertemporal CGE model called G-Cubed was developed by McKibbin and Wilcoxen (1999) to analyze global issues. The G-Cubed model is a combination of the disaggregated, econometrically estimated intertemporal CGE model of the US economy by Jorgensen and Wilcoxen (1990) and the dynamic macroeconomic modelling approach of the MSG2 (McKibbin-Sachs-Global) model. In the G-Cubed model, there are 8 regions, with each region having 12 productive sectors and one household. In order to take into account intertemporal budget constraints imposed on households, governments and countries, the G-Cubed models incorporates forward looking behaviour in consumption and investment behaviours. A portion of consumption is determined by current income, which can be inferred to as liquidity-constrained behaviour, while a percentage of investment in each sector is determined by current profits. Since firms are not able to borrow and lend, this is interpreted as firms constrained to financing investment expenditures out of retained earnings. In addition, contrast to the Jorgensen and Wilcoxen (1990) model, the share parameters in the G-Cubed model are calibrated and not econometrically estimated. A Cobb-Douglas and utility functions are used to ensure the elasticities of substitution equals unity.

As demonstrated above, using the pure and multiple shooting methods are not suitable for solving a simple intertemporal CGE model for an artificial economy. For pure shooting, because of its numerical instability, an error (even a small error) in the trial values assigned to the unknown initial conditions can result in very large and uncontrollable errors. As for multiple shooting, even though this method prevents explosive results, a steady-state solution is not found after a temporary shock is imposed on labour supply. A third method (not demonstrated but discussed briefly) that is commonly used to solve intertemporal CGE models is the finite differences method. This method, although is easier to use compared to pure and multiple shooting in terms of controlling explosive propensities in the solution as well as as less computer time, is a very inefficient method for solving very large intertemporal CGE models.

Hence, instead of using a large intertemporal CGE model to investigate the impact of a tariff reduction in motor vehicles on the Malaysian labour market, we use a dynamic recursive CGE model for Malaysia: MyAGE_LM.

2.7.2.2   Recursive CGE Models

Recursive CGE models are where agents have static or backward looking behaviour. In recursive CGE models, economic agents do not require information about the future in order to make current decisions. These kinds of models are consistent with both static and backward-looking (adaptive) expectations and may be solved period by period.

These types of models are treated as an *initial value problem*, where differential equations for which all boundary conditions are known at the initial point in time (Dixon et al. 1992). If decisions made in the present period are not affected by future periods, then the values of variables used in the first period for such models can be obtained from historical data. Therefore, endogenous variables for each period in the model are obtained by solving the model recursively. Models that are solved sequentially include the ORANI and MONASH models[6]. CGE models have become popular among economists and policy makers employed in both government and private sectors (Powell & Lawson 1989 and Powell 1991). There are two different types of recursive CGE models: static and dynamic models.

2.7.2.2 (a)   Static - ORANI

The ORANI model is used widely by many government departments and non-government agencies. The applications of the model covered a wide range of analysis including industry assistance (tariffs, quota protection), labour market reforms, taxes and technical change. ORANI is a multi-sectoral, comparative static model of the Australian economy. The ORANI model has been the standard for numerous CGE models domestically and internationally. It has been adapted to many countries worldwide, including China, Thailand, South Africa, Korea, Pakistan, Brazil, the Philippines, Japan, Ireland, Vietnam, Indonesia, Venezuela, Taiwan and Denmark. The main equation blocks which form the CGE core of ORANI are:

---

[6] Full documentation of the ORANI model is found in Dixon et al. (1982) and MONASH is found in Dixon and Rimmer (2002).

- Industry demands for inputs and primary factors;

- Industry demands for investment;

- Household demands by a representative household sector;

- Government consumption;

- Demands for margins;

- Zero profit conditions and

- Market clearing conditions.

The market has many industries as producers, but it has only one representative household. Producers and the consumer in ORANI optimize their behaviours. While the representative consumer maximizes utility subject to budget constraints, producers minimize their costs given the level of their outputs.

In terms of structure, ORANI is identified as being in the Johansen class of multi-sectoral models. However, ORANI was expanded to incorporate eight extensions from the usual Johansen framework (Dixon et al. 1982):

- ORANI allows for multi-product industries and multi-industry products in the agricultural sector in particular;

- It incorporates detail estimates of elasticities of substitution between domestically produced products and similar imported products;

- Detailed modelling of marginal industries is included in the model;

- It has a regional dimension;

- ORANI gives solutions for many variables;

- The model allows maximum freedom to reclassify variables between the exogenous and endogenous categories; each combination of exogenous and endogenous variables is defined as a closure of the model. Therefore, the model allows flexibility where it can be solved for various closures depending on the assumptions made by the policy maker;

- ORAN is a flexible tool for analyzing the effects of technical change and

- Finally, ORANI retains the advantage of Johansen's computational approach while eliminating its disadvantages.

2.7.2.2 (b)   **Dynamic**

Recent years has seen the development of dynamic CGE models. Following the development of the dynamic CGE model for Australia, MONASH, by Dixon and Rimmer (2002), the two large scale bottom-up models of Australia were also developed into dynamic models: FEDERAL-F (Giesecke 2000) and MMRF-Green (Adams et al. 2002). The application of FEDERAL-F is found in Giesecke and Madden (2003). They use FEDERAL-F to demonstrate that a feasible government policy to halt Tasmania's declining share of national GDP does not exist.

Monash

The MONASH model (Dixon & Rimmer 2002) has evolved from ORANI (Dixon et al. 1982) in order to cater for the need for forecasting and policy analysis on a year-to year basis; a recursive dynamic model compared with the comparative static mode of ORANI. Equations in MONASH are more advanced, as MONASH refines ORANI equations further while maintaining every detail of the multi-sectoral Australian economy of ORANI. There are three types of inter-temporal links in the MONASH model which advanced over the ORANI model: physical capital accumulation, financial asset/liability accumulation and lagged adjustment processes. Building in the pioneering work of Johansen (1960), MONASH-type models have the added advantage of having incorporated several extensions to the initial framework. This includes greater flexibility in the choice of model closure, the ability to deal with large dimensions and the elimination of linearization errors.

MONASH has different closures for different types of simulations[7]. There are four types of closures and their associated simulations that MONASH can run with: historical, decomposition, forecasting and policy. [8]In these simulations, naturally endogenous variables become exogenous and their results are imposed onto the model. At the same time, some naturally exogenous variables become endogenous. The sets of naturally endogenous and exogenous variables in MONASH contain many variables. Examples of naturally endogenous variables include exports, imports, household consumption, employment and

---

[7] More technical information can be found in Chapter 1 of Dixon and Rimmer (2002).
[8] Details of the development of the historical, forecast and policy closures for MyAGE_LM adopted from the MONASH model is discussed in Chapter 5 (Development of MyAGE_LM Closures).

industry inputs. Examples of naturally exogenous variables include shifts in export demands, consumer preferences, industry technology and labour productivity.

There are two differences between historical and forecasting closures. Firstly, more data are exogenously imposed in historical closure than in forecasting closure. Secondly, data for historical closure are the observed data while data for forecast closure are estimates for the future period. Policy closure is used in simulations that incorporate shocks of policy instruments such as tariff reduction or changes in income tax rates on top of the forecast closure. Policy simulations measure the deviation of the economy from the estimated base forecast due to the policy shocks. The decomposition simulation can be conceptualised as a simulation in which impacts if naturally exogenous variables are isolated as if each shock was implemented individually.

2.7.3   Regional CGE Models

For regional CGE models, a distinction is made between 'top-down' or 'bottom-up'. The term 'top' and 'up' refer to the national level. The term 'down' and 'bottom' refer to regions.

2.7.3.1   Regional 'Top-Down'

A top-down CGE model is simple in theory and does not require a large amount of regional data (Liew 1984). The top-down approach involves the running of a model at the national level in order to achieve economy-wide results and then feeding the results into a second model that will decompose the national results into a set of regional results (Madden 1990). The regional results for this type of models are only a decomposition of national results. This means that results at the national level are disaggregated down to the state-levels using regional shares. An indepth survey of regional CGE models with a top-down approach can be found in Partridge and Rickman (1998). The first regional model of Australia was the ORANI-Regional Equation System (ORES) (Dixon et al. 1982), which later became MRES (MONASH- Regional Equation System) (Adams & Dixon 1995).

The main features of ORES have been effectively used in Australia to analyze the regional effects of national policy shocks and regional demand shocks. ORES models national

economic activity, then allocates the economy-wide results among the states on the basis of relative regional output patterns and local multiplier effects. The Regional Equation System (RES) in MRES and ORES has the advantage of being very simple, requiring minimal data to operate (mainly regional output shares) and seemingly sufficient in producing all results at the regional level from shocks at the national level.

However, there are limitations for both MRES and ORES. According to Madden (1990), one of the limitations is a dichotomy between local and national commodities. Even though the top-down models are attractive in decreasing regional data requirements, this dichotomy can be unrealistic and have distorting effects on regional results (Madden 1990). Another limitation of the models is that the distinctive characteristics and the importance of differences amongst regions are separated. This is because the models do not take into consideration the assumption where national industries in all regions always move in line with national industries at the national level to maintain fixed industry shares. Also, with changes in both national and local commodities independent of resource constraints, growth in a regional industry does not cause direct crowding out effects on other regional industries. In addition, even though the RES in ORES may perform adequately in regional industries, it is only useful for the applications that mainly simulate shocks to the economy at the national level. According to the study carried out by Parmenter and Welsh (2001) on the performance of the RES in MRES for forecasting, they found that "MONASH-RES forecasts in which no region-specific macroeconomic data are used and in which regions' shares in national-industry outputs held constant, will fail to capture important features of regional economic development".

2.7.3.2   Regional 'Bottom-Up'

The limitation of the top-down models is overcome using a bottom-up approach, where each region is modelled independently. An early regional bottom-up CGE model for Australia was MRSMAE, which was used to model each economic agent in six Australian regions (Liew 1984). After MRSMAE, a larger scaled multiregional CGE model: FEDERAL was developed by Madden (1990), which incorporates elements such as detailed modelling of two-tiers of regional government, regionally-sourced margins and interregional factor ownership. By using this two-region approach, data problems were eased by estimating the

larger region's data flows as a residual from the national flows. Another extensively used bottom-up CGE model in Australia is the Monash Multi-Regional Forecasting (MMRF) model, which explicitly treats the behaviour of economic agents in the eight states and two territories in Australia and up to 144 commodities/industries.

The model contains explicit representations of intra and inter-regional and international trade flows based on regional input-output data developed at the Centre of Policy Studies (CoPS), as well as detailed data on the budgets of the state and the Federal Government. The MMRF model is appropriate in determining the impact of region-specific economic shocks because each region is modelled as a mini-economy itself. The outputs from the model include the forecast of:

- GDP and aggregate national employment;
- Sectoral output, value-added and employment by region;
- Export earnings, import expenditure and the balance of trade;
- Greenhouse gas emissions by fuel, fuel user and region of fuel use;
- Energy usage by fuel, energy user and region of energy use;
- State and Territory revenues and expenditures;
- Regional gross products and employment; and
- Regional international export earnings, international import expenditures and international balance of payments.

In contrast to its predecessor (MMRF model), another bottom up CGE model of Australia is TERM (The Enormous Regional Model). One of the key features of this model is the ability to handle a much bigger number of regions and sectors: up to 144 sectors and 57 regions. This high degree of detail allows policy makers to investigate regional impacts of shocks that may be region-specific. Also, TERM has a particularly detailed treatment of transport costs and is naturally suited to simulating the effects of improving particular road or rail links. The original model is comparative static in nature, where it shows the differences produced in the regional economies by changes in taxes, technology, tariffs and other exogenous variables for a single year. A dynamic TERM model was developed by Glyn Wittwer which integrates the dynamic features similar to the MONASH model:

- Equations explaining regional labour market adjustment;

- Equations relating investment to capital in year-to-year simulations;

- Equations explaining the relationship between year-to-year capital growth and rate-of-return expectations, and equations that facilitate the running of forecasting and dynamic policy simulations; and

- Regional data for industry investment/capital ratios, for industry rates of return and for dynamic adjustment parameters.

2.8   Conclusion

This chapter provides an overview of the Malaysian economy focusing on trends in wages, employment and tariffs since independence. This will motivate the theoretical and simulation discussions using the MyAGE_LM model.

Malaysia has undergone significant trade liberalization, with a decrease in its tariff rates. At the same time, the wage gap between skilled wages semi and unskilled wages has been fairly constant throughout the years from 1985 to 2005. Trade liberalization in Malaysia in the form of tariff reductions does not seem to have much effect on the occupational wages. For employment, there is a downward trend for the semi-skilled and unskilled occupations relative to skilled employment. As Malaysia underwent a second round export-oriented phase in 1985, there was an increase in the demand for skilled workers in the manufacturing industry. This is consistent with the Malaysian government's emphasis on human capital development and moving the country towards becoming a more knowledge-based economy. Because of limitations in the availability of occupational data for both wages and employment, using econometric analysis to investigate the effects of a motor vehicle tariff cut on Malaysia's labour market would not produce reasonable results. Hence, we introduced CGE models as a useful tool for addressing this limitation.

We highlighted the key features of CGE models and introduced the different types of CGE models that are used as tools for policy analysis. In addition, we drew attention to the constraints of intertemporal CGE models, and how a recursive CGE framework is better suited for detailed policy analysis. This provides the motivation for using a dynamic recursive CGE model to investigate the effects of a motor vehicle tariff cut on the Malaysian labour market.

CHAPTER 3

THEORETICAL STRUCTURE FOR THE MYAGE_LM MODEL

3.1 Introduction

The model for the Malaysian economy used in this thesis is the Malaysian Applied General Equilibrium Labour Market (MyAGE_LM) model. This model is an adaptation of the Malaysian Applied General Equilibrium (MyAGE) model[9], which is a MONASH style dynamic model for Malaysia. The theoretical structure underpinning the MyAGE model is adapted from the static ORANI model for the Australian economy (Dixon et al. 1982) and the dynamics of the MONASH model for Australia (Dixon and Rimmer 2002). Changes to the assumptions, parameters and the structure of MyAGE are made where applicable in order to reflect the characteristics of the Malaysian economy. The MyAGE_LM model involves the introduction of the nine occupational groups into the labour market. Instead of using aggregated real wages and employment, for each of the equations describing the labour market adjustment process, a corresponding equation for incorporating the occupation set is included.

The extension made to the labour market in MyAGE to form MyAGE_LM includes the following specifications: (i) The division of workers into nine different occupational groups (ii) The division of the labour force into categories at the start of each year to reflect workforce functions in the previous year, (iii) The identification of workforce activities, i.e., what people do during the year, (iv) The determination of labour supply from each category to each activity, (v) The determination of labour demand in employment activities, (vi) The specification of wage adjustment processes reflecting both demand and supply of labour and (vii) The determination of everyone's activity, i.e., who gets the jobs and what happens to those who do not.

---

[9] See CoPS (2010).

The MyAGE_LM model contains of a number of dynamic mechanisms in order to facilitate forecasting and dynamic policy analysis; (1) Physical capital accumulation (2) Accumulation of financial assets and liabilities (net foreign liabilities) and (3) Lagged adjustment processes in the labour market.

In the model, the changes in industry capital stock at the start of period *t* equal capital at the end of period *t-1* plus investment minus depreciation during that period.

Net foreign liabilities at the start of year *t* equal the net foreign liabilities at the end of period *t-1*. Changes in the value of a financial asset or liability are linked to its values at the beginning of the period, the accumulation during the period and the average rate of interest or dividend rate applying to the asset or liability during the period.

For the labour market, real wages are sticky in the short run and flexible in the long run. It is assumed for each occupation that the deviation in the real wage rate away from its basecase forecast path in period *t* increases (from a policy shock) at a rate which is proportional to the deviation in the occupational demand-supply gap. This is the deviation in employment from its forecast level minus the deviation in labour supply from its forecast level.

The core equations describing the key features of MyAGE_LM are presented in the Sections 3.2 to 3.18. The theoretical structure in MyAGE_LM is a system of simultaneous equations and is classified into the following blocks; (1) Equations that describe industry demands for primary factors and intermediate inputs; (2) Equations for household and other final demands for commodities; (3) Price equations reflecting zero pure profit conditions (4) Market clearing conditions where supply equals demand (5) Miscellaneous equations such as equations that define GDP, aggregate employment and consumer price index and (6) Dynamic equations to link the flow of capital stocks and lagged adjustment in the labour market. Section 3.19 provides a detailed discussion on the labour market specification in MyAGE_LM and Section 3.20 concludes.

3.2   Industry Input Decisions

In the MyAGE_LM model, producers are assumed to take all input prices as exogenously given. Primary and intermediate inputs are chosen to minimise costs for any given level of activity. They are constrained in their choice of inputs by a three-level nested production technology, shown in Figure 3.1.

As shown in Figure 3.1, at the first level, the intermediate-input bundles and the primary-factor bundles are used in fixed proportions to output. At the second level, the intermediate input bundles are constant-elasticity-of-substitution (CES) combinations of import and domestic goods, and the primary factor composite is a CES combination of inputs of land, capital and labour. At the third level, the labour input is a CES combination of occupational inputs. The input decision for each sector at each level of production technology is discussed in subsections 3.2.1 to 3.2.3.

Figure 3.1   Input Technology for Current Production
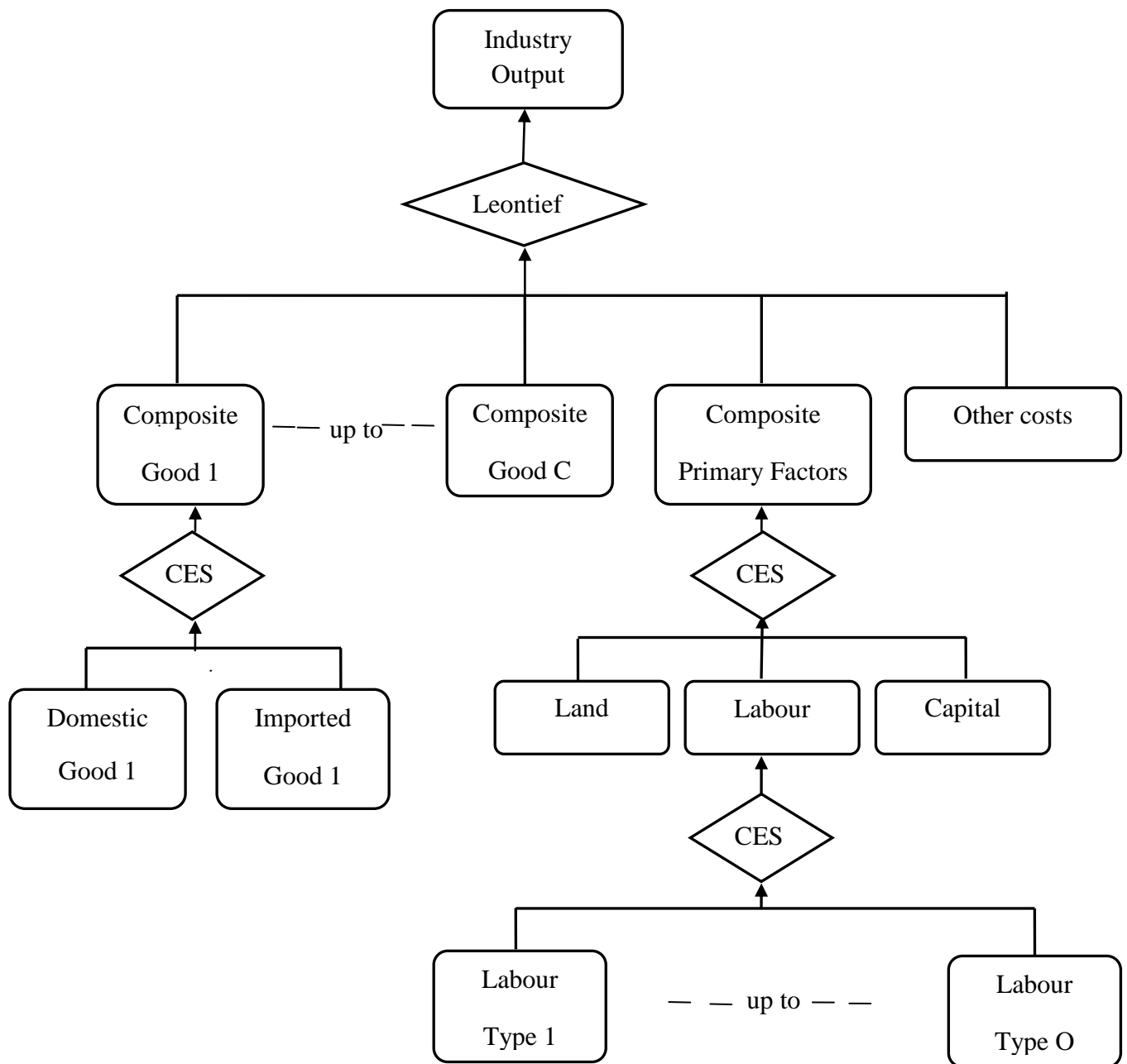
3.2.1 Demand for Composite Primary Factors

Starting at the top of Figure 3.1, each industry chooses effective composite intermediate inputs $X_{c,i}^{(1)}$ and composite primary input $X_{prim,i}^{(1)}$ to minimise the total costs $\sum_{c \in COM} X_{c,i}^{(1)} P_{c,i}^{(1)} + X_{prim,i}^{(1)} P_{prim,i}^{(1)}$, subject to the Leontief production function:

$$Z_i = \min \left\{ \frac{X_{1,i}^{(1)}}{A_{1,i}^{(1)}}, ..., \frac{X_{c,i}^{(1)}}{A_{c,i}^{(1)}}, \frac{X_{prim,i}^{(1)}}{A_{prim,i}^{(1)}} \right\} \tag{3.1}$$

where

- $P_{c,i}^{(1)}$ is the cost to industry i of a unit of composite good c or primary factor; and

- Z_i is the output of industry i and the $A_{k,i}^{(1)}$ is the input of k required in industry i per unit of output. Movements in $A_{k,i}^{(1)}$ can be used to simulate the effects of k-saving/ augmenting technical progress in industry i.

The Leontief production function does not allow for substitutability between different materials or between materials and primary factors in the creation of units of industry output. Thus, for a given technology, as a result of changes in the composite price of each input, there is no change to the proportions of each composite input demanded. With Leontief technology, the equations describing demands for composite inputs of materials and primary factors can be written in TABLO as follows:

Excerpt 3.1   Demands for Composite Primary Factors and Intermediate Demands

```
Equation E_x1_s  # Intermediate demands for commodity composites #
  (All,c,COM)(All,i,IND)
  x1_s(c,i) - a1_s(c,i) – a1(i) = z(i);

Equation E_x1prim  # Demands for primary factor composite #
  (All,i,IND)
  x1prim(i) - a1prim(i) - a1(i) = z(i);
```

According to the equations in Excerpt 3.1, in the absence of any changes in the input technology *(a1, a1_s or a1prim)*, input demands move in proportion with a given level of output *z(i)*. This is consistent with the constant returns to scale property of the Leontief production function. The absence of input prices in Equations *E_x1_s* and *E_x1prim* follows from the absence of substitution possibilities in the Leontief production function.

The "*a*" terms allow for technical change. The all input augmenting technical change variable *(a1(i))* allows for a commodity-neutral shift in industry *i*'s production function. When *a1(i)* decreases by 10 per cent, this allows industry *i* to achieve any given level of output *z(i)* with 10 per cent less of all inputs. In equation *E_x1_s*, a 10 per cent decrease in *a1_s(c,i)* introduces a 10 per cent input-*c* saving technical change by industry *i*, allowing the achievement of any given level of *z(i)* with 10 per cent less input of input *c* without changing the level of any other inputs. Similarly, in equation *E_x1prim*, a decrease in *a1prim(i)* by 10 per cent decreases primary inputs used to produce a given level of *z(i)* by 10 per cent.

3.2.2 Demand for Source Specific (Domestic & Imported) Intermediate Inputs

The second stage on the left hand side of Figure 3.1 shows the industry demands for source specific intermediate inputs. In the MyAGE_LM model, each industry is assumed to face imperfect substitution between domestic and imported varieties of each intermediate input. This is consistent with a situation in which both the imported and domestic varieties of a good can survive in the domestic market when there is a change in their relative prices. If imported and domestic goods are treated as perfect substitutes, then an increase in the price of one variety relative to the other will lead users to substitute completely to the cheaper variety. The concept of imperfect substitutability between imported and domestically produced inputs is modelled following Armington (1969).

Domestic and imported intermediate inputs of each commodity are chosen to minimise cost. Hence, producers' in industry *i*, ($i \in IND$) choose intermediate input type *c* ($c \in COM$) from domestic or imported sources $\left(X_{c,s,i}^{(1)}\right)$ to minimise the cost:

$$\sum_{s \in \{dom,imp\}} X_{c,s,i}^{(1)} P_{c,s,i}^{(1)} \tag{3.2}$$

$$\text{subject to } X_{c,i}^{(1)} = \left[\sum_{s \in SRC} \delta_{c,s,i}^{(1)} \left(\frac{X_{c,s,i}^{(1)}}{A_{c,s,i}^{(1)}} \right)^{-\rho_c^{(1)}} \right]^{-1/\rho_c^{(1)}} \tag{3.3}$$

where

- $X_{c,i}^{(1)}$ is the quantity of composite commodity c used in industry i;

- $X_{c,s,i}^{(1)}$ and $P_{c,s,i}^{(1)}$ are the quantity and purchaser's price of commodity c from source s used in industry i for current production;

- $\delta_{c,s,i}^{(1)}$ is a positive parameter. The parameter $\rho_c^{(1)}$ has a value $-1 < \rho_c^{(1)} \neq 0$; and

- $A_{c,s,i}^{(1)}$ is a variable that can be used in simulating input-(c, s)-augmenting technological change in i.

The TABLO code below shows equations for the demands for source specific intermediate inputs from domestic and imported sources:

Excerpt 3.2   Demands for Source Specific (Domestic and Imported) Intermediate Inputs

```
Equation E_x1  # Source-specific demands for intermediate inputs #
  (All,c,COM)(All,s,SRC)(All,i,IND)
  x1(c,s,i) = x1_s(c,i) - SIGMA1(c)*{p1(c,s,i) - p1_s(c,i)}
  + [a1csi(c,s,i)] -SIGMA1(c)*{ a1csi(c,s,i) – a1csi_s(c,i)};


Equation E_p1_s  # Effective price of composite intermediate input #
  (All,c,COM)(All,i,IND)
  p1_s(c,i) = Sum{s,SRC,S1(c,s,i)*[p1(c,s,i)+ a1csi(c,s,i)]};


Equation E_a1csi_s  # Technology in using composite intermediate
input #
  (All,c,COM)(All,i,IND)
  a1csi_s(c,i) = Sum{s,SRC,S1(c,s,i)*a1csi(c,s,i)};
```

The demand for intermediate input c, from source s (domestic or imported) by each industry i, $x1(c,s,i)$, depends on the intermediate demands for the composite $x1\_s(c,i)$, the relative price of commodities and input saving technical change from different sources and the ability to substitute commodities from different sources (SIGMA1(c); Armington elasticity). Thus, for a given $x1\_s(c,i)$, a decrease in the price of variety s relative to a weighted average of domestic and import prices ($p1(c,s,i)$-$p1\_s(c,i)$<0) would decrease the industry's demand for inputs of s and cause substitution towards the other variety. This substitution is determined by the Armington elasticity.

The variable $a1(c,s,i)$ plays two roles. The first is as an input-(c,s)-saving technical change for industry i. If no substitution is assumed to occur ($SIGMA1(c)=0$), when $a1(c,s,i)$ decreases by 10 per cent, industry i would require 10 per cent less of intermediate input c from source s to produce a given level of output $z(i)$ holding constant all other inputs. With substitution ($SIGMA1(c) \neq 0$), for a given $x1\_s(c,i)$, a 10 per cent decrease in the input-(c,s)-saving technical change would induce substitution towards input (c,s) and away from input c from the other source. The extent to which this substitution effect would lead to a net increase in the use of input (c,s) given the level of output $z(i)$ depends on the value of SIGMA1(c). If SIGMA1(c) is big enough, then the substitution effect in favour of using (c,s) would outweigh the input-(c,s)-saving effect from $a1csi(c,s,i)$.

The second role of $a1(c,s,i)$ is to decrease the cost per unit of a composite intermediate input $p1\_s(c,i)$ shown in equation $E\_p1\_s(c,i)$[10]. A 10 per cent decrease in $a1(c,s,i)$ decreases the cost of a unit of composite intermediate input in industry i for a given a level of output $z(i)$.

3.2.3 Demands for Primary Factors

Producers combine units of capital, land and composite labour to produce a composite primary factor input. They choose primary factor inputs $X_f^{(1)}$ to minimise the total cost of acquiring the primary factor composite input; i.e., they minimise

---

[10] The derivation of equation $E\_p1\_s(c,i)$ is found in Appendix A.1.

$$\sum_{f \in FAC} X_{f,i}^{(1)} P_{f,i}^{(1)} \tag{3.4}$$

subject to the CES production function:

$$X_{prim,i}^{(1)} = \underset{f \in FAC}{CES} \left\{ \frac{X_{f,i}^{(1)}}{A_{f,i}^{(1)}} \right\} \tag{3.5}$$

where

- $X_{prim,i}^{(1)}$ is the demand for composite primary factor inputs in industry i;

- $X_{f,i}^{(1)}$ is the input for factor f (composite labour, capital and land);

- $P_{f,i}^{(1)}$ is the price of factor f used in industry i; and

- $A_{f,i}^{(1)}$ is technological coefficient for factor f used in industry i.

The linearized factor input demand equations are shown in the TABLO code in Excerpt 3.3 below:

Excerpt 3.3   Demands for Primary Factors

```
Equation E_x1lab_o  # Industry demands for  labour #
  (All,i,IND)
  x1lab_o(i) - a1lab_o(i)
        = x1prim(i) - SIGMA1PRIM(i)*[p1lab_o(i) - p1prim(i)]
          -SIGMA1PRIM(i)*[a1lab_o(i) - a1lkn(i)];


Equation E_p1cap  # Industry demands for capital #
  (All,i,IND)
  x1cap(i) - a1cap(i) = x1prim(i) - SIGMA1PRIM(i)*[p1cap(i) -
p1prim(i)] -SIGMA1PRIM(i)*[a1cap(i) - a1lkn(i)];


Equation E_p1lnd # Industry demands for land #
  (All,i,IND)
  x1lnd(i) - a1lnd(i) = x1prim(i) - SIGMA1PRIM(i)*[p1lnd(i) -
p1prim(i)] -SIGMA1PRIM(i)*[a1lnd(i) - a1lkn(i)];
```

```
Equation E_p1prim  # Price term in factor demand equations #
  (All,i,IND)
  V1PRIM(i)*p1prim(i) =
  V1lab_o(i)*p1lab_o(i) + V1CAP(i)*p1cap(i) + V1LND(i)*p1lnd(i);


Equation E_a1lkn  # Primary factor technology #
  (All,i,IND)
  V1PRIM(i)*a1lkn(i) =
      V1lab_o(i)*a1lab_o(i) + V1CAP(i)*a1cap(i) + V1LND(i)*a1lnd(i);
```

In equations *E_x1lab_o*, *E_p1cap* and *E_p1lnd*, the variables *x1lab_o(i), x1cap(i) and x1lnd(i)* are the percentage changes in the demands for labour, capital and land in industry *i*. The interpretation of these equations show that in the absence of changes in prices and technology, a 10 per cent increase in industry *i*'s demand for the composite primary factor *x1prim(i)* leads to a 10 per cent increase in its demand for the three primary factors (capital, land and composite labour). This is consistent with the constant returns to scale property.

With substitution, the second term on the right hand side of equations *E_x1lab_o*, *E_p1cap* and *E_p1lnd* (the *SIGMA1PRIM(i)* term) reflect the price-induced substitution effect among the three factors. When the price of factor *f* decreases relative to the cost-share-weighted average price of all primary factors, *p1prim(i)*[defined as a Divisia index in *E_p1prim*], industry *i* will substitute towards using more of *f* and less of the other factors. The magnitude of the substitution effects depends on the values of the elasticities of substitution, *SIGMA1PRIM(i)*.

The "a" terms in equations *E_x1lab_o*, *E_p1cap* and *E_p1lnd* allow for technical change. The variable *a1lab_o(i)* is labour saving technical change in industry *i*. If *a1lab_o(i)* is set at -10, then industry *i* is able to use 10 per cent less labour holding all other primary factor inputs (capital and land) constant for a given level of overall primary factor inputs. This is reflected by the appearance of *–a1lab_o(i)* on the left hand side of *E_x1lab_o*. Similarly, *a1cap(i)* and *a1lnd(i)* are interpreted as capital and land saving technical change respectively for industry *i*, and appear with negative signs on the left hand sides of *E_p1cap* and *E_p1lnd*.

With *a1lab_o(i)* at -10, industry *i* doesn't necessarily choose to achieve any given level of primary factor input with 10 per cent less labour. Since labour is now a more efficient factor, industry *i* will substitute towards labour. Technological substitution effects are reflected in the last term on the right hand sides of equations *E_x1lab_o*, *E_p1cap* and *E_p1lnd*. In these terms, industry *i* substitutes towards factor *f* if technological change carried by factor *f* is more rapid than an average of the technological changes (*a1lkn(i),*defined as a Divisia index in *E_a1lkn*) carried by all primary factors.

3.2.4   Demands for Labour Based on Occupations

From Figure 3.1, on the right hand side at the third level, each industry faces limited substitution possibilities between labour of different occupational types. This is modelled using a CES function, with effective units of labour represented by a CES combination of labour based on the nine different types of occupations (legislators, senior officials and managers; professionals; technicians and associate professionals; clerical workers; service workers and shop and market sales workers; skilled agricultural and fishery workers; craft and related trade workers; plant and machine-operators; and assemblers and elementary occupations).

The industry's decision problem is shown below, where they choose different types of labour based on occupations $X_{o,i}^{(1)}$ to minimise the total cost of acquiring the given effective unit of labour; i.e., they minimise:

$$\sum_{o \in OCC} X_{o,i}^{(1)} P_{o,i}^{(1)} \tag{3.6}$$

subject to the CES aggregation function:

$$X_{lab,i}^{(1)} = \underset{o \in OCC}{CES} \left\{ \frac{X_{o,i}^{(1)}}{A_{o,i}^{(1)}} \right\} \tag{3.7}$$

where

- $X_{lab,i}^{(1)}$ is the demand for labour input in industry *i*;

- $X_{o,i}^{(1)}$ is the input for occupation *o*;

- $P_{o,i}^{(1)}$ is the wage of occupation *o* used in industry *i;* and

- $A_{o,i}^{(1)}$ is technological coefficient for occupation *o* used in industry *i*.

The occupational labour demand functions are shown in the following TABLO code:

Excerpt 3.4   Occupational Composition of Labour Demand

```
Equation E_x1lab # Demand for labour by industry and skill group #
(All,o,OCC)(all,i,IND)
    x1lab(o,i)=x1lab_o(i) -SIGMA1LAB(o,i)*[p1lab(o,i)-p1lab_o(i)]
    +a1lab(o,i)-SIGMA1LAB(o,i)*{a1lab(o,i) - a1lab_ave(i)};

Equation E_p1lab_o  # Effective price of composite labour #
  (All,i,IND)
  ID01[V1LAB_O(i)]*p1lab_o(i) = Sum{o,OCC,V1LAB(o,i)*p1lab(o,i)};


Equation E_a1lab_ave  # Technology in using composite labour #
  (All,i,IND)
  ID01[V1LAB_O(i)]*a1lab_ave(i) = Sum{o,OCC,V1LAB(o,i)*a1lab(o,i)};
```

Equation *E_x1lab* indicates that in the absence of technical change or movements in relative wages, the demand for labour in industry *i (x1lab_o(i))* moves in proportion to overall labour demand *(x1lab(o,i))*. With substitution, a change in the overall wage rate *(p1lab(o,i))* relative to the average wage rate faced by the industry *(p1lab_o(i))* induces a substitution between labour types. For a given relative wage movement, the strength of this substitution is governed by the elasticity of substitution between occupations, *SIGMA1LAB(i)*. The percentage changes in the average wage *((p1lab_o(i))* is given by equations *E_p1lab_o*. Thus, with a given demand for effective labour *(x1lab_o(i))*, industries would decrease the demand for that particular occupation in favour of other occupations when there is an increase in the wage rate of occupation *o* relative to the overall wage rate of effective labour *((p1lab_o(i))*.

Equation *E_a1lab_ave* defines the average changes in labour technology as the Divisia index of changes in technology by each occupation. It is also noted that in equations *E_p1lab_o* and *E_a1lab_ave*, for an industry which does not use labour, i.e. dwellings, *V1LAB_O(i)* would contain only zeros, and *p1lab_o(i)* and *a1lab_ave* would be undefined. In order to prevent this, the function ID01 is included in the equations, which would return the value of 1 to *V1LAB_O(i)* when the coefficient is zero. With the left hand side zeros for that industry, the equations *E_p1lab_o(i)* becomes *p1lab_o(i)=0*. This method is used for other equations in the MyAGE_LM model.

3.3 Industry Output Decisions (Commodity Supplies)

In the official Malaysian input-output data, there is a high degree of multi-production in the Malaysian economy. That is, many industries produce more than one commodity, and many commodities are produced by more than one industry. In the MyAGE_LM model, industry-specific decision making on the commodity composition of output is made via the assumption of revenue maximization. Each industry i chooses $X_{c,dom}^{(0)}, c \in COM$, to maximise total revenue $\sum_{c \in COM} X_{c,dom}^{(0)} P_{c,dom}^{(0)}$, subject to the Constant Elasticity of Transformation (CET) production function:

$$Z_i = \left[\sum_{c \in COM} \lambda_{c,i}^{(0)} \left(\frac{X_{c,i}^{(0)}}{A_i^{(0)} A_{c,i}^{(0)}} \right)^{-\rho_i^{(0)}} \right]^{-1/\rho_i^{(0)}} \tag{3.8}$$

where

- Z_i is the activity level of industry i;

- $X_{c,i}^{(1)}$ is the quantity of commodity c produced by industry i;

- $\lambda_{c,i}^{(0)}$'s are non-negative parameters with $\sum_c \gamma_{c,i}^{(0)} = 1$. The parameter $\rho_i^{(1)}$ is less than -1.

- $A_c^{(0)}$ allows for a common commodity c-augmenting technical change across all industries, while $A_{c,i}^{(1)}$ allows for industry i's specific c-augmenting technological change.

Excerpt 3.5 below shows the TABLO code for industry *i*'s output decisions.

Excerpt 3.5 Composition of Output Supplies

```
Equation E_x0  # Supplies of commodities by industries #
  (All,c,COM)(all,i,IND)
x0(c,i) + a0(c,i) = z(i) + SIGMA0(i)*(p0ci(c,i) - a0(c,i) -p0_e(i));

Equation
E_p0_e # Effective price for the commodity supply equations #
  (All,i,IND)
  MAKE_C(i)*p0_e(i) = Sum{c,COM,MAKE(c,i)*(p0ci(c,i) - a0(c,i))};

Equation
 E_p0ci  # Each industry gets the same price for a given commodity #
 (all,c,COM)(all,i,IND) p0ci(c,i) = p0dom(c);

 E_x0dom # Total output of commodities (as simple addition) #
 (all,c,COM) x0dom(c) = sum{i,IND, [MAKE(c,i)/MAKE_I(c)]*x0(c,i)};

Equation E_x0ind # Output of industries #
(All,i,IND)
[Sum{c,COM, MAKE(c,i)}]*x0ind(i) = Sum{t,COM, MAKE(t,i)*x0(t,i)};
```

Equation *E_x0* shows how an industry makes decisions about its output composition. In the MyAGE_LM model, it is assumed that goods produced by industries are perfect substitutes, i.e., paddy produced by industry 1 is a perfect substitute for paddy produced by industry 2. Thus, each industry *i* will receive the same price for a given commodity *c*, reflected in equation *E_p0ci*. According to equation *E_x0*, in the absence of changes in prices and technology, the supply of output of commodity *c* from industry *i* moves in proportion with the level of activity, *z(i)*.

The CET aggregation function is identical to CES, except that the transformation parameter, ρ, in the CET function must be less than -1 rather than greater than -1 as in the CES case. From equation *E_x0*, an increase in a commodity price (*p0(c,i)*), relative to the average ((*p0_e(i)*)), induces transformation in favour of that output. The technical change variable

(*a0(c,i)*) allows for commodity *c* output augmenting technical change in industry *i*. With a 10 per cent decrease in *a0(c,i)*, industry *i* is able to increase its output of commodity *c* by 10 per cent without changing the outputs of the other commodities or the levels of its inputs.

In equation *E_p0_e*, the variable *p0_e* is calculated as average revenue, which is the same as the effective price of a unit of activity. This reflects the zero profit condition in production. The total output for industry *i* is just the sum of the output of different commodities by *i*, shown in equation *E_x0ind*. Equation *E_x0dom* shows that total output of commodity *c* in the economy is obtained by adding up the outputs of *c* from different industries.

3.4 Demands for Inputs to Capital Creation (Investment Output Decisions)

It is assumed that capital is created by domestically produced and imported commodities. The nesting structure for the creation of capital is shown in Figure 3.2. In contrast to the structure of input demands in the production nest, the demands for investments require only commodity inputs. Thus, primary factors such as land, labour and capital are not used as inputs, although they are indirectly involved in capital creation through the intermediate inputs. Employment of primary factors in capital formation is handled indirectly through the employment in the industries producing domestic goods that are input to the capital creation process.

The creators of new units of physical capital are assumed to minimise the cost of capital creation subject to a nested production function shown in Figure 3.2. At the top level of the nesting structure, units of fixed capital used in industry *i* $\left(X_i^{(2)}\right)$ are created by combining the effective units of produced inputs, independent of prices according to a Leontief function:

$$X_{tot,i}^{(2)} = \min\left\{\frac{X_{1,i}^{(2)}}{A_{1,i}^{(2)}}, \ldots, \frac{X_{c,i}^{(2)}}{A_{c,i}^{(2)}}, \right\} \tag{3.9}$$

where

- the superscript (2) denotes the activity of investment; and

- $A_i^{(2)}$ and $A_{c,i}^{(2)}$ are positive coefficients denoting the efficiency with which inputs of c are used to create a unit of capital for industry i.

At the bottom level, imported and domestic varieties of each commodity input to capital creation are modelled as imperfect substitutes using CES aggregation functions (based on the Armington assumption) of the form:

$$X_{c,i}^{(2)} = \sum_{s \in SRC} CES\left[\frac{X_{c,s,i}^{(2)}}{A_{c,s,i}^{(2)}}\right] X_i^{(2)} \tag{3.10}$$

The TABLO code showing the demands for inputs used in the creation of capital is as follows:

Excerpt 3.6 Investment Demands

```
Equation E_x2_s # Demands for composite commodities for use in
capital creation#
  (All,c,COM)(All,i,IND)
  x2_s(c,i)- a2_s(c,i)= x2tot(i);

Equation E_x2 # Source-specific demands for inputs to capital
creation #
  (All,c,COM)(All,s,SRC)(All,i,IND)
  x2(c,s,i) = x2_s(c,i) + a2(i) - SIGMA2(c)*{p2(c,s,i) - p2_s(c,i)}
  + a2csi(c,s,i) - SIGMA2(c)*{a2csi(c,s,i) - a2csi_s(c,i)};

Equation E_p2_s # Effective price term for inputs-to-capital
equation #
  (All,c,COM)(All,i,IND)
  p2_s(c,i) = Sum{s,SRC,S2(c,s,i)*[p2(c,s,i)+a2csi(c,s,i)]};

Equation E_a2csi_s  # Technology in using composite intermediate
input #
  (All,c,COM)(All,i,IND)
  a2csi_s(c,i) = Sum{s,SRC,S2(c,s,i)*a2csi(c,s,i)};
```

Equation *E_x2_s* shows the percentage change in demands for composite commodities used in the creation of capital based on the cost minimisation via the Leontief function at the top level in Figure 3.2. In the absence of *c*-saving technical change in industry *i*, (*a2_s(c,i)*), a given percentage change in the units of capital *x2tot(i)* to be installed in industry i leads to the same percentage change in the demand for all composite inputs for capital creation *x2_c(c,i)* by that sector. This reflects the constant returns to scale property of the Leontief production function for capital creation.

The elasticity of substitution given by SIGMA2 governs the ability of substitution between domestic and imported inputs for capital creation. Similar to corresponding equations describing the source specific demands for intermediate inputs in the production nests (Section 3.2.2), the variable *a2(c,s,i)* plays two roles. The first is as an input-(*c,s*)-saving technical change for capital creation in industry *i*. If no substitution is assumed to occur (SIGMA2(c) = 0), when *a2(c,s,i)* decreases by 10 per cent, industry *i* would require 10 per cent less of intermediate input *c* for capital creation from source *s* to produce a given level of output *z(i)* holding constant all other inputs. With substitution (SIGMA2(c) ≠ 0), for a given *x2_s(c,i)*, a 10 per cent input-(*c,s*)-saving technical change would induce substitution towards input (*c,s*) and away from input *c* from the other source. The extent to which this substitution effect would lead to a net increase in the use of input *(c,s)* given the level of capital creation depends on the value of SIGMA2(c). If SIGMA2(c) is big enough, then the substitution effect in favour of using *(c,s)* would outweigh the input-(*c,s*)-saving effect from *a2csi(c,s,i)*.

The second role of *a2(c,s,i)* is as to decrease the cost per unit of a composite investment input *p2_s(c,i)* as shown in equation *E_p2_s(c,i)*. A value of -10 for *a2(c,s,i)* decreases the cost of a unit of composite investment input for capital creation in industry *i* by 10 times *S2(c,s,i)*, where this is the share of *c-s* in the cost of a unit of capital for industry *i*.

Figure 3.2   Structure of Investment Demand

```
                        ┌──────────────┐
                        │ Capital good │
                        │              │
                        │ Industry j   │
                        └──────────────┘
                               ▲
                          ╱────┴────╲
                         ◄  Leontief  ►
                          ╲─────────╱
                               ▲
              ┌────────────────┴────────────────┐
                              up to
              ┌────────┐   - - - -- - - --   ┌────────┐
              │ Good 1 │                     │ Good C │
              └────────┘                     └────────┘
                   ▲                              ▲
               ╱───┴───╲                      ╱───┴───╲
              ◄   CES   ►                    ◄   CES   ►
               ╲───────╱                      ╲───────╱
                   ▲                              ▲
           ┌───────┴───────┐              ┌───────┴───────┐
     ┌──────────┐   ┌──────────┐    ┌──────────┐   ┌──────────┐
     │ Domestic │   │ Imported │    │ Domestic │   │ Imported │
     │          │   │          │    │          │   │          │
     │ Good 1   │   │ Good 1   │    │ Good C   │   │ Good C   │
     └──────────┘   └──────────┘    └──────────┘   └──────────┘
```
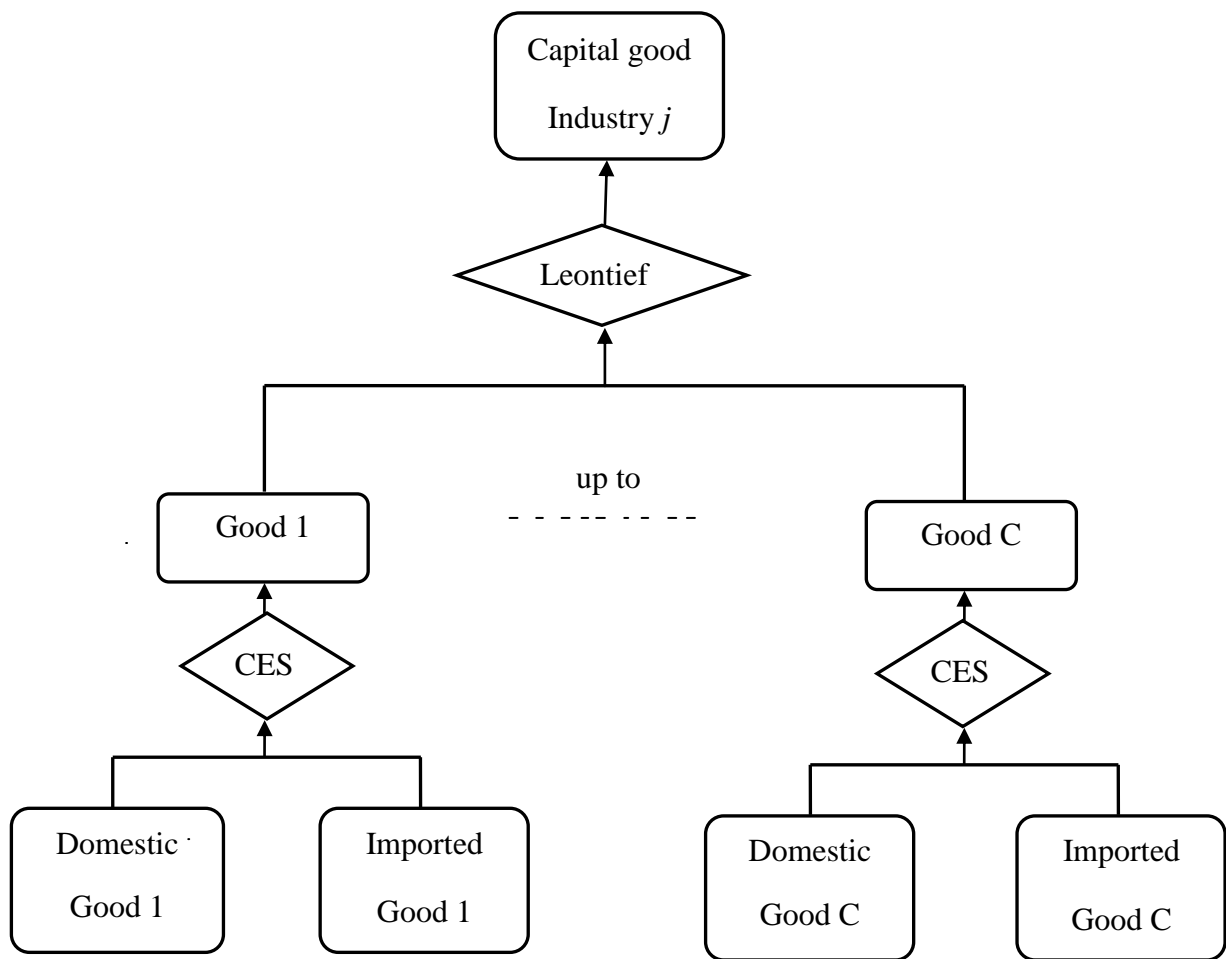
3.5   Household Demands

Households are price takers and are assumed to face a two-stage decision problem as shown in Figure 3.3. In the first stage, households choose their purchases in order to maximise their utility using an additive nested utility function subject to an aggregate expenditure constraint. This is similar to the structure of investment demand, but instead of the Leontief function, a more flexible functional form such as the Klein-Rubin utility function is adopted, where the household determines the optimal composition of its consumption bundle, $\left(X_c^{(3)}\right)$ subject to a budget constraint for utility maximization, given below:

Households choose $X_c^{(3)}$ to maximise

$$U = U\left(\frac{X_1^{(3)}}{A_1^{(3)}Q}, \ldots, \frac{X_c^{(3)}}{A_c^{(3)}Q}\right) \qquad\qquad (3.11)$$

subject to $\quad \displaystyle\sum_{c \in COM} \frac{X_c^{(3)}}{Q}P_c^{(3)} = \frac{V_{tot}^{(3)}}{Q} \qquad\qquad (3.12)$

where

- U is household utility, $X_c^{(3)}$ is economy-wide consumption of commodity c;

- $P_c^{(3)}$ is the household price for a unit of commodity c;

- Q is the number of households;

- $A_c^{(3)}$ is the combined change in household preferences for commodity c; and

- $V_{tot}^{(3)}$ is the aggregate household budget which is linked to household disposable income or some other income variable such as GNP or GDP.

Once the household determines levels for composite commodities, it will choose the sources of commodities in order to minimise costs based on a CES nest. This is given in the second stage, given as follows:

Choose $X_{c,s}^{(3)}$ to minimise $\displaystyle\sum_{s \in SRC}P_{c,s}^{(3)}X_{c,s}^{(3)} \qquad\qquad (3.13)$

subject to $\quad X_c^{(3)} = \underset{s \in SRC}{CES}\left(X_{c,s}^{(3)}\right) \qquad\qquad (3.14)$

where

- $X_{c,s}^{(3)}$ is the household demand for commodity c from source s; and

- $P_{c,s}^{(3)}$ is the household purchaser's price of source specific commodity c.

Excerpt 3.7 shows the TABLO code for household demands for commodities.

Excerpt 3.7   Household demands for Commodities

```
Equation  E_x3_s # Household demands for composite commodities #
  (All,c,COM)
  x3_s(c) - q = EPS(c)*(w3tot-q) + Sum{k,COM,ETA(c,k)*p3_s(k)}
                + a3com(c) - ave_a3com;

Equation E_ave_a3com # Average value of a3com #
  ave_a3com = Sum{k,COM, S3_S(k)*a3com(k)};

Equation E_deltapc
  # Movements in marginal budget shares in the linear expenditure
system #
  (All,c,COM) deltapc(c) = a3com(c) - Sum{k,COM, DELTA(k)*a3com(k)};

Equation E_d_gamma
  # Movements in subsistence variables in the linear expenditure
system #
  (All,c,COM) d_gamma(c) = [1 + EPS(c)/FRISCH]*[a3com(c)-ave_a3com];

Equation E_x3 # Source-specific commodity demands by household #
  (All,c,COM)(All,s,SRC)
  x3(c,s) = x3_s(c) - SIGMA3(c)*{p3(c,s) - p3_s(c)}
      + a3cs(c,s)- a3cs_s(c) - SIGMA3(c)*{a3cs(c,s) - a3cs_s(c)};

Equation E_p3_s # Effective price term of dom/imp-household demand
equation #
  (All,c,COM)
  p3_s(c) = Sum{s,SRC,S3(c,s)*p3(c,s)};

Equation E_a3cs_s  # Average household taste change #
  (All,c,COM)
  a3cs_s(c) = Sum{s,SRC,S3(c,s)*a3cs(c,s)};
```

In equation *E_x3_s, EPS(c)* is the household expenditure elasticities of demand for good *c* and *ETA(c,k)* is the elasticity of demand for commodity *c* with respect to changes in the price of commodity *k* (own and cross price elasticity of demand). The change in household

preferences is given by the term [*a3com(c)* – *ave_a3com*]. If the combined change in household taste variable *a3com(c)* is a positive value holding all other *a3com* zero, this allows for a movement in consumer preferences in favour of commodity *c* and away from other commodities.

Equation E_*x3* is the source-specific commodity demand by households and is analogous with the source-specific equations for intermediate and investment demands. The variable *x3(c,s)* depends on the total household demand for composite commodities, *x3_s(c)*, the relative prices of household commodities from different sources and the ability to substitute commodities from different sources, depicted by the parameter *SIGMA3(c)*, which is the household Armington elasticity. This suggests that household will decrease the demand for domestic commodities and substitute towards imported commodities when the weighted average price of imports and domestic commodities (*p3_s(c)*) becomes cheaper relative to the price of domestic commodities.

The (*c-s*) augmenting change in household preferences is given by the variable *a3cs(c,s)*, which allows for the change in preferences between domestic and imported good *c*. Whether a negative value for *a3cs(c,s)* increases or decreases the consumption of good *c* from domestic source depends on *SIGMA3(c)*. If *SIGMA3(c)<1*, then a negative value for *a3cs(c,s)* will generate a decrease in consumption of good *c* from source *s* and an increase in consumption of good c from the other source. If *SIGMA3(c)=1*, then movements in *a3cs(c,s)* will have no effect on consumption of good *c* from the two sources.

In MyAGE_LM, the Klein-Rubin specification for U in (3.11) is adopted, that is,

$$\text{Max } U = \sum_{c \in COM} \Delta_c \text{In}(X_c - \gamma_c) \tag{3.15}$$

$$\text{subject to } \sum_{c \in COM} X_c P_c = Y \tag{3.16}$$

where

- X_c and P_c are the quantity and price of good *c* consumed by households;

- Y is the budget constraint;

- Δ_c is a positive parameter with $\left(\sum_{c=1}^{k} \Delta_c = 1 \right)$; and

- γ_c is a parameter.

Under this specification, the price elasticity of demand for c with respect to k, (*ETA(c,k)*), in equation *E_x3_s*) is evaluated as[11]:

$$\text{ETA}(c, k) = -\text{KD}_{c,k} \frac{\Delta_c}{S_c} \frac{1}{F} - \frac{\Delta_c}{S_c} \left(S_c + \Delta_k \frac{1}{F} \right) \tag{3.17}$$

$$= \text{KD}_{c,k} \frac{E_c}{F} - E_c \left(S_k + \frac{\Delta_k}{F} \right) \tag{3.18}$$

where

- $\text{KD}_{c,k}$ is Kronecker delta, which takes the value of 1 if $c = k$ and the value of 0 if $c \neq k$;

- E_c is the household expenditure elasticity for commodity c;

- S_c is the share of expenditure on good c in total household expenditure, $S_c = \frac{P_c X_c}{Y}$; and

- F is the Frisch parameter, which is the negative of the inverse of the share of supernumerary expenditure in total household expenditure. That is, $F = -Y \Big/ \left(Y - \sum_{t \in \text{COM}} P_t \gamma_t \right)$, where $P_t \gamma_t$ is the household subsistence expenditure on good t.

---

[11] Full derivation can be found in Appendix A.2.

ETA(c,k) is interpreted as household own-and cross-price elasticity. The elasticity is the effect on household consumption of good *c* from a 1 per cent increase in the general price of good *k*. *EPS(c)* is household expenditure elasticity of good *c*, which is the effect of household consumption for a 1 per cent increase in average household expenditure.

In equation *E_x3_s,* the change in household preferences is given by the term [*a3com(c) – ave_a3com*]. However, by allowing household preferences to change, it is assumed that the utility function form in (3.11) is changing. Thus, equations *E_deltapc* and *E_d_gamma* are used to allow this change in preferences. Equations *E_deltapc* and *E_d_gamma* show how the change in household preferences *a3com(c)* affect the movements in marginal budget shares for commodity *c*, *deltapc(c)* and subsistence demands for commodity *c*, *d_gamma(c)* (as a percentage of consumption) respectively. The specifications of *deltapc(c)* and *d_gamma(c)* normally imply that a 10 per cent household preference shift in taste of commodity *c*, [*a3com(c) – ave_a3com*] is achieved by approximately 10 per cent increase in both *deltapc(c)* and *d_gamma(c)*.

Figure 3.3   Structure of Consumer Demand
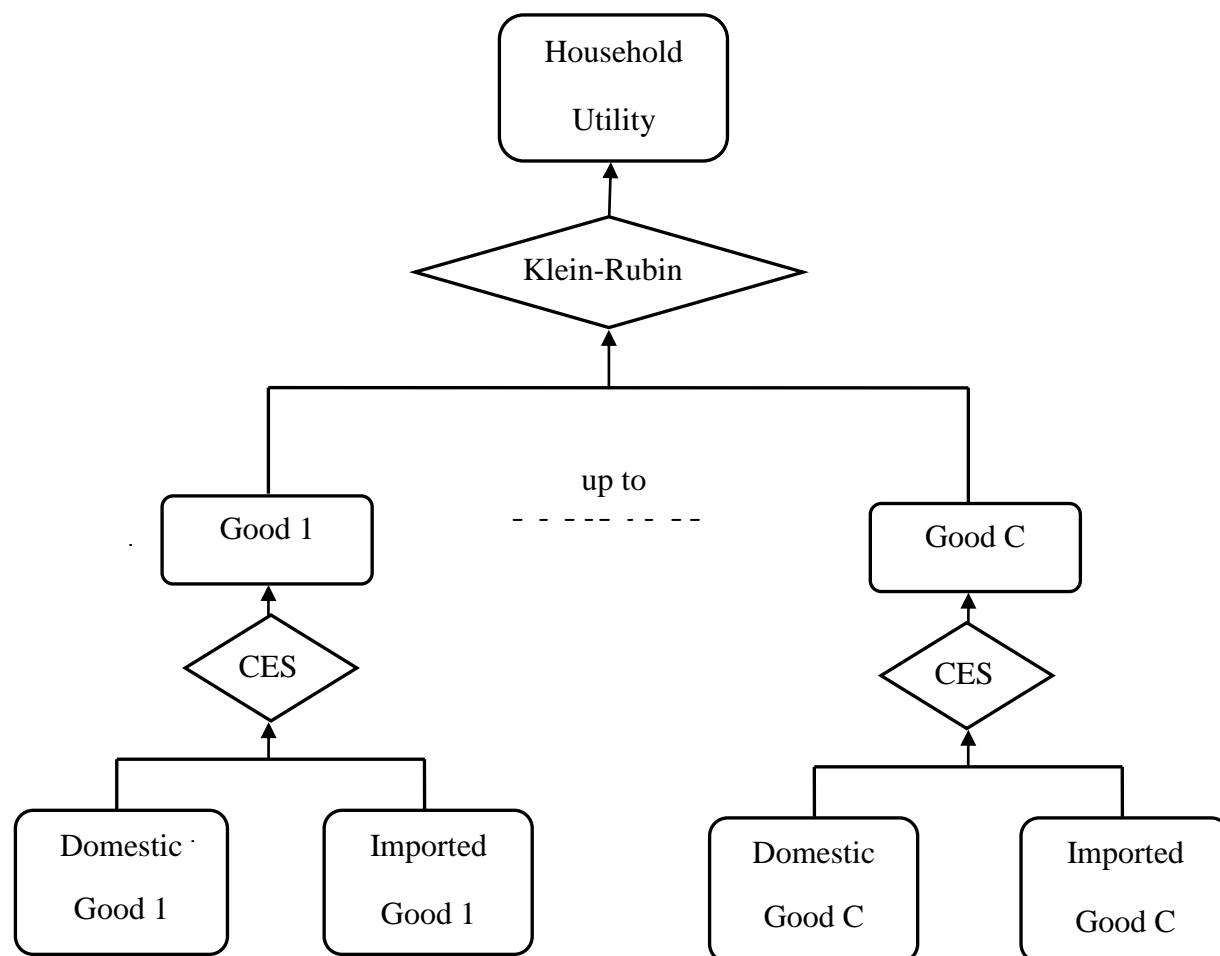
3.6   Export Demands

Foreign demands in Malaysia are given by export demand functions. In order to model the export demands, commodities in MyAGE_LM are divided into two groups; (1) Individual exports commodities (commodities for which exports are 20 per cent or more of total sales) and (2) Non-traditional exports, in which export comprises a small proportion of their sales (i.e., less than 20 per cent).

The biggest individual export commodities include electronics, office machinery, crude oil and gas, radio and television equipment. For individual exports commodities, export demand is inversely related to the commodity's price:

$$X_c^{(4)} = \left[\frac{P_c^{(4)}}{\Phi FP_c^{(4)} FP_{gen}^{(4)}} \right]^{\varepsilon_c} FQ_c^{(4)} FQ_{gen}^{(4)} \qquad (3.19)$$

where

- $X_c^{(4)}$ is the volume of exports of commodity c;

- $P_c^{(4)}$ is the f.o.b. export price of commodity c in Malaysian Ringgit;

- Φ is the foreign exchange rate defined as the price of a unit of foreign country's currency in terms of Malaysian Ringgit;

- ε_c is a parameters and is the elasticity of demand for good c; and

- F's are shift variables to allows the change in the position of the export demand curves.

From equation (3.19), $FP_c^{(4)}$ and $FQ_c^{(4)}$ allow for vertical and horizontal commodity-specific shifts in exports demand curves while $FP_{gen}^{(4)}$ and $FQ_{gen}^{(4)}$ allow for uniform vertical and horizontal shifts in all exports demand schedules.

Demand for non-traditional export commodities is modelled as demand for a collective product made up of a bundle of non-traditional export commodities. Demand for this collective product is negatively related to the price of the export bundle, which is a Divisia index of the prices of all non-traditional exports.

In TABLO language:

Excerpt 3.8 Export Demands

```
Equation  E_x4A  #  Export  demand  functions  -  individual  export
commodities#
  (All,c,INDEXP)
  x4(c)  = EXP_ELAST(c)*[p4(c) + phi - f4p(c)- f4pgen] + f4q(c) +
f4qgen;


Equation E_x4C # Export demand functions - composite export bundle #
  (All,c,NTRADEXP)
  x4(c) = EXPELASNTRD * [p4ntrad + phi - f4pntrad - f4pgen] +
f4q(c)+ f4qgen;



Equation E_p4ntrad
    [Sum{c,NTRADEXP, V4PUR(c)}] * p4ntrad = Sum{t,NTRADEXP, V4PUR(t)
* p4(t)};
```

Equation *E_x4A* shows that the percentage change in export demand for individual export commodity *c* depends on the percentage changes in f.o.b. export price of commodity *c* in Malaysian Ringgit and shift variables. The increase in the *p4(c)* would increase export demand of commodity *c*. The sensitivity of the export demand price depends on the export demand elasticity parameter *EXP_ELAST(c)*.

Equation *E_p4ntrad* shows the percentage change in the price of the non-traditional export bundle (*p4ntrad*) as the sum of f.o.b export prices. This price variable is an index of the prices of all non-traditional exports because there is no subscript *c* for *p4ntrad*.

For export commodities, there is a close connection between the price in Malaysia and the international price. This is legitimate for commodities in which exports represent a high share of Malaysian output. However, for services such as haircuts where there are very little exports, we would expect little connection between Malaysian price and the international price. Consequently, these commodities (which are called non-traditional export commodities) have a price index given by *p4ntrad*. This is reflected in equation *E_x4C* which specifies the non-traditional export demand commodities. With no *c* subscript on the price

term, when *f4pntrad* and *f4pgen* are set to zero, the export demands for all non-traditional exports move in the same proportion.

3.7 Government Demands

The demand for imported and domestically produced goods and services by the government is represented by government demand, *x5(c,s)*. The TABLO code in excerpt 3.9 shows two ways of modelling aggregate public consumption. In equation *E_fx5totA*, when the shift variable *fx5totA* is exogenous, aggregate public consumption (*x5tot*) will be proportional to the movements in real private consumption (*x3tot*). This means that the percentage movements in public consumption follow the percentage movements in private consumption. If the shift variable *fx5totB* in equation *E_fx5totB* is exogenous, this means that the aggregate nominal consumption (*x5tot* plus *p5tot*) is a fixed proportion of aggregate nominal consumption (both private and public).

Excerpt 3.9   Government Demands

```
Equation E_x5 # Government demand, undifferentiated by source #
    (All,c,COM)(All,s,SRC)
    x5(c,s) =  f5(c,s)  + f5gen;

Equation E_fx5totA # Indexation of real public consumption to real
private consumption#
x5tot = x3tot + fx5totA;

Equation E_fx5totB
#Nominal public cons'n linked to GNDI - useful for targeting G's
share in GNDI#
  x5tot + p5tot = w0gndi + apc_gndi + fx5totB;
```

3.8 Changes in Inventories

In most applications of the MyAGE model, the inventory demand for commodity *c* from source *s* moves in proportion to total output of the domestic commodity *c*. The TABLO code

for inventory demands is shown in excerpt 3.10. In this code, SDOM(s) has the value 1 if s equals domestic and zero if s equals imports.

Excerpt 3.10 Inventory Demands

```
Equation E_delx6 # Change in inventories #
(all,c,COM)(all,s,SRC)
100*P0LEV(c,s)*delx6(c,s) =
 V6BAS(c,s)*{SDOM(s)*x0dom(c) + [1-SDOM(s)] * x0imp(c) + fx6(c,s)};
```

In equation *E_delx6*, the *change* in inventory demand for commodity *c* from source *s* is used instead of the *percentage* change because inventory demands can pass through zero. The shifter *fx6* is included in the equation to determine the deviation in the movement in inventories from the movement in commodity supply. This shifter is also used to either activate or deactivate equation *E_delx6*.

With *fx6* being exogenous, equation *E_delx6* is turned on and the change in inventories is determined by the supply of domestic (*x0dom*) and imported (*x0imp*) goods. An example is agricultural commodities, where information is available on agricultural outputs, i.e., changes in the rate at which inventories are being accumulated or decummulated. If it is assumed that there is no change to inventories, then *fx6* will be endogenized and equation *E_delx6* is turned off.

3.9   Changes in Margins

Margins are services that are used to facilitate the flows of goods from producers to users (for domestically-produced commodities), or from the point of entry to users (for imported goods). In the adaptation of the MyAGE model used in this thesis, the original eight margins are aggregated into three margins (trade and repair; other transport services and highway, bridge and tunnel operation services). Also, since MyAGE_LM is a one-country model, the margins are only used to facilitate commodity flows within Malaysia.

In the absence of margin-using technical change, it is assumed that each margin service is used in fixed proportion to the commodity flow that it facilitates. Thus, the use of margin

service m in facilitating the flow of commodity c from source s to user u $\left(X_{c,m}^{(u)}\right)$ is specified by the following equation:

$$X_{c,s,m}^{(u)} = A_{c,s,m}^{(u)} * X_{c,s}^{(u)} \qquad\qquad (3.20)$$

where

- $A_{c,s,m}^{(u)}$ is a technological variable representing the quantity of margin service m required per unit of flow (c,s,u).

The TABLO code for the change in margins in the MyAGE_LM model is shown in excerpt 3.11.

Excerpt 3.11 Change in Margins

```
Equation E_x1mar  # Margins on inputs to production#
  (All,c,COM)(All,s,SRC)(All,i,IND)(All,m,MAR)
  x1mar(c,s,i,m) = x1(c,s,i) + a1mar(c,s,i,m);

Equation E_x2mar  # Margins on inputs to capital creation #
  (All,c,COM)(All,s,SRC)(All,i,IND)(All,m,MAR)
  x2mar(c,s,i,m) = x2(c,s,i) + a2mar(c,s,i,m);

Equation E_x3mar  # Margins on flows of commodities to households  #
  (All,c,COM)(All,s,SRC)(All,m,MAR)
  x3mar(c,s,m) = x3(c,s) + a3mar(c,s,m);

Equation E_x4mar  # Margins on flows of exports to ports of exit #
  (All,c,COM)(All,m,MAR)
  x4mar(c,m) = x4(c)+ a4mar(c,m);

Equation E_x5mar  # Margins on flows of commodities to government  #
  (All,c,COM)(All,s,SRC)(All,m,MAR)
  x5mar(c,s,m) = x5(c,s) + a5mar(c,s,m);
```

3.10 Zero Pure Profit Conditions

The price system in the MyAGE_LM model is based on two assumptions: (1) The absence of pure profits in the production of commodities and capital and in the distribution of commodities; and (2) The basic prices received by the producer is uniform across all customers.

3.10.1 Zero Pure Profits in Production

The total basic value of industry i's output $\left(V_i^{(1)}\right)$ is defined as the sum of domestic and imported intermediate input costs $\left(\sum_c \sum_s V_{c,s,i}^{(1)}\right)$, factor payments (labour, capital and land) and taxes on production $\left(\sum_{t \in PTAX} V_{PTAX(t,i)}^{(1)}\right)$. This is written as:

$$V_i^{(1)} = \sum_{c \in COM} V_{c,i}^{(1)} + V_{lab,i}^{(1)} + V_{cap,i}^{(1)} + V_{lnd,i}^{(1)} + \sum_{t \in PTAX} V_{PTAX(t,i)}^{(1)} \tag{3.21}$$

Replacing each of the (V) with (P.X) gives:

$$P_i^{(0)}Z_i = \sum_{c \in COM} P_{c,i}^{(1)}X_{c,i}^{(1)} + P_{lab,i}^{(1)}X_{lab,i}^{(1)} + P_{cap,i}^{(1)}X_{cap,i}^{(1)} + P_{lnd,i}^{(1)}X_{lnd,i}^{(1)} + \sum_{t \in PTAX} P_{i,dom}^{(0)}Z_i^{(1)}\left(T_{t,i}^{(1)} - 1\right) \tag{3.22}$$

where

- $P_i^{(0)}$ is the basic price of industry i's output;

- Z_i is the output of industry i for intermediate input c;

- $P_{c,i}^{(1)}$ is the price faced by industry i (purchaser's price for intermediate input c);

- $X_{c,i}^{(1)}$ is the quantity of intermediate input c used in industry i;

- $P_{lab,i}^{(1)}$ is the average price of labour used in industry i;

- $X_{lab,i}^{(1)}$ is the quantity of labour used in industry i;

- $P_{cap,i}^{(1)}$ and $P_{lnd,i}^{(1)}$ are rental prices of capital and land respectively used in industry i;

- $X_{cap,i}^{(1)}$ and $X_{lnd,i}^{(1)}$ are quantities of capital and land used in industry i respectively; and

- $T_{t,i}^{(1)}$ is the power (one plus tax rate) of production tax type t levied on industry i.

Converting equation (3.22) into percentage form and eliminating the quantity variables using the input demand equations gives the following expression[12]:

$$\left[V_i^{(1)} - \sum_{t \in PTAX} V_{PTAX(t,i)}^{(1)} \right]\left(p_i^{(0)} - a_i \right) = \sum_{c \in COM} V_{c,i}^{(1)} p_{c,i}^{(1)} + V_{lab,i}^{(1)} p_{lab,i}^{(1)} + V_{cap,i}^{(1)} p_{cap,i}^{(1)} + V_{lnd,i}^{(1)} p_{lnd,i}^{(1)} \qquad (3.23)$$

$$+ \sum_{t \in PTAX} \left(V_i^{(1)} + V_{PTAX(t,i)}^{(1)} \right) t_{t,i}$$

where a_i is the weighted average of the percentage changes in industry i's input-using technical changes, calculated as:

$$\left[V_i^{(1)} - \sum_{t \in PTAX} V_{PTAX(t,i)}^{(1)} \right] a_i =$$

$$\sum_{c \in COM} MAKE_{c,i} a_{c,i}^{(0)} + \sum_{c \in COM} V_{c,i}^{(1)} \left(a_{c,i}^{(1)} + a_i^{(1)} \right) + \sum_{c \in COM} \sum_{s \in SRC} V_{c,s,i}^{(1)} a_{c,s,i}^{(1)}$$

$$+ V_{lab,i}^{(1)} \left(a_{lab,i}^{(1)} + a_i^{(1)} \right) + V_{cap,i}^{(1)} \left(a_{cap,i}^{(1)} + a_i^{(1)} \right) + V_{lnd,i}^{(1)} \left(a_{lnd,i}^{(1)} + a_i^{(1)} \right) + V_{prim,i}^{(1)} a_{prim,i}^{(1)} \qquad (3.24)$$

Equation (3.22) is represented by equation *E_p0ind* while equations (3.23) and (3.24) represent *E_z* and *E_a* respectively. The *z's* and *x's* disappear because of the constant returns to scale assumption, where both revenue and costs per unit of activity are independent of the activity level. They are only affected by the changes in prices and technology. The TABLO

---

[12] An example of how the quantity variables (x's) are eliminated using the output variables (z's) is shown in Appendix A.3.

code for zero pure profit conditions in the production of industry output, capital creation and from imports are shown as follows:

Excerpt 3.12 Zero Pure Profits in Production

```
Equation E_p0ind # Price of industry outputs #
  (All,i,IND)
  MAKE_C(i)*p0ind(i) = Sum{c,COM,MAKE(c,i)*p0ci(c,i)};


Equation E_z  # Zero pure profits in production #
  (All,i,IND)
  [V1TOT(i)-Sum{t,PTAX, V1PTX(t,i)}]*(p0ind(i) - a(i))=
    Sum{c,COM,V1PUR_S(c,i)*(p1_s(c,i))}  +
    V1lab_o(i)*p1lab_o(i) + V1CAP(i)*p1cap(i) + V1LND(i)*p1lnd(i) +
    Sum{t,PTAX, [V1TOT(i)+V1PTX(t,i)]*t1ptx(t,i)};


Equation E_a # Technical change by industry #
  (All,i,IND)
  [V1TOT(i)-Sum{t,PTAX,V1PTX(t,i)}]*a(i) =
    Sum{c,COM,MAKE(c,i)* a0(c,i)}
         +  Sum{c,COM,V1PUR_S(c,i)*(a1_s(c,i)+a1(i))}
        +  Sum{c,COM,Sum{s,SRC, V1PUR(c,s,i)*a1csi(c,s,i)}}
        + V1lab_o(i)*(a1lab_o(i)+a1(i)) + V1CAP(i)*(a1cap(i)+a1(i))+
        V1LND(i)*(a1lnd(i)+a1(i)) +  V1PRIM(i)*a1prim(i);
```

Equation *E_p0ind* shows the percentage change in industry *i*'s basic price as a weighted average of percentage changes in the price of commodity *c* for industry *i*.

In equation *E_z,* the technical change variable for industry *i* captures the effects of a unit costs of changes in technology. A 10 per cent decrease in *a(i)* decreases industry *i*'s unit costs by 10 per cent. Each of the changes in input prices: *p1lab_0(i)*, *p1cap(i)*, *p1lnd(i)* and tax power in production taxes *t1ptx(t,i)* is weighted reflecting the share of the input in *i*'s costs net of production taxes. The reason that these shares in input prices are calculated as input costs divided by total costs of net production of taxes is to ensure that they sum to one.

3.10.2   Zero Pure Profits in Capital Creation

For the zero profit capital creation condition, the total value of industry i's investment is equal to the total values of inputs to the industry's capital formation. As shown in the TABLO code below, equation E_p2tot shows the percentage change in the per-unit cost of new capital for industry i ($p2tot$) as a share weighted sum of the changes in the costs of the effective inputs to the capital production of that industry.

Excerpt 3.13 Pure Profits in Capital Creation

```
Equation E_p2tot  # Zero pure profits in capital creation #
  (All,i,IND)
  V2TOT(i)*p2tot(i) = Sum{c,COM,Sum{s,SRC,
    V2PUR(c,s,i)*[p2_s(c,i)+a2(i) + a2_s(c,i)+a2csi(c,s,i)]}};
```

3.10.3   Zero Pure Profits in Importing

For the zero profit condition in importing, the revenue received by the importer per unit of import sold $\left(P_{c,imp}^{(0)}\right)$ is equal to the foreign currency measured in c.i.f. (cost, insurance, freight) price of imports $\left(P_c^{*(0)}\right)$, converted to domestic currency via the current nominal exchange rate (Φ), and multiplied by the power of the tariff $\left(T_{imp}^{(0)}\right)$. This is shown in the equation below:

$$P_{c,imp}^{(0)} = \frac{P_c^{*(0)}}{\Phi} T_{imp}^{(0)} \tag{3.25}$$

The TABLO input file is as follows:

Excerpt 3.14 Pure Profits in Importing

```
Equation E_p0imp  # Zero pure profits in importing #
  (All,c,COM)
  p0imp(c) = pf0cif(c) - phi + t0imp(c);
```

3.10.4 Zero Pure Profits in Supplying Goods to Users

In MyAGE_LM, it is assumed that zero pure profits are earned in the distribution of goods to the end users of those goods. This relationship is shown where the total value of purchasers of (c,s) by user u $\left(V_{pur(c,s)}^{(u)}\right)$ equals the total basic value $\left(V_{bas(c,s)}^{(u)}\right)$, commodity tax $\left(V_{tax(c,s,t)}^{(u)}\right)$ and margin services $\left(V_{mar(c,s,t)}^{(u)}\right)$ associated with that purchase:

$$V_{pur(c,s)}^{(u)} = V_{bas(c,s)}^{(u)} + \sum_{t\in CTAX} V_{tax(c,s,t)}^{(u)} + \sum_{m\in MAR} V_{mar(c,s,m)}^{(u)} \tag{3.26}$$

The zero pure profit in supply to producers, investors, households, export and the government in percentage form is shown in the TABLO code below:

Excerpt 3.15 Pure Profits in Movement of Commodities

```
Equation E_p0 # Definition of basic prices of commodities #
  (All,c,COM)(All,s,SRC)
  p0(c,s) = SDOM(s)*p0dom(c) + (1-SDOM(s))*p0imp(c);

Equation E_p1  # Purchasers prices of inputs to producers #
  (All,c,COM)(All,s,SRC)(All,i,IND)
  [V1PUR(c,s,i)+TINY]*p1(c,s,i)  =
    [V1BAS(c,s,i)+Sum{t,CTAX,V1TAX(c,s,i,t)}+TINY] *
        [p0(c,s) + Sum{t,CTAX, t1(c,s,i,t)} ]  +
        Sum{m,MAR,   V1MAR(c,s,i,m)*(p0(m,"dom")+a1mar(c,s,i,m))};

Equation E_p2 # Purchasers prices of inputs to capital creation #
  (All,c,COM)(All,s,SRC)(All,i,IND)
  [V2PUR(c,s,i)+TINY]*p2(c,s,i) =
        [V2BAS(c,s,i)+Sum{t,CTAX,V2TAX(c,s,i,t)}+TINY]*
            [p0(c,s) +Sum{t,CTAX, t2(c,s,i,t)}] +
        Sum{m,MAR,V2MAR(c,s,i,m)*(p0(m,"dom")+a2mar(c,s,i,m))};

Equation E_p3 #Purchasers prices for commodity flows to households #
  (All,c,COM)(All,s,SRC)
  [V3PUR(c,s)+TINY]*p3(c,s) =
        [V3BAS(c,s)+Sum{t,CTAX,V3TAX(c,s,t)}+TINY] *
```

```
            [p0(c,s) + Sum{t,CTAX, t3(c,s,t) }] +
        Sum{m,MAR,V3MAR(c,s,m)*(p0(m,"dom")+a3mar(c,s,m))};


Equation E_p4 # Fob export prices #
  (All,c,COM)
  [V4PUR(c)+TINY] *p4(c) =
        [V4BAS(c)+Sum{t,CTAX,V4TAX(c,t)}+TINY] *
            [p0(c,"dom") + Sum{t,CTAX, t4(c,t) } ]   +
        Sum{m,MAR,V4MAR(c,m)*(p0(m,"dom")+a4mar(c,m))};


Equation E_p5 # Purchasers prices for commodity flows to government
#
  (All,c,COM)(All,s,SRC)
  [V5PUR(c,s)+TINY]*p5(c,s) =
        [V5BAS(c,s)+Sum{t,CTAX,V5TAX(c,s,t)}+TINY] *
            [p0(c,s) + Sum{t,CTAX,  t5(c,s,t) } ] +
        Sum{m,MAR,V5MAR(c,s,m)*(p0(m,"dom")+a5mar(c,s,m))};
```

Equations E_p1 to E_p5 equate purchasers' price to basic prices plus sales tax and margins costs. In equation E_p1, $p1(c,s,i)$ is the purchasers' price for industry i for intermediate input c from source s. The variable $p0(c,s)$ is the basic price of commodity c from source s and $t1(c,s,i,t)$ is the intermediate sales tax power. The margin cost $p0(i,"dom")$ reflects the assumption that all margins are produced domestically. Variations in purchasers' price across intermediate users of (c,s) stem from the variations in the rate of sales tax and margin services. It is assumed that the basic prices received by producers are the same across all purchasers. The theoretical explanations for equations E_p2, E_p3 and E_p5 are the same as E_p1.

In equation E_p4, there is no subscript s because only the purchaser price for commodity c from domestic source is considered. It is assumed that imports are not re-exported and only domestic variety is exported. Also, similar to the MONASH model, the purchaser's price of exports are in Malaysian Ringgit at Malaysian ports of exit; i.e. *f.o.b* prices.

3.11 Market Clearing Conditions (Demand Equals Supply)

The market clearing conditions in the MyAGE_LM model equate the demand and supply for domestic commodities and for imported commodities. Under this assumption, there is no excess supply or demand for commodities. Market clearing equations for domestic goods ensure that the total supply of domestic goods equals the total demand from domestic agents and foreigners (exports).

3.11.1 Supplies of Domestic Commodities Equal Demands

The commodity market clearing condition for non-margin commodity is given in the following equation:

$$X_{c,s}^{(0)} = \sum_{i \in IND} X_{c,s,i}^{(1)} + \sum_{i \in IND} X_{c,s,i}^{(2)} + X_{c,s}^{(3)} + X_{c,s}^{(4)} + X_{c,s}^{(5)} + X_{c,s}^{(6)} \qquad (3.27)$$

where

- $X_{c,s}^{(0)}$ is the quantity supplied of good c from source s to all users;

- $X_{c,s,i}^{(1)}$ is the demand for commodity (c,s) by industry i for current production;

- $X_{c,s,i}^{(2)}$ is the demand for commodity (c,s) by industry i for capital formation;

- $X_{c,s}^{(3)}$ is the demand for (c,s) for consumption;

- $X_{c,s}^{(4)}$ is the export demand for (c,s);

- $X_{c,s}^{(5)}$ is the demand for (c,s) for public consumption; and

- $X_{c,s}^{(6)}$ is the demand for (c,s) for the accumulation of inventory. Also, it is assumed that imports and not re-exported. Hence, $X_{c,imp}^{(4)} = 0$.

The differences in the specification of demand for margin commodities and non-margin commodities are: (1) Margin commodities are used to facilitate the flow of other

commodities, as well as directly; and (2) Margin commodities are domestically produced. Hence, the market clearing condition for margin commodities applies only to *s=1* and is expressed as:

$$X_{m,1}^{(0)} = \sum_{i \in IND} X_{m,1,i}^{(1)} + \sum_{i \in IND} X_{m,1,i}^{(2)} + X_{m,1}^{(3)} + X_{m,1}^{(4)} + X_{m,1}^{(5)} + X_{m,1}^{(6)}$$

$$+ \sum_{c \in COM} \sum_{s \in SRC} \sum_{i \in IND} \left(X_{c,s,i,m}^{(1)} + X_{c,s,i,m}^{2} \right) + \sum_{c \in COM} \sum_{s \in SRC} X_{c,s,m}^{(3)}$$

$$+ \sum_{i \in IND} X_{c,m}^{(4)} + \sum_{c \in COM} \sum_{s \in SRC} X_{c,s,m}^{(5)}$$

(3.28)

where

- $X_{m,1}^{(0)}$ is the domestic production of margin commodity *m*;

- $X_{m,1,i}^{(1)}$ is the demand for commodity *m* by industry *i* for input to current production;

- $X_{m,1,i}^{(2)}$ is the demand for commodity *m* by industry *i* for the use in capital;

- $X_{m,1}^{(3)}$ is the demand for commodity *m* for household consumption;

- $X_{m,1}^{(4)}$ is the foreign demand for commodity *m*;

- $X_{m,1}^{(5)}$ is public consumption demand for commodity *m*;

- $X_{m,1}^{(6)}$ is the demand for commodity *m* for addition to stocks;

- $X_{c,s,i,m}^{(1)}$ is the demand for commodity *m* as a margin service to facilitate flows of (*c,s*) to industry *i* for current production processes;

- $X_{c,s,i,m}^{(2)}$ is the demand for commodity *m* as a margin service to facilitate flows of (*c,s*) to industry *i* for the formation of capital;

- $X_{c,s,m}^{(3)}$ is the demand for commodity *m* as a margin service to facilitate purchases of commodity (*c,s*) by households;

- $X_{c,m}^{(4)}$ is the demand for commodity *m* as a margin service to facilitate purchases of domestic commodity *c* to the export market; and

- $X_{c,s,m}^{(5)}$ is the demand for commodity *m* as a margin service to facilitate purchases of commodity (*c,s*) by the government.

The TABLO code below shows the equations for non-margin commodities (*E_p0domA*) and margin commodities (*E_p0domB*).

Excerpt 3.16 Supplies of Domestic Commodities Equals Demand

```
Equation E_p0domA  # Demand equals supply for dom. non-margin
commodities #
  (All,n,NONMAR)
  (SALES(n)+TINY)*x0dom(n) =
Sum{i,IND,V1BAS(n,"dom",i)*x1(n,"dom",i)
    + V2BAS(n,"dom",i)*x2(n,"dom",i)}
    + V3BAS(n,"dom")*x3(n,"dom") +
V4BAS(n)*x4(n)+V5BAS(n,"dom")*x5(n,"dom")
    + 100*P0LEV(n,"dom")*delx6(n,"dom");


Equation E_p0domB  # Demand equals supply for domestic margin
commodities #
  (All,m,MAR)
  (SALES(m)+TINY)*x0dom(m) =
    Sum{i,IND,  V1BAS(m,"dom",i)*x1(m,"dom",i)      +
                V2BAS(m,"dom",i)*x2(m,"dom",i)}     +
                V3BAS(m,"dom")  *x3(m,"dom") +
                V4BAS(m)*x4(m)+
                V5BAS(m,"dom")*x5(m,"dom") +
                100*P0LEV(m,"dom")*delx6(m,"dom") +
                Sum{c,COM,V4MAR(c,m)*x4mar(c,m) +
                Sum{s,SRC,
V3MAR(c,s,m)*x3mar(c,s,m)+V5MAR(c,s,m)*x5mar(c,s,m)+
                Sum{i,IND,V1MAR(c,s,i,m)*x1mar(c,s,i,m)+
                        V2MAR(c,s,i,m)*x2mar(c,s,i,m)}}};
```

```
Equation E_x0imp # Supplies of imports equal demands for imports   #
  (All,c,COM)
  (V0IMP(c)+TINY)*x0imp(c) =
Sum{i,IND,V1BAS(c,"imp",i)*x1(c,"imp",i)
    + V2BAS(c,"imp",i)*x2(c,"imp",i)} + V3BAS(c,"imp")*x3(c,"imp") +
      V5BAS(c,"imp")*x5(c,"imp") +
100*P0LEV(c,"imp")*delx6(c,"imp");
```

In equation *E_p0domA*, *x0dom(n)* is the percentage change in the supplies of domestic non-margin good ,which is the sum of intermediate [*x1(n,"dom",i)*], investment [*x2(n, "dom",i)*] , household [*x3(n,"dom")*], export [*x4(n)*], government [*x5(n,"dom")*] and [*delx6(n,"dom")*] demands. There is no percentage change in basic prices because *SALES(n)* is the sum of demands in basic values and can be omitted. Equation *E_x0imp(c)* is the percentage change in the supply and demand of imports of good *c*.

The percentage changes in the margin demands in equation *E_p0domB* for domestic good *m* are weighted by the basic values of their associated margin flows. This equation imposes a supply/demand balance for domestic margin commodities. If margin services used to facilitate the flow of commodity *c* from source *s* to households represents 10 per cent of household demand for domestic good *m*: i.e., $\left[\dfrac{V3MAR(c,s,m)}{SALES(m)} = 0.1\right]$, then according to equation *E_p0domB*, a 50 per cent increase in X3MAR(c,s,m), that is, *x3mar(c,s,m) = 50*, increases overall demand of domestic good *m* by 5 per cent.

3.11.2   Factor Market Clearance

In the TABLO code below (excerpt 3.17), the percentage change in the quantity of capital demanded by each industry (*x1cap (i)*) equals the percentage change in the quantity of capital supplied to that industry by investors (*cap_t(i)*). This is given in equation *E_cap_t*. In year-on-year simulations of the type conducted in this thesis, *cap_t(i)* is effectively exogenous in each year, reflecting the level of capital inherited from the previous year.

Equation *E_employ_oi* calculates the percentage change in employment for occupation *o* as a share weighted sum of percentage changes in the demand for occupation *o* in each industry. Equation *E_employ_i* defines the percentage change in aggregate employment.

If the percentage change in aggregate employment, *employ_i*, is set exogenously to reflect the movement in labour supply, then we have a simulation in which it is assumed that the shock under consideration does not affect the rate of unemployment. Similarly, we can set *employ_i(o)* exogenously if we want to simulate under the assumption that there is full employment in occupation *o*. However, in this thesis, both *employ_i* and *employ_i(o)* are treated as endogenous variables. They may move independently of labour supply at both the aggregate and occupational levels.

Excerpt 3.17 Factor Market Clearances

```
Equation E_cap_t  # Demand equals supply for capital #
  (All,i,IND)
  x1cap(i) = cap_t(i);

Equation E_employ_i  # Aggregate employment, wage bill weights, by L
types #
 (All,o,OCC)V1LAB_I(o)*employ_i(o) =
Sum{i,IND,V1LAB(o,i)*x1lab(o,i)};

Equation E_employ_oi  # Aggregate employment, wage bill weights #
    V1LAB_OI*employ_oi = Sum{i,IND,V1lab_o(i)*x1lab_o(i)};
```

3.12   Rates of Return and Investment/Capital Ratios

3.12.1   After-Tax Rate of Return

The return on capital is defined as the ratio of (1) the net present value $\left(\text{NPV}_{i,t}\right)$ of purchasing in year t a unit of physical capital for use in industry i to (2) the cost of the creation of one unit of capital for the use in industry i. The equation below describes the net present value of a unit of physical capital in industry i:

$$\text{NPV}_{i,t} = -P_{i,t}^{(2)} + \frac{P_{\text{cap},i,t+1}^{(1)}\left(1 - t_{i,t+1}\right)}{1 + R\left(1 - t_{i,t+1}\right)} + \frac{P_{i,t+1}^{(2)}\left(1 - D_i\right)}{1 + R\left(1 - t_{k,t+1}\right)} \tag{3.29}$$

where

- $P_{i,t}^{(2)}$ is the cost of constructing in year t a unit of capital for use in industry i;

- D_i is the depreciation rate of i's capital stock;

- $P_{cap,i,t}^{(1)}$ is the rental rate on i's capital in year t;

- $t_{i,t}$ is the tax rate on i's gross capital income in year t; and

- R is the nominal rate of interest in year t.

Equation (3.29) shows the net present value of purchasing one unit of capital in year t for industry i equals the difference between the discounted values of the year $t+1$ benefits from that unit of capital and the cost of acquiring those benefits $\left(P_{i,t}^{(2)}\right)$. The future benefits in year $t+1$ include the post-tax rent earned on the unit of capital $\left(P_{cap,i,t+1}^{(1)}\left(1-t_{i,t+1}\right)\right)$ and the capital scrap value at the end of $t+1$ $\left(P_{i,t+1}^{(2)}\left(1-D_i\right)\right)$. The discount rate is one plus the tax-adjusted interest rate.

The rate of return is derived by dividing both sides of equation (3.29) by $P_{i,t}^{(2)}$, which is the cost of acquiring the unit of capital in year t, giving the following:

$$ROR_{i,t} = -1 + \frac{P_{cap,i,t+1}^{(1)}\left(1-t_{i,t+1}\right)}{P_{i,t}^{(2)}\left[1+R\left(1-t_{i,t+1}\right)\right]} + \frac{P_{i,t+1}^{(2)}\left(1-D_i\right)}{P_{i,t}^{(2)}\left[1+R\left(1-t_{k,t+1}\right)\right]} \tag{3.30}$$

It can be seen from equation (3.30) that the calculation of expected rates of return in year t requires making an assumption about how investors form expectations about values for $t+1$ subscripted variables. For static assumptions, investors anticipate an unchanged capital tax rate, and assume that per-unit capital rental rates and asset prices will inflate by the current rate of general price inflation, where $P_{i,t+1}^{(1)} = P_{i,t}^{(1)}\left(1+INF_t\right)$ and $P_{i,t+1}^{(2)} = P_{i,t}^{(2)}\left(1+INF_t\right)$. Using this assumption, the expected rate of return (ROR_t) is given by:

$$E_t\left[ROR_{i,t}\right] = -1 + \left[\frac{P_{i,t}^{(1)}\left(1 - t_{i,t}\right)}{P_{i,t}^{(2)}} + \left(1 - D_i\right)\right]\left[\frac{1 + INF_t}{\left[1 + R\left(1 - t_{i,t}\right)\right]}\right] \qquad (3.31)$$

Excerpt 3.18 Change in the Expected Rates of Return

```
Equation E_del_ror # Changes in expected rors by industry: static
exp. #
(All,i,IND) 100*del_ror(i) = (1/(1 + RINT_PT(i)))*
        { [V1CAP(i)*(1-TAX_K_RATE(i))/VCAP(i)]*[p1cap(i) -
p2tot(i)]
          -TAX_K_RATE(i)*[V1CAP (i)/VCAP(i)]*tax_k_r(i)
     -[ V1CAP (i)*(1-TAX_K_RATE(i))/VCAP(i)+1-DEP(i)]*
          (1/[(1 + RINT_PT(i))])*100*d_rint_pt(i) };

Equation E_d_rint_pt
# Change in real post-tax rate of interest #
(all,i,IND) 100*d_rint_pt(i) = (1/(1+INF))*{100*(1-
TAX_K_RATE(i))*d_int
              - INT*TAX_K_RATE(i)*tax_k_r(i)
              - 100*(1/(1+INF))*(1+INT*(1-TAX_K_RATE(i)))*d_inf};

Equation E_d_int # Nominal rate of interest #
d_int = (1+INF)*d_rint + (1+RINT)*d_inf;
```

In the TABLO code, the linearized form of equation (3.31) is given by equation *E_del_ror*, where the nominal interest rate *R* is replaced by the static expectation of real post-tax, inflation-adjusted interest rate for industry *i*, *RINT_PT(i)* defined as $\left[\dfrac{1}{1 + RINT\_PT_t} = \dfrac{1 + INF_t}{\left[1 + R\left(1 - t_{i,t}\right)\right]}\right]$. The change in the real post-tax interest rate is given by equation *E_d_rint_pt* where *d_int* is the change in nominal rate of interest, *d_inf* is the change in the rate of inflation and *tax_k_r* is the rate of tax on capital income. The change in the before-tax real rate of interest is given in *E_d_int*.

Model such a MyAGE_LM can be run under forward looking expectations of the type discussed in Chapter 2 (Section 2.7). In this case, the *t+1* variables on the right hand side of equation (3.30) are replaced by model outcomes for year *t+1*. With this approach, an iterative

solution method such as shooting must be used. For this thesis, iterative methods are avoided by using the static expectation assumption.

3.12.2   Ratios of Investment to Capital and the Determination of Investment

The investment-capital ratio is related to the rate of capital accumulation and the depreciation rate as follows:

$$\frac{I_{i,t}}{K_{i,t}} = \frac{K_{i,t+1}}{K_{i,t}} - 1 + D_i = Kgr_i + D_i \tag{3.32}$$

where

Kgr_i is the growth rate of industry i's capital stock.

In comparative static long-run simulations, it is normally assumed that it is the solution year in which the economy reaches a steady state, with the growth rate in capital $\left(Kgr_i\right)$ returning to control. The depreciation rate $\left(D_i\right)$ is usually assumed to be a parameter, and therefore constant over time. Based on that assumption, equation (3.32) implies that the investment-capital ratio would also return to its basecase forecast. This concept is expressed in MyAGE_LM in the form:

$$I_{i,t} \big/ K_{i,t} = R_i R_{gen} \tag{3.33}$$

where

- R_i and R_{gen} are industry-specific and general shift variables that can be used to impose exogenous changes in I/K ratios. In this thesis, it is generally assumed that the I/K ratios adjust endogenously to the shocks under consideration. In this case, R_{gen} is exogenous but R_i is endogenous.

In TABLO code, equation (3.33) is represented by *E_x2tot* in excerpt 3.19. If *r_inv_cap_u* is exogenous on zero change, then *r_inv_cap(i)* is used to compute percentage changes

(endogenously or exogenously) in investment/capital ratios. For long run comparative static simulations, *r_inv_cap(i)* will be normally be exogenous. Then, equation *E_x2tot* can be used to force all industries to have the same percentage changes in their investment/capital ratios to hit an exogenous target for investment.

Equations *E_f2tot_i* and *E_ff2tot_i* are used for providing variations in determining aggregate investment. Usually, the *f2tot_i* and *ff2tot_i* shifters will be endogenous, hence turning equations *E_f2tot_i* and *E_ff2tot_i* off. However, for long run and forecasting simulations, these two equations can be used to lock the movements in aggregate real investment with either real household consumption (*f2tot_i* exogenous) or real GDP, (*ff2tot_i* exogenous).

For industries where investment is not mainly driven by current profits such as the education industry, the shifter for exogenous investment rule, *finv2* can be exogenized such that investment *x2tot(i)* will follow the movement in aggregate real investment *x2tot_i*.

In year-on-year dynamic simulations, we make I/K ratios for industries depend on rates of return. We relate investors' willingness to supply capital to industry *i* to the industry's expected rate of return via equations of the form:

$$\text{Kgr}_i = F_{i,t}\left[\text{EROR}_{i,t}\right] \tag{3.34}$$

where

- $\text{EROR}_{i,t}$ is the expected rate of return on investment in industry *i* in year *t* and $F_{i,t}[\ ]$ is an increasing function of the expected rate of return.

The relationship $F_{i,t}[\ ]$ between the expected rate of return for industry *i* and the rate of growth in capital in industry *i* (Figure 3.4) is given by the inverse logistic function:

$$E_t\left(\text{ROR}_{i,t}\right) = \left(\text{RORN}_i + F_{\text{eeqror},i} + F_{\text{eeqror}}\right) + \frac{1}{C_i}.\text{In}\left[\frac{\text{Kgr}_{i,t} - \text{Kgr}_{\text{min},i}}{\text{Kgr}_{\text{max},i} - \text{Kgr}_{i,t}} . \frac{\text{Kgr}_{\text{max},i} - \text{Kgr}_{\text{trend},i}}{\text{Kgr}_{\text{trend},i} - \text{Kgr}_{\text{min},i}}\right] \tag{3.35}$$

In (3.35), the shifters $F_{eeqror,i}$, F_{eeqror} and $RORN_t$ allow for industry-specific and uniform vertical shifts in the capital supply curves. If $F_{eeqror,i}$ and F_{eeqror} are set at zero, then $RORN_i$ can be interpreted as industry i's historically normal rate of return. For each industry, it is an estimate of the average rate of return that applied over an historical period in which the industry's average annual rate of capital growth was $Kgr_{trend,i}$. The minimum possible rate of growth of capital in industry i, which is the negative of i's depreciation rate, is given by $Kgr_{min,i}$. The parameter $Kgr_{max,i}$ is the maximum feasible rate of capital growth in industry i. In MyAGE_LM, $Kgr_{max,i}$ is set as $Kgr_{trend,i}$ plus 0.1. That is, the maximum growth rate of capital is 10 percentage points higher than the industry's trend growth rate. Industry i's capital growth rate in period t is given by $Kgr_{i,t}$, given by (3.32), i.e., $Kgr_{i,t} = \dfrac{K_{i,t+1}}{K_{i,t}} - 1$. C_i is a positive parameter controlling the sensitivity of industry i's capital growth to variations in its equilibrium expected rate of return.

When the shifters $F_{eeqror,i}$ and F_{eeqror} are exogenous, equation (3.35) states that in order for industry i to attract sufficient investment to achieve capital growth at the rate $Kgr_{trend,i}$ in year t, the expected rate of return must be $RORN_i$. If the expected rate of return is higher (lower) than $RORN_i$, then investors will supply capital at a level above (below) the level required to generate capital growth at the trend rate. The shifters are used to vary the relationship between the rates of return and investment in equation (3.35). When the aggregate economy wide investment is determined either exogenously or via an indexing relationship with some other macroeconomic variable, F_{eeqror} is modelled to be endogenous to ensure that the movements in industry-specific investments sum to the independently determined levels of aggregate investment. The industry-specific shifters, $F_{eeqror,i}$ can be set endogenously to accommodate exogenous paths for industry-specific rates of investment growth. The relevant element of the shifter can also be set exogenously to model either an increase or decrease in investment at a given rate of return.

Figure 3.4   The Equilibrium Expected Rate of Return Schedule for Industry i
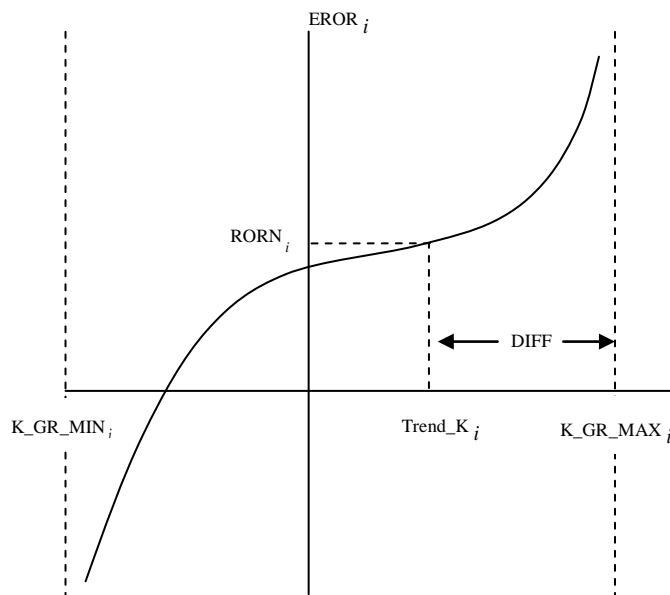
Source: Adapted from Dixon and Rimmer, 2002:191

Equation *E_cap_t1* in excerpt 3.19 is the percentage change form of the left hand equality in (3.32). Equation *E_d_f_cap_t* is used to give shocks to the starting capital in year-to-year simulations to ensure that the starting year capital in year *t* is equal to the ending year capital in year *t-1*. Equation *E_del_ror* depicts the ordinary change in the static expectations rate of returns on capital in industry *i*. Equation *E_del_k_gr* defines the rate of growth of capital. Equation *E_d_f_eeqror_j* is the TABLO representation of the inverse logistic relationship between the expected rate of return for industry *i* (*del_ror_(i)*) and the current rate of growth of capital in industry *i* (*del_k_gr(i)*).

Excerpt 3.19 Investment/Capital Ratios and Dynamics of Capital Stock, Investment and Inverse Logistic

```
Equation E_x2tot  # Investment/capital ratios by industry #
  (All,i,IND)  x2tot(i) =  x1cap(i) + r_inv_cap(i) + r_inv_cap_u;


Equation E_f2tot_i # Can be used to lock agg. invest. & consumption
together #
  x2tot_i = x3tot + f2tot_i ;
```

101

```
Equation E_ff2tot_i # Used to lock agg.invest. & real GDP together #
  x2tot_i = x0gdpexp + ff2tot_i ;

Equation E_finv2 # Alternative rule for "exogenous" investment
industries#
 (all,i,IND) x2tot(i) = x2tot_i + finv2(i);

Equation E_cap_t1  # End-of-year capital stock #
  (All,i,IND)
  (QCAP1(i)+TINY)*cap_t1(i) = (1-DEP(i))*QCAP(i)*cap_t(i)+
QINVEST(i)*x2tot(i);

Equation E_d_f_cap_t # Capital Stock for current production #
  (All,i,IND)
  QCAP(i)*cap_t(i) = 100*(QCAP1_B(i) - QCAP_B(i))*del_unity +
100*d_f_cap_t(i);

Equation E_d_f_eeqror_j # Change in expected rate of return in
forecast year #
  (All,i,IND) del_ror(i) =
  (1/COEFF_SL(i))*[1/(K_GR(i)-K_GR_MIN(i))+1/(K_GR_MAX(i)-
K_GR(i))]*del_k_gr(i)
                  + d_f_eeqror_j(i) + d_f_eeqror;

Equation E_del_k_gr # Capital growth through a year  #
  (All,i,IND) del_k_gr(i) =
  [{QCAP1(i)/QCAP(i)}/100]*[cap_t1(i) - cap_t(i)];

Equation E_del_ff_rate # Allows for equalization of changes in rates
of return #
  (All,i,IND) del_ror(i) = del_r_tot +  del_ff_rate(i);
```

3.13   Powers of Taxes and Tax Collections (Indirect Taxes)

In Malaysia, the indirect tax system is divided into three groups: sales taxes, tariffs and production taxes. Sales taxes consist of export duties, excise duties, sales taxes, other taxes on commodities and subsidies for commodities. Production taxes include business fees and production subsidies. Tax rates are either positive or negative. A negative tax rate indicates a subsidy on an activity. As a policy change might involve movement from a tax to a subsidy

or vice versa, tax rates can pass through zero, or start from zero. Thus, to facilitate percentage-change computations in the MyAGE_LM model, we use powers of taxes (equals 1 + rate) rather than tax rates. The value of the power of a tax is one plus the ratio of the tax revenue to the tax base. This is given in the following equation:

$$T^{(u)}_{c,s,t} = \left(1 + TAXRATE^u_{c,s,t}\right) = \left(1 + \frac{TAXREV^u_{c,s,t}}{TAXBASE^u_{c,s,t}}\right) \qquad (3.36)$$

where

- $T^{(u)}_{c,s,t}$ is the power of tax t on the flows of (c,s) to user u;

- $TAXRATE^u_{c,s,t}$ is the rate of tax t on flows of (c,s) to user u;

- $TAXBASE^u_{c,s,t}$ is the base upon which tax t is levied with

$$TAXREV^u_{c,s,t} = TAXRATE^u_{c,s,t} * TAXBASE^u_{c,s,t}.$$

The power of taxes in the MyAGE_LM model is used as policy variables. These variables are generally treated as naturally exogenous. The flexible treatment of exogenous shocks to Malaysia's indirect tax system is implemented using the equations in the TABLO code below:

Excerpt 3.20 Power of Taxes

```
Equation E_t1 # Power of tax on sales to intermediate #
 (All,c,COM)(All,s,SRC)(All,i,IND)(all,t,CTAX)
 t1(c,s,i,t) = f0tax_s(c) + ft1(c,s,i,t) + f1tax_csi + f0tax_csu +
ft1_i(c,s,t);


Equation E_t2 # Power of tax on sales to investment #
 (All,c,COM)(All,s,SRC)(All,i,IND)(all,t,CTAX)
 t2(c,s,i,t) = f0tax_s(c) + ft2(c,s,i,t) + f2tax_csi + f0tax_csu +
ft2_i(c,s,t);


Equation E_t3 # Power of tax on sales to households #
  (All,c,COM)(All,s,SRC)(all,t,CTAX)
  t3(c,s,t) = f0tax_s(c) + ft3(c,s,t) + f3tax_cs + f0tax_csu;
```

```
Equation E_t4 # Power of tax on exports #
  (All,c,COM)(all,t,CTAX)
  t4(c,t) = f0tax_s(c) + ft4(c,t) + f4tax(c) + f4tax_c + f0tax_csu;

Equation E_t5 # Power of tax on government #
  (All,c,COM)(All,s,SRC)(all,t,CTAX)
  t5(c,s,t) = f0tax_s(c) + f0tax_csu + ft5(c,s,t);

Equation E_t0imp  # Allows uniform tariff changes #
  (All,c,COM)
  t0imp(c) = f_t0imp(c) + ff_t0imp;
```

In equations *E_t1, E_t2, E_t3* and *E_t5*, the variable *f0tax_s(c)* is used to impose a uniform increase in the powers of taxes by commodity. In order to impose increases in the powers of taxes for intermediate sales of intermediate, investment goods, households and the government, the variables *ft1(c,s,i,t), ft2(c,s,i,t), ft3(c,s,t)* and *ft5(c,s,t)* are used respectively. The variable *ft4(c,t)* is used to allow movements in the power of tax on exports.

The variable *ff_t0imp* in equation *E_t0imp* allows for a uniform change in the power of tariffs across commodities. To simulate a change in the power of the tariff in the motor vehicle industry, we can shock the relevant component of *f_t0imp(c),* making the scalar shifter, *ff_t0imp* exogenous.

MyAGE_LM keeps track of the revenue generated by each tax. In developing the revenue equations, we start with the general equation:

$$R = B(T - 1) \tag{3.37}$$

where

- R is the tax revenue;

- B is the value of the tax base, where $B = PX$, with P being the basic price of the relevant commodity or industry output and X being the quantity flow or output. T is the power (one plus tax rate) of the tax, while $(T - 1)$ is the tax rate.

After some rearranging, equation (3.37) can be redefined as:

$$BT = R + B \tag{3.38}$$

Taking the percentage change for (3.38) gives the following[13]:

$$100*dR = 100.BT.\frac{dT}{T} + 100.(T-1).PX\frac{dP}{P} + 100.(T-1).PX\frac{dX}{X} \tag{3.39}$$

$$\Rightarrow 100*dR = t(R+B) + T(p+x) \tag{3.40}$$

In (3.40), t, p and x are the percentage changes in T, P and X respectively.

The format used in equation (3.40) is similar to equations *E_w1tax_csi* to *E_w5tax_cs* of the TABLO code describing indirect taxes in Excerpt 3.21.

Excerpt 3.21   Government Revenue from Indirect Taxes

```
Equation E_w1tax_csi # Revenue from indirect taxes on flows to
intermediate #
  V1TAX_CSI*w1tax_csi =
    Sum{t,CTAX,Sum{c,COM, Sum{s,SRC, Sum{i,IND,
    V1TAX(c,s,i,t)* {x1(c,s,i) + p0(c,s)}  +
    [V1BAS(c,s,i) + V1TAX(c,s,i,t)]*t1(c,s,i,t) }}}};

Equation E_w1ptx_i # Revenue from production taxes #
    V1PTX_I*w1ptx_i = 100*Sum{t,PTAX, Sum{i,IND, d_w1ptx(t,i)}};

Equation E_w2tax_csi # Revenue from indirect taxes on flows to
investment #
V2TAX_CSI*w2tax_csi =
  Sum{t,CTAX, Sum{c,COM, Sum{s,SRC, Sum{i,IND,
  V2TAX(c,s,i,t)* {x2(c,s,i) + p0(c,s)}  +
  [V2BAS(c,s,i) + V2TAX(c,s,i,t)]*t2(c,s,i,t)}}}};

Equation E_w3tax_cs # Revenue from indirect taxes on flows to
households #
[V3TAX_CS+TINY]*w3tax_cs =
```

---

[13] Full derivation is found in Appendix A.4.

```
    Sum{t,CTAX,Sum{c,COM, Sum{s,SRC,
    V3TAX(c,s,t)* {x3(c,s) + p0(c,s)}  +
    [V3BAS(c,s) + V3TAX(c,s,t)]*t3(c,s,t)}}};


Equation E_w4tax_c # Revenue from indirect taxes on exports #
100*d_w4tax_c =
    Sum{t,CTAX, Sum{c,COM,
     V4TAX(c,t)* {x4(c) + p0(c,"dom")}  +
    [V4BAS(c) + V4TAX(c,t)]*t4(c,t)}};


Equation E_w5tax_cs # Revenue from indirect taxes on flows to
government #
[V5TAX_CS+TINY]*w5tax_cs =
    Sum{t,CTAX, Sum{c,COM, Sum{s,SRC,
    V5TAX(c,s,t)* {x5(c,s) + p0(c,s)}  +
    [V5BAS(c,s) + V5TAX(c,s,t)]*t5(c,s,t)}}};

Equation E_w0tar_c  # Tariff revenue #
  V0TAR_C*w0tar_c = Sum{c,COM, V0TAR(c)*{pf0cif(c) - phi + x0imp(c)}
                                        + V0IMP(c)*t0imp(c)};


Equation E_d_w1ptx # Change in production tax payments #
  (all,t,PTAX) (All,j,IND) 100*d_w1ptx(t,j) =
    V1PTX(t,j)*(p0ind(j) + x0ind(j)) + [V1PTX(t,j) +
V1TOT(j)]*t1ptx(t,j);
```

3.14   National Income and Expenditure Aggregates

MyAGE_LM has equations that describe national aggregate price and quantity indexes. Most
of the macro definitions in MyAGE_LM are derived from levels equations of the type below:

$$V_{tot} = \sum_k V_k = P_{tot}X_{tot} = \sum_k P_k X_k \tag{3.41}$$

where

- V_{tot} is a nominal aggregate variable with industry or commodity components, V_k and
  P_{tot} and X_{tot} are aggregate price and quantity indexes. V_{tot} may represent household

expenditure in which case V_k is household expenditure on good k. V_{tot} may represent the value of investment, in which case V_k is investment expenditure by industry k, etc.

From (3.42), we obtain the percentage change forms:

$$v_{tot} = \sum_k S_k v_k = p_{tot} + x_{tot} = \sum_k S_k (p_{tot} + x_{tot}) \tag{3.42}$$

where

- Lower case symbols represent percentage changes in the variables denoted by the corresponding upper case variables; and

- S_k is the share of component k in the aggregate, that is, $S_k = V_k / V_{tot}$. We define p_{tot} and x_{tot} by:

$$p_{tot} = \sum_k S_k p_k \quad \text{and} \quad x_{tot} = \sum_k S_k x_k \tag{3.43}$$

Equations in the style of (3.42) and (3.43) are shown in excerpt 3.22 for investment, consumption, exports, government expenditure and imports. The TABLO code below shows the percentage changes in price, quantity and value indexes of GDP and its components. For the expenditure side indicators in the MyAGE_LM model, GDP is defined as the sum of household consumption, investment, government consumption, exports and inventory accumulation minus imports.

Excerpt 3.22   Expenditure Side Indicators

```
Equation E_x2tot_i # Total real investment #
    V2TOT_I*x2tot_i = Sum{i,IND,V2TOT(i)*x2tot(i)};

Equation E_p2tot_i # Investment price index #
    V2TOT_I*p2tot_i = Sum{i,IND,V2TOT(i)*p2tot(i)};
```

```
Equation E_w2tot_i # Total nominal investment #
    w2tot_i = x2tot_i + p2tot_i;


Equation E_p3tot # Consumer price index #
    V3TOT*p3tot = Sum{c,COM,Sum{s,SRC,V3PUR(c,s)*p3(c,s)}};


Equation E_w3tot # Household expenditure (budget constraint) #
    w3tot = x3tot + p3tot;


Equation E_x4tot # Export volume index #
    V4TOT*x4tot = Sum{c,COM,V4PUR(c)*x4(c)};


Equation E_p4tot # Exports price index, $RM #
    V4TOT*p4tot = Sum{c,COM,V4PUR(c)*p4(c)};


Equation E_w4tot # $RM border value (f.o.b) of exports #
    w4tot = x4tot + p4tot;


Equation E_x5tot # Government volume index #
    V5TOT*x5tot = Sum{c,COM,Sum{s,SRC, V5PUR(c,s)*x5(c,s)}};


Equation E_p5tot # Government price index #
    V5TOT*p5tot = Sum{c,COM,Sum{s,SRC, V5PUR(c,s)*p5(c,s)}};


Equation E_w5tot # Government expenditure #
    w5tot = x5tot + p5tot;


Equation E_x6tot # Stock volume index #
[TINY+V6TOT]*x6tot =100*sum{c,COM,sum{s,SRC,P0LEV(c,s)*delx6(c,s)}};


Equation E_p6tot # Stock price index #
    V6TOT*p6tot = Sum{c,COM,Sum{s,SRC, V6BAS(c,s)*p0(c,s)}};



Equation E_w6tot # Total additions to stocks#
    w6tot = x6tot + p6tot;


Equation E_x0cif_c # C.i.f. import volume index #
    V0CIF_C*x0cif_c = Sum{c,COM,V0CIF(c)*x0imp(c)};


Equation E_x0imp_c  # Import volume index, duty-paid weights #
    V0IMP_C*x0imp_c = Sum{c,COM,V0IMP(c)*x0imp(c)};
```

```
Equation E_p0cif_c # $RM c.i.f. imports, price index #
    V0CIF_C*p0cif_c = Sum{c,COM,V0CIF(c)*{-phi+pf0cif(c)}};


Equation E_w0cif_c  # $RM c.i.f. value of imports #
    w0cif_c = x0cif_c + p0cif_c;


Equation E_x0gdpexp # Real GDP, expenditure side #
    V0GDPEXP*x0gdpexp = V3TOT*x3tot + V2TOT_I*x2tot_i
    + V4TOT*x4tot +  V5TOT*x5tot +  V6TOT*x6tot - V0CIF_C*x0cif_c;


Equation E_p0gdpexp # Price index for GDP, expenditure side #
    V0GDPEXP*p0gdpexp = V3TOT*p3tot + V2TOT_I*p2tot_i
    + V4TOT*p4tot + V5TOT*p5tot  +V6TOT*p6tot- V0CIF_C*p0cif_c;


Equation E_w0gdpexp # Nominal GDP from expenditure side #
    w0gdpexp = x0gdpexp + p0gdpexp;

Equation E_w0imp_c # Value of imports, duty-paid #
    w0imp_c = x0imp_c + p0imp_c;

Equation E_x1cap_i # Aggregate usage of capital, rental weights #
    V1CAP_I*x1cap_i = Sum{i,IND,V1CAP(i)*x1cap(i)};


Equation E_x1lnd_i # Aggregate stock of land, rental weights #
    V1LND_I*x1lnd_i = Sum{i,IND,V1LND(i)*x1lnd(i)};




Equation E_p1cap_i # Average capital rental #
    V1CAP_I*p1cap_i = Sum{i,IND,V1CAP(i)*p1cap(i)};

Equation E_p1lnd_i # Average land rental #
    V1LND_I*p1lnd_i = Sum{i,IND,V1LND(i)*p1lnd(i)};
```

Other macro variables are defined in Equations *E_del_b* to *E_p0realdev* in excerpt 3.23. These show the change or percentage change movements in miscellaneous trade-related macro variables. Equation *E_p0toft* describes the percentage change in the terms of trade as the difference between the percentage changes in the price indexes for f.o.b exports and c.i.f imports. Equation *E_p0realdev* calculates the real depreciation in the exchange rate based on the following equation:

$$REALDEP = \frac{P_M^*/\Phi}{P} = \frac{P_M}{P}$$

(3.44)

where

- REALDEP is the real exchange rate;

- Φ is the nominal exchange rate, defined as \$F/RM, with RM being the Malaysian currency;

- P_M^* and P_M are the price of imports in foreign and domestic currency respectively; and

- P is the domestic price level represented by the GDP deflator.

Excerpt 3.23   Miscellaneous Trade Related Macro Variables

```
Equation E_del_b # Change in the balance of trade #
  100*del_b = V4TOT*w4tot - V0CIF_C*w0cif_c;


Equation E_del_b_gdp # (Balance of trade)/GDP #
    100*V0GDPEXP*del_b_gdp = V4TOT*w4tot - V0CIF_C*w0cif_c
    - (V4TOT-V0CIF_C)*w0gdpexp;


Equation E_p0imp_c # Duty-paid imports, price index #
    V0IMP_C*p0imp_c = Sum{c,COM,V0IMP(c)*p0(i,imp")};


Equation E_p0toft # Terms of trade #
    p0toft = p4tot - p0cif_c;


Equation E_p0realdev # Real devaluation #
    p0realdev =  p0cif_c - p0gdpexp;
```

3.15   Nominal and Real GDP from Income Side Indicators

The income side indicators relate to the supply-side feature of the Malaysian economy. The TABLO equations in the MyAGE_LM model for these indicators are shown in excerpt 3.25. These equations follow the standard form for percentage change expression of macro

indicators outlined in Section 3.14. In excerpt 3.24, equation *E_x0gdpinc* shows the movement in real GDP from the income side as a weighted sum of movements in factor supplies and technology variables. The technology variables describe the efficiency with which inputs are used and outputs produced. The aggregate contribution of technological change to movements in real GDP is calculated by equation *E_a_cont*. This equation calculates the contribution of cost savings from technological improvements to real GDP. The negative sign in front of the right hand side of the equation indicates an improvement in technology. This means that the same output can now be produced with fewer inputs. The negative sign is used to convert the negative percentage changes in technologies into positive contribution to GDP.

Excerpt 3.24   National Income and Expenditure Side Indicators

```
Equation E_w1lab_oi # Aggregate payments to labour #
  V1LAB_OI*w1lab_oi = Sum{i,IND,V1lab_o(i)*{x1lab_o(i)+p1lab_o(i)}};


Equation E_w1cap_i # Aggregate payments to capital #
  V1CAP_I*w1cap_i = Sum{i,IND,V1CAP(i)*{x1cap(i)+p1cap(i)}};


Equation E_w1lnd_i # Aggregate payments to land #
  V1LND_I*w1lnd_i = Sum{i,IND,V1LND(i)*{x1lnd(i)+p1lnd(i)}};



Equation E_w0tax_csi # Aggregate value of indirect taxes #
  V0TAX_CSI*w0tax_csi = V1TAX_CSI*w1tax_csi + V2TAX_CSI*w2tax_csi +
    V3TAX_CS*w3tax_cs + 100*d_w4tax_c + V5TAX_CS*w5tax_cs +
    V0TAR_C*w0tar_c+ V1PTX_I*w1ptx_i;

Equation E_w0gdpinc # Aggregate nominal GDP from income side #
  V0GDPINC*w0gdpinc = V1CAP_I*w1cap_i + V1LAB_OI*w1lab_oi +
    V1LND_I*w1lnd_i + V0TAX_CSI*w0tax_csi;

Equation E_a0_c # Output-augmenting technical change by industry #
  (All,i,IND)
  MAKE_C(i)*a0_c(i) = Sum{c,COM, MAKE(c,i)*a0(c,i)};



 Equation E_x0gdpinc  # Real GDP from income side #
  V0GDPINC*x0gdpinc =
```

```
        V1LND_I*x1lnd_i +
        V1CAP_I*x1cap_i +
        V1LAB_OI*employ_oi  -
        Sum{i,IND, [V1TOT(i)-Sum{t,PTAX,V1PTX(t,i)}]*a(i)} -
        Sum{m,MAR, Sum{c,COM,Sum{s,SRC,
            Sum{i,IND,  V1MAR(c,s,i,m)*a1mar(c,s,i,m)+
            V2MAR(c,s,i,m)*a2mar(c,s,i,m)} +
            V3MAR(c,s,m)*a3mar(c,s,m)+V5MAR(c,s,m)*a5mar(c,s,m) }
+
            V4MAR(c,m)*a4mar(c,m)}} -
        Sum{c,COM,Sum{i,IND,V2PUR_S(c,i)*(a2_s(c,i)+a2(i))}} -
        Sum{c,COM,Sum{s,SRC,Sum{i,IND,V2PUR(c,s,i)*a2csi(c,s,i)}}}
+

Sum{c,COM,Sum{s,SRC,Sum{i,IND,Sum{t,CTAX,V1TAX(c,s,i,t)*x1(c,s,i)}}}
}+

Sum{c,COM,Sum{s,SRC,Sum{i,IND,Sum{t,CTAX,V2TAX(c,s,i,t)*x2(c,s,i)}}}
}+
        Sum{c,COM,Sum{s,SRC,Sum{t,CTAX,V3TAX(c,s,t)*x3(c,s)}}}  +
        Sum{c,COM,Sum{t,CTAX,V4TAX(c,t)*x4(c)}} +
        Sum{c,COM,Sum{s,SRC,Sum{t,CTAX,V5TAX(c,s,t)*x5(c,s)}}}  +
        Sum{c,COM,V0TAR(c)*x0imp(c) } +
        Sum{t,PTAX,Sum{i,IND, V1PTX(t,i)*x0ind(i) }};


Equation E_p1lab_oi # National unit cost of labour #
V1LAB_OI*p1lab_oi = sum{i,IND, V1lab_o(i)*p1lab_o(i)};

Equation E_w0gdpfc # Aggregate nominal GDP at factor cost #
  V1PRIM_I*w0gdpfc = V1CAP_I*w1cap_i + V1LAB_OI*w1lab_oi
+V1LND_I*w1lnd_i;

Equation E_x0gdpfc
  # Real GDP at factor costs #
  Sum{i,IND, V1PRIM(i)} * x0gdpfc
        = V1PRIM_I*a_cont + Sum{i,IND,V1lab_o(i)*x1lab_o(i)}
        + Sum{i,IND, V1CAP(i)*x1cap(i)} +
Sum{i,IND,V1LND(i)*x1lnd(i)};

Equation E_a_cont # Contribution of tech change to GDP #
 a_cont = -(1/V0GDPINC)*
        [Sum{i,IND, [V1TOT(i)-Sum{t,PTAX,V1PTX(t,i)}]*a(i)}
```

```
        + Sum{m,MAR, Sum{c,COM,Sum{s,SRC,
            Sum{i,IND,  V1MAR(c,s,i,m)*a1mar(c,s,i,m)+
            V2MAR(c,s,i,m)*a2mar(c,s,i,m)} +
            V3MAR(c,s,m)*a3mar(c,s,m)+V5MAR(c,s,m)*a5mar(c,s,m) }
+
            V4MAR(c,m)*a4mar(c,m)}}
        + Sum{c,COM,Sum{i,IND,V2PUR_S(c,i)*(a2_s(c,i)+a2(i))}}
        +
Sum{c,COM,Sum{s,SRC,Sum{i,IND,V2PUR(c,s,i)*a2csi(c,s,i)}}}];
```

3.16   Government Financial Accounts

3.16.1   Government Revenues

In the TABLO code in excerpt 3.25, the change in government revenue is defined as a share-weighted-sum of the percentage changes in the relevant tax bases and tax rates. Equations *E_wgovrevA* to *E_wgovrevH* describe government revenue collections from the following: (A) Capital income tax collected from the non-oil sector, (B) Capital income tax collected from the oil sector, (C) Personal income tax, (D) Commodity taxes (export duties, excise duties, sales tax and other taxes on commodities), (E) Import duties, (F) Business fees, (G) Net foreign grants; and (H) Non-tax revenues. There are equations in the TABLO code in excerpt 3.26 that determine foreign unrequited transfers to the government (*E_wftrans_g*) and other non-tax revenue (*E_ntaxrev*). Government transfer to foreigners is assumed to move with government non-tax revenue, which in turn is proportional to nominal GDP.

Excerpt 3.25   Tax Rates and Government Revenues

```
Equation E_d_wgovrev # Change (RM m) in government revenue #
(all,r,GOVREV)
100 * d_wgovrev(r) = VGOVREV(r)*wgovrev(r);


Equation E_wgovrevA # Corporate income tax revenue, non-oil #
VGOVREV("CIT") * wgovrev("CIT") =

Sum{j,NOTOIL,[TAX_K_RATE(j)*V1CAP(j)]*(x1cap(j)+p1cap(j)+tax_k_r(j))
} +
```

```
Sum{j,NOTOIL,[TAX_N_RATE(j)*V1LND(j)]*(x1lnd(j)+p1lnd(j)+tax_n_r(j))
};


Equation E_wgovrevB #Corporate income tax revenue, oil#
VGOVREV("PetrolIT") * wgovrev("PetrolIT") =

Sum{j,OIL,[TAX_K_RATE(j)*V1CAP(j)]*(x1cap(j)+p1cap(j)+tax_k_r(j)) }
+
Sum{j,OIL,[TAX_N_RATE(j)*V1LND(j)]*(x1lnd(j)+p1lnd(j)+tax_n_r(j)) };


Equation E_wgovrevC #Individual income tax revenue#
wgovrev("PIT") = w1lab_oi + tax_l_r;


Equation E_wgovrevD # commodity taxes #
(all,t,CTAXNS)VGOVREV(t) * wgovrev(t) =
    Sum{c,COM, Sum{s,SRC, Sum{i,IND,
        V1TAX(c,s,i,t)* {x1(c,s,i) + p0(c,s)}  +
        [V1BAS(c,s,i) + V1TAX(c,s,i,t)]*t1(c,s,i,t) }}}+
    Sum{c,COM, Sum{s,SRC, Sum{i,IND,
        V2TAX(c,s,i,t)* {x2(c,s,i) + p0(c,s)}  +
        [V2BAS(c,s,i) + V2TAX(c,s,i,t)]*t2(c,s,i,t) }}}+
    Sum{c,COM, Sum{s,SRC,
        V3TAX(c,s,t)* {x3(c,s) + p0(c,s)}  +
        [V3BAS(c,s) + V3TAX(c,s,t)]*t3(c,s,t) }}+
    Sum{c,COM,  V4TAX(c,t)* {x4(c) + p0(c,"dom")}  +
        [V4BAS(c) + V4TAX(c,t)]*t4(c,t) }+
    Sum{c,COM, Sum{s,SRC,
        V5TAX(c,s,t)* {x5(c,s) + p0(c,s)}  +
        [V5BAS(c,s) + V5TAX(c,s,t)]*t5(c,s,t) }};


Equation E_wgovrevE #Tariff revenue#
wgovrev("ImpDuties") = w0tar_c;


Equation E_wgovrevF # Business fees #
VGOVREV("BusFees")*wgovrev("BusFees") =

Sum{j,IND,V1PTX("BusFees",j)*(p0ind(j)+x0ind(j))+[V1PTX("BusFees",j)
    +V1TOT(j)]*t1ptx("BusFees",j)};


Equation E_wgovrevG
wgovrev("ForeignGrant") = wftrans_g;
```

```
Equation E_wgovrevH
wgovrev("NonTaxRev") = Ntaxrev;


Equation E_wftrans_g # Foreign unrequited transfers to government #
  wftrans_g = w0gdpexp + f_for_grantG;


Variable f_non_tax_rev # shifter for government non-tax revenue #;



Equation E_ntaxrev # Other non-tax revenue #
  ntaxrev = w0gdpexp + f_non_tax_rev;


Equation E_L_R_REV_GNDI
(all,v,GOVREV)
L_R_REV_GNDI(v) = R_REV_GNDI(v)*del_unity;
```

Further equations to facilitate the treatment of direct taxes in the MyAGE_LM model are listed in excerpt 3.26. Equations *E_tax_k_r* and *E_tax_l_r* define the percentage change in the tax rate of capital and labour income using exogenous shifters. The rates of capital income tax for industries is allowed to vary using the shifter *f_tax_k(i)*, while *f_tax_l* is used to allow the change in tax rate on labour income. Shocking the shifter *f_tax_inc* is used to implement the same percentage change in the tax rates for both capital and labour incomes.

In general, labour and capital income tax rates are exogenous. However, there are equations in the MyAGE_LM model that allow the endogeneity of the direct taxes. The endogenising of labour income taxes to compensate for a loss in revenue from a tariff reduction is explained in detail in Chapter 6 in connection with the MyAGE_LM policy simulation.

Excerpt 3.26 Direct Tax Rates

```
Equation E_tax_k_r    # Rate of tax on capital income  #
(all,i,IND) tax_k_r(i)  = f_tax_inc + f_tax_k(i);


Equation E_tax_l_r   # Rate of tax on labour income #
        tax_l_r     = f_tax_inc + f_tax_l;


Equation E_net_tax_tot
  # Net collection of indirect taxes and income taxes #
  NET_TAXTOTG*net_tax_tot
```

```
          = V0TAX_CSI*w0tax_csi + INCTAX*taxrev_inc ;


Equation E_d_net_tax_gdp # Net tax to GDP ratio #
  100*d_net_tax_gdp = (NET_TAXTOTG/V0GDPEXP)*(net_tax_tot -
w0gdpexp);


Equation E_taxrev_inc # Income tax revenue #
  INCTAX*taxrev_inc = TAX_LAB*(w1lab_oi + tax_l_r ) +
    Sum{i,IND,
[TAX_K_RATE(i)*V1CAP(i)]*(x1cap(i)+p1cap(i)+tax_k_r(i)) } +
    Sum{i,IND,
[TAX_N_RATE(i)*V1LND(i)]*(x1lnd(i)+p1lnd(i)+tax_n_r(i)) };



Equation E_ftax_l_imp
#Endogenous replacement of lost tariff revenue via individual income
tax#
VGOVREV("PIT")*[ tax_l_r + ftax_l_imp] =
    -Sum{c,COM,  V0IMP(c)*t0imp(c)};


Equation E_ftax_l_cap
#Endogenous replacement of lost tax revenue via individual income
tax#
VGOVREV("PIT")*[ tax_l_r + ftax_l_cap] =
    -Sum{j,IND,[TAX_K_RATE(j)*V1CAP(j)]*tax_k_r(j) };
```

3.16.2 Government Expenditures

3.16.2.1 Government Transfers to Households and Other Expenditures

The TABLO code for government transfers to households and other public expenditures is given in excerpt 3.27. Equation *E_transfers* determines transfers to households as the total of welfare benefits and interest payments on domestic public debt. *Equation E_bens* determines the social security paid by the government, where aggregate nominal government benefits (*bens*) are indexed to movements in the population (*pop*) and the nominal economy-wide wage rate (*p3tot + real_wage_c*). Equation *E_d_net_int_g* gives the change in net interest payments to households. These payments are determined by domestic public sector debt in year *t* (PSDATT) and the average interest rate on that debt (ROIDOMDEBT). Other government expenditures are shown in equation *E_oth_expend*.

Excerpt 3.27 Government Transfers

```
Equation E_transfers # Transfers from the government to households #
  TRANS*transfers = BENEFITS*bens  + 100*d_net_int_g;


Equation E_bens # Social security paid by government #
  bens = pop + p3tot + real_wage_c + fbens;


Equation E_d_net_int_g # Net interest payments from government to
households #
  d_net_int_g = PSDATT*d_int_psd + ROIDOMDEBT*d_psd_t;


Equation E_d_int_psd # Nominal rate of interest on public sector dom
debt#
  d_int_psd = (1+INF)*d_rint_psd + (1+RINT_PSD)*d_inf;


Equation E_oth_expend # Other government expenditure #
oth_expend = w0gdpexp + f_oth_expend;
```

3.16.2.2   Interest Rate on Government Domestic Debt

Equation *E_d_inf* in the TABLO code in excerpt 3.28 defines the change in the rate of inflation, which requires the percentage change in the lagged inflation rate given by *p3tot_l*. The lagged inflation is calculated using equation *E_d_f_p3tot_l*. The causal link between changes in the real interest rate on public sector debt and the real interest rate on business borrowing is given by equation *E_d_rint_psd*. Equation *E_d_f_psd_t* gives the shock to the start of the year public domestic debt.

Equation *E_d_r_psdgdp* calculates the percentage change in the start of year ratio of public sector domestic debt to GDP while the level of this ratio is given by the equation *E_lev_r_psdgdp*.

Excerpt 3.28 Interest Rates on Government Domestic Debt

```
Equation E_d_inf # Rate of inflation #
  100*d_inf =(1+INF)*(p3tot - p3tot_l);
```

```
Equation  E_d_f_p3tot_l
 # Lagged value of the CPI if initial sol for year t is sol for year
t-1 #
  LEV_CPI_L*p3tot_l = 100*(LEV_CPI_B - LEV_CPI_L_B)*del_unity +
100*d_f_p3tot_l;


Equation E_d_rint_psd
  # Link between real rates of interest on PSD and business
borrowing #
  d_rint_psd = d_rint ;


Equation E_d_f_psd_t
  # Gives shock to start-of-year public sector domestic debt, yr-to-
yr sims #
  d_psd_t = DDEBTISSUE_B*del_unity + d_f_psd_t;


Equation E_d_f_psd_t2
  # Gives %-change shock to start-of-year public sector domestic
debt #
  p_psd_t = [100/PSDATT]*d_psd_t + d_f_psd_t2;


Equation E_d_r_psdgdp
  # Ratio of st-of-yr public sector domestic debt to GDP #
  d_r_psdgdp = (1/V0GDPEXP)*d_psd_t - 0.01*R_PSDGDP*w0gdpexp;



 Equation E_lev_r_psdgdp
  # Level of ratio of st-of-yr public sector domestic debt to GDP #
  lev_r_psdgdp = R_PSDGDP_B*del_unity + d_r_psdgdp;
```

3.16.3   Government Investment

The TABLO code for government investment is shown in excerpt 3.29. Equation *E_fgv2tot*
shows the movements in the government's share of investment in each industry. In this
equation, *fgv2tot(i)* and *fgv2tot_i* are industry-specific and uniform shifters, which are
typically exogenous. The ratio of private to public investment in each industry is normally
held constant in the MyAGE_LM simulations. The percentage change in aggregate
government investment is given by equation *E_agginv_g*, which is calculated as the share-
weighted sum of the value of investment by government across industries. The percentage

changes in the quantity of aggregate public investment and the price index for aggregate government investment are defined in equation *E_agginv_rg* and *E_p2tot_g* respectively.

Excerpt 3.29   Government Investment

```
Equation E_fgv2tot
#Percentage change in govt's share of investment in industry (i) #
(all,i,IND) gv2tot(i) = fgv2tot(i) + fgv2tot_i;

Equation E_agginv_g # In each ind, Gov invest is a fixed share of
total invest #
  INVEST_G*agginv_g =
    Sum{i,IND,G_VINVEST(i)*(p2tot(i)+x2tot(i)+gv2tot(i))};

Equation E_agginv_rg # Aggregate real public investment #
  INVEST_G*agginv_rg =
    Sum{i,IND,G_VINVEST(i)*(x2tot(i)+gv2tot(i))};

Equation E_p2tot_g # Price index for government investment
expenditure #
  INVEST_G*p2tot_g=
     Sum{i,IND,G_VINVEST(i)*p2tot(i)};
```

3.16.4   Government Budget Deficit

The government budget deficit is defined as the difference between government outlays and government revenues, or between government investment and government savings. The ratios of government deficit to GNDI and GDP are given by the equations *E_d_def_gndi_r* and *E_d_def_gdp_r* respectively. Equation *E_lev_def_gdp_r* calculates the level of the ratio of government deficit to GDP in year *t-1*.

Excerpt 3.30   Government Budget Deficit

```
Equation E_d_gov_def
  # Public sector deficit, or public sector financing transactions #
  100*d_gov_def = V5TOT*w5tot + INVEST_G*agginv_g + 100*d_intG_fd
```

```
    - NET_TAXTOTG*net_tax_tot  + TRANS*transfers
    - FTRANS_G*wftrans_g;


Equation E_d_def_gdp_r
  # Change in the ratio of the government deficit to GDP #
  100*d_def_gdp_r = (100/V0GDPEXP)*d_gov_def -
(GOV_DEF/V0GDPEXP)*w0gdpexp;


Equation E_d_def_gndi_r
  # Change in the ratio of the government deficit to GNDI #
  100*d_def_gndi_r = (100/GNDI)*d_gov_def - (GOV_DEF/GNDI)*w0gndi;


Equation E_lev_def_gdp_r
  # Level of the ratio of the government deficit to GDP #
  lev_def_gdp_r = R_DEFGDP_B*del_unity + d_def_gdp_r;

Equation E_L_R_EXP_GNDI
 #Level of the ratio of gov't expenditure item (v) to GNDI#;
(all,v,GOVEXP)
L_R_EXP_GNDI(v) = R_EXP_GNDI(v)*del_unity;
```

3.17 Household Income, Expenditure and Saving

The TABLO code in excerpt 3.31 shows the linearized form of standard accounting identities relating to GNP and household disposable income. Household disposable income is defined as:

HDY = domestic primary factor income (V1PRIM)

> + transfers from government (TRANS)

> - income taxes (INCTAX)

> - interest paid on private foreign debt (d_intP_fd)

> + transfers from foreigners (FTRANS_P)

> - government non tax revenue (NONTAXREV)

> - net compensation to foreign workers (NETCOE)

The percentage change in household disposable income is given by equation *E_hdy*. Equation *E_wftrans_p* indicates foreign transfers to households. In MyAGE_LM, the shifter on foreign transfers to households, *f_for_grantP* is usually exogenous. With this setting, *wftrans_p* is determined endogenously, moving proportionately with nominal GDP, *w0gdpexp*.

Equation *E_d_housav* is used to determine the absolute change in gross household savings. Household gross savings is the difference between household disposable income, HOUS_DIS_INC and household consumption, V3TOT.

Equations *E_apc*, *E_apc_gndi* and *E_aps_gnp* are used to provide different ways for linking consumption with income. In equation *E_apc*, when the average propensity to consume (APC) is exogenous, household consumption moves with household disposable income. When the national propensity to consume out of GNDI, *apc_gndi* is exogenous, equation *E_apc_gndi* allows aggregate private (*w3tot*) and public (*w5tot*) nominal consumption to move with gross national disposable income. Equation *aps_gnp* calculates the average private propensity to save from GNP.

In equation *E_x3tot*, when the ratio of total consumption to GNP (*apc_gnp*) is exogenous, this relates household expenditure to gross national product. Equation *E_x35tot* shows economy-wide aggregate consumption, *x35tot,* as the sum of public and private consumption spending.

Excerpt 3.31   Household Income, Saving and Propensity to Consume

```
Equation E_hdy   # Household disposable income #
  HOUS_DIS_INC*hdy =
    V1PRIM_I*w0gdpfc + TRANS*transfers - INCTAX*taxrev_inc
  - 100*d_intP_fd + FTRANS_P * wftrans_p - NONTAXREV*ntaxrev -
NETCOE*forlab;

Equation E_wftrans_p  # Foreign transfers to households #
  wftrans_p = w0gdpexp + f_for_grantP;

Equation E_d_housav # Household saving #
  100*d_housav = HOUS_DIS_INC*- V3TOT*w3tot;
```

```
Equation E_apc # Consumption related to disposable income #
 V3TOT*w3tot = AV_PROP_CON*HOUS_DIS_INC*(apc + hdy);


Equation E_x3tot  # Relates total private consumption to GNP #
 w3tot = gnpnom + apc_gnp;




Equation E_apc_gndi # Economy-wide consumption related to GDNI#
 V3TOT*w3tot + V5TOT*w5tot = [V3TOT + V5TOT]*(w0gndi + apc_gndi);


Equation E_x35tot  #Economy-wide aggregate real consumption#
[V3TOT+V5TOT]*x35tot = V3TOT*x3tot + V5TOT*x5tot;


Equation E_aps_gnp # Consumption and saving propensities add to one
#
   0 = V3TOT*apc_gnp + (GNP -V3TOT)*aps_gnp ;
```

3.18   Equations that Convert Twists into Technical or Taste Changes

In forecasts, it is convenient to use twist variables endogenously to accommodate external forecasts for import volumes and primary factor inputs. For example, the import twist allows an exogenously specified rate of aggregate import growth to be accommodated by MyAGE_LM via a cost-neutral change in the import/domestic quantity ratio for all users of imports. The TABLO code in excerpt 3.32 shows equations that convert twists into technical/taste changes.

Equation *E_twist_src* is used to impose cost-neutral import/domestic preference twists. The cost-neutral twist is interpreted as a domestic-import-saving technical change. The relationship between the twist variable and the source-specific technical change is important in forecasting and in policy analysis. In forecasts, we usually endogenize the twist terms in order to accommodate external forecasts for import volumes and real wages. Through equations *E_a1csi* to *E_a1cap*, the required cost-neutral movements in technology variables are endogenously determined. In policy simulations however, the twists are endogenous and the technology variables are exogenized instead and given the same values as calculated

endogenously in the forecast. This is to guarantee that the technical and taste changes (instead of twists) are the same as in both policy and forecast. Instead, if the twists in policy are exogenized, then we are imparting different technical changes in policy than in forecast. This is because import/domestic shares are different in policy than in forecast. Hence, it is difficult to interpret results for the policy simulation when technical change in policy is different in unintended ways than in forecasts.

Equation *E_twistlk* is useful for the introduction of cost-neutral industry-specific changes (though *ftwistlk (i)*) or uniform changes (through *twist_i*) in labour/capital ratios. Such twists are used to accommodate external forecasts for employment and wage rates.

Excerpt 3.32 Equations for Converting Twists into Tech/Taste Changes

```
Equation E_twist_src # Import/domestic  twist and shift #
(All,c,COM) twist_src(c) = twist_c+ ftwist_src(c);


Equation E_twistlk # Labour/capital twist #
 (All,i,IND)  twistlk(i) = twist_i+ ftwistlk(i);


Equation E_a1csi # Convert twist_src into tech change,  intermediate
inputs #
(all,c,COM)(all,s,SRC)(all,i,IND)
    a1csi(c,s,i) = [RS1(c,s,i)/(SIGMA1(c)-1)]*twist_src(c)+
f_a1csi(c,s,i);


Equation E_a2csi # Convert twist_src into tech change, inputs into
investment #
(all,c,COM)(all,s,SRC)(all,i,IND)
    a2csi(c,s,i) = [RS2(c,s,i)/(SIGMA2(c)-1)]*twist_src(c)+
f_a2csi(c,s,i);


Equation E_a3cs # Convert twist_src into tech change, inputs into
investment #
(all,c,COM)(all,s,SRC)
    a3cs(c,s) = [RS3(c,s)/(SIGMA3(c)-1)]*twist_src(c)+ f_a3cs(c,s);


Equation E_a1lab_o  # Converts twist into tech change, production
labour #
  (All,i,IND)
```

```
a1lab_o(i) = [V1CAP(i)/(V1PRIM(i)*(SIGMA1PRIM(i)-1))]*twistlk(i) +
f_a1lab_o(i);


Equation E_a1cap  # Converts twist into tech change, production
capital #
  (All,i,IND)
a1cap(i) = -[V1lab_o(i)/(V1PRIM(i)*(SIGMA1PRIM(i)-1))]*twistlk(i) +
f_a1cap(i);
```

3.19 Extension to the MyAGE Model – MyAGE_LM Labour Market Specification[14]

3.19.1 MyAGE_LM Labour Market Overview

The extension made to modelling the labour market for the Malaysian economy in the MyAGE_LM model is based on the following specifications: (i) The categorizing of labour into nine different occupational groups (ii) The division of the labour force into categories at the start of each year to reflect workforce functions in the previous year (iii) The identification of workforce activities, i.e., what people do during the year (iv) The determination of labour supply from each category to each activity (v) The determination of labour demand in employment activities (vi) The specification of wage adjustment processes reflecting both demand and supply of labour and (vii) The determination of everyone's activity, i.e., who gets the jobs and what happens to those who do not.

In Dixon and Rimmer (2003; 2008), the labour market is modelled to investigate the effects of reducing illegal immigrants. In MyAGE_LM, it is assumed that there are no illegal immigrants. The labour force specification in MyAGE_LM is a simplified version of the specification by Dixon and Rimmer (2003; 2008), where in MyAGE_LM, everyone is assumed to be a Malaysian citizen. Hence, categories (*cat*) and activities (*act*) are only defined over the dimension that describes the labour force function (*f*). Categories reflect the activities that people undertook in year *t-1*, with the main activities being employment in occupation (*o*). The activities that people in a given category undertake in year *t* are

---

[14] The construction of the database to support the MyAGE_LM labour supply specification is explained in detailed in Chapter 4.

determined mainly by their supply to that activity, relative to the supply from people in other categories and by the demand for the services of that activity.

Labour force functions (the *f* dimension) include: employment in 3 skilled occupations (*o* =LegSenOffMan, Professional or TechAssProf); 5 semi-skilled occupations (*o* = Clerical, ServiceSales, SklAgriFish, CraftTraders or PlantMachOpr); and 1 unskilled occupation (*o* = ElementOcc); short-term unemployed (S), where workers are unemployed for a substantial amount of year *t-1*, but not unemployed in year *t-2;* and long-term unemployed (L), where workers are unemployed for a substantial amount of year *t-1* and year *t-2*. Also, an exogenously specified number of new entrants (*NEW*) to the labour market at the start of each year is introduced. It is assumed that 1 per cent of people in every activity drop out of the labour force through either retirement or death.

3.19.2   Link between Categories, Functions and Activities

The link (shown by the upward slopping arrows in Figure 3.5) between people in different activities in year *t-1* and the number of people in each category at the start of year *t* is specified using the following equations:

$$CAT_t(f) = ACT_{t-1}(f)*T(f) \qquad \text{for all} \quad f \neq NEW \qquad (3.45)$$

where

- $CAT_t(f)$ is the number of people at the start of year *t* who performed labour force function *f* in year *t-1* and survive in the labour force at the start of year t;

- $CAT_t('NEW')$ is the number of people in the extended workforce at the start of year *t* who were not in the extended workforce in year *t-1*, i.e., the number of new entrants into the extended workforce;

- $ACT_{t-1}(f)$ is the number of people in activity (*f*) in year *t-1*, i.e., number of people who in year *t-1* performed function (*f*) and

- $T(f)$ is the proportion of people in activity (*f*) in year *t-1* who are allocated to category (*f*) at the start of year *t*. It is assumed that 1 per cent of people in activity year *t-1* die or retire, i.e. $T_{(o)} = 0.99$ for everyone in activity *o* in year *t-1*.

Figure 3.5   MyAGE_LM Labour-Market Dynamics
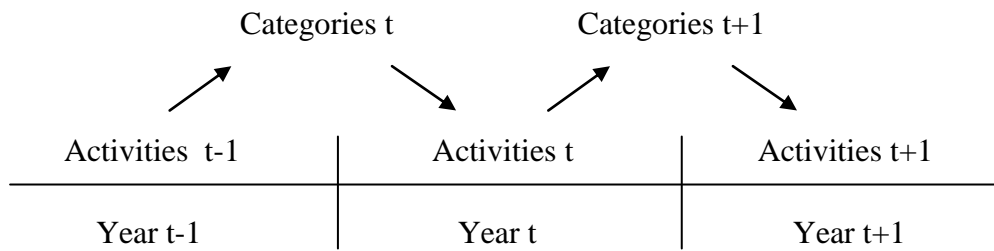
Source: Adapted from Dixon and Rimmer (2008).

3.19.3   MyAGE_LM Labour Supply Specification

MyAGE_LM specifies labour supply from people in each category to each activity. For example, most people in an activity (working as professionals) will offer to continue their employment from last year (year *t-1*). However, some will offer to switch to another occupation in response to changes in the relative wages and a few will offer to become unemployed.

To model labour supply functions in MyAGE_LM, it is assumed that at the beginning of year *t*, people in category (*cat*) will decide their offers to activity (*act*) for the year *t* by solving a problem of the following form:

Choose $L_t(\text{cat}; \text{act})$ for all activities (*act*) to:

maximize:

$$U_c\big(ATRW_t(act)*L_t(cat;act)\forall act\big) \qquad (3.46)$$

subject to $\displaystyle\sum_{act} L_t\big(cat;act\big) = CAT\big(cat\big)$ \qquad (3.47)

where

- $L_t\big(cat;act\big)$ is the labour supply people in category (*cat*) make to activity (*act*);

- $CAT\big(cat\big)$ is the number of people in category (*cat*);

- $ATRW_t\big(act\big)$ is the after tax real wage for workers in activity (*act*) and

- U_c is a homothetic function[15] with the usual properties of a utility function (positive first derivatives and quasi-concavity).

It is assumed in equations (3.46) and (3.47) that people in category (*cat*) treat Malaysian Ringgit (RM) earned in different activities as imperfect substitutes. This assumption allows the flexibility for labour to shift between activities in response to changes in after-tax wage rates. Also, by specifying a separate utility function for each (*cat*), this ensures that each category supplies to activities that are compatible with the category's occupational characteristics.

The utility function in equation (3.46) has the following CES form:

$$U_c = \left[\sum_{act} \big(B_t(cat;act)^* ATRW_t(act)^* L_t(cat;act)\big)^{\eta/1+\eta} \right]^{\frac{1+\eta}{\eta}} \qquad (3.48)$$

where

- η is a parameter which reflects the ease in which people are able to shift between activities and

---

[15] This mean that as the number of people in category *cat* increases by 10 per cent, the number of offers to each activity from *cat* will increase by 10 per cent as well.

- $B_t(\text{cat};\text{act})$ is a variable that reflects the preference of people in category (*cat*) at the start of year *t* for earning money in activity (*act*) in year *t*.

Using equations (3.45) to (3.47), the labour supply function is given by:

$$L_t(\text{cat};\text{act}) = \text{CAT}(\text{cat})^* \left[\frac{\left(B_t(\text{cat};\text{act})^* \text{ATRW}_t(\text{act})\right)^\eta}{\sum_q \left(B_t(\text{cat};q)^* \text{ATRW}_t(q)\right)^\eta} \right] \tag{3.49}$$

Total labour supply to activity (*act*) is obtained as:

$$L_t(\text{act}) = \sum_{\text{cat}} L_t(\text{cat};\text{act}) \tag{3.50}$$

Converting equation (3.49) into percentage changes gives:

$$l_t(\text{cat};\text{act}) = \text{cat}_t(\text{cat}) + \eta^* \left(\text{atrw}_t(\text{act}) - \text{atrw}_t^{\text{ave}}(\text{cat})\right)$$

$$+ \eta^* \left(b_t(\text{cat},\text{act}) - b_t^{\text{ave}}(\text{cat})\right) \tag{3.51}$$

where

- $l_t(\text{cat};\text{act})$, $\text{cat}_t(\text{cat})$, $\text{atrw}_t(\text{act})$ and $b_t(\text{cat},\text{act})$ are percentage changes in $L_t(\text{cat};\text{act})$; $\text{CAT}(\text{cat})$, $\text{ATRW}_t(\text{act})$ and $B_t(\text{cat};\text{act})$ respectively;

- $\text{atrw}_t^{\text{ave}}(\text{cat})$ and $b_t^{\text{ave}}(\text{cat})$ are weighted averages of the $\text{atrw}_t(q)$'s and $b_t(q)$'s with the weights reflecting the share of activity *q* in the offers from people in category (*cat*).

Equation (3.51) shows that people in category (*cat*) will switch their offers towards activity (*act*) if the after-tax real-wage in activity (*act*), $\text{atrw}_t(\text{act})$ increases relative to an average of the rates across all activities in which category (*cat*) people can participate, $\text{atrw}_t(\text{act})$. The TABLO code for the supply for labour to different activities is shown in excerpt 3.33.

Excerpt 3.33   Labour Supply from Each Category (CAT) to Each Activity (ACT)

```
Equation E_lfcoffer  # Offer by oo to o #
  (All,oo,OCCP)(All,o,NONNEW)
  lfcoffer(oo,o) = lfcoffer_oi(oo) +
  ELAS_LS*[rwag_pt_o(o)+ b_pref(oo,o)
                    - rwptd_cat(oo)-ave_b_pref(oo)];

Equation E_rwptd_cat # Ave potential real wage post-tax for oo #
  (All,oo,OCCP)
  [OFFER_FROM(oo)+TINY]*rwptd_cat(oo)
  = Sum(o,NONNEW,LFC_OFFER(oo,o)*[rwag_pt_o(o)] );


Equation E_ave_b_pref # Ave potential real wage post-tax for oo #
  (All,oo,OCCP)
  [OFFER_FROM(oo)+TINY]*ave_b_pref(oo)
  = Sum(o,NONNEW,LFC_OFFER(oo,o)
                        *[ b_pref(oo,o)] );

 Equation E_emp_hourslrd
  # Total offers to activity o #
      (All,o,NONNEW)
 [Sum(oo,OCCP,LFC_OFFER(oo,o))+TINY]*emp_hourslrd(o)
      = Sum(oo,OCCP,
      LFC_OFFER(oo,o)*lfcoffer(oo,o) );
```

Equation *E_lfcoffer* shows the offer of labour supply, *lfcoffer (oo,o),* of people from category *oo* to activity *o*. The index *oo* runs over the nine occupations (LegSenOffMan,Professional,TechAssProf,Clerical, ServiceSales, SklAgriFish, CraftTraders, PlantMachOpr and ElementOcc) and short and long term unemployed as well as new entrants. The index *o* runs just over the nine occupations. The variable *lfcoffer_oi* is the total supply from category *oo* and *b_pref (oo,o)* is the preference variable of people in *oo* to work in *o*. From equation *E_lfcoffer*, people from category *oo* are willing to switch their offers towards activity *o* if there is an increase in the after tax real wage, *rwag_pt_o(o)* relative to the average potential post-tax real wage in category *oo*, *rwptd_cat(oo)*.

The total offer to activity *o* is given in equation *E_emp_hourslrd*, which is the sum of all offers of people willing to supply labour from category *oo* to activity *o*.

3.19.4　Demand for Labour

The demand for labour input $D_t^l(i)$ to Malaysian industry i in year t is specified in MyAGE_LM along conventional CGE lines as a function of the industry's capital stock, $K_t(i)$, the overall real before tax wage rate for the industry, $BTRW_t^l(i)$ and other variables, $A(i)_t$, that influence's industry i's demand for labour, including technology and commodity prices. In stylized form, labour demand by industry i is given by the following equation:

$$D_t^l(i) = \xi_i^l\left(BTRW_t^l(i); K_t(i); A(i)_t\right) \qquad \text{for all industry } i \qquad (3.52)$$

The overall real wage to industry i, $BTRW_t^l(i)$ is determined as the average of real wage rates applying to the types of labour that industry i employs.

To determine demands for labour by occupation, it is assumed in MyAGE_LM that industry i chooses;

$D_t(o,i)$, i's input of labour from occupation o to:

Minimize:

$$\sum_{o \in OCC} BTRW_t(o)^* D_t(o,i) \qquad (3.53)$$

subject to $\quad D_t^l(i) = \underset{o \in OCC}{CES}\left[D_t(o,i) \forall o \in OCC\right] \qquad (3.54)$

where

- $BTRW_t(o)$ is the real before tax wage for workers in occupation o and
- $D_t(o,i)$ is employment of occupation o in industry i in year t.

The demand function obtained using equations (3.53) and (3.54) has the form:

$$D_t(o,i) = D_t^l(i)^* \xi_{o,i}\left(BTRW_t(oo) \forall oo \in OCC\right) \text{ for all occupations } o \text{ and industry } i \qquad (3.55)$$

The aggregate demand for labour in occupation *o* is obtained by aggregating across industries to obtain:

$$D_t(o) = \sum_{i \in IND} D_t(o,i) \qquad \text{for all occupation } o \qquad (3.56)$$

It is assumed that the employment of all Malaysian workers in occupation *o*, $E_t(o)$ is determined by the demand as:

$$E_t(o) = D_t(o) \qquad (3.57)$$

3.19.5   Relationship between After and Before Tax Real Wage Rates

The relationship between after-tax and before-tax real wages is given by the following equations in MyAGE_LM:

$$ATRW_t(o) = BTRW_t(o)^* (1 - T_t) \qquad \text{for all occupations } o \qquad (3.58)$$

$$ATRW_t(u) = F(u) * BTRW_t^{ave} \qquad \text{for all unemployment function } u \qquad (3.59)$$

where
- T_t is labour tax on all workers in Malaysia;
- $BTRW_t^{ave}$ is the average real before tax wage rate of workers in Malaysia and
- F(u) is the fraction of the average real before tax wage rate received by unemployed workers of type *u* (short or long run) in the form of family assistance of other forms of support.

3.19.6   Wage Adjustment

In comparative static analysis, national real wage rate and national employment are analyzed based on the assumptions of either (1) The national real wages rate adjusts such that there

will be no effect on aggregate employment with any policy shock imposed (this is a typical long run assumption) or (2) There is no change in the national wage from a policy shock and employment adjusts (this is a typical short run assumption).

The dynamic feature of the MyAGE_LM model uses a combination of the two assumptions, where real wages are sticky in the short run but flexible in the long run. Employment can be flexible in the short run and sticky in the long run. For example, for year-to-year policy simulations, the deviation in the national wage rate is assumed to increase through time in proportion to the deviation in national employment from its basecase forecast level. The coefficient of adjustment is chosen such that approximately after five years, the employment benefits of favourable shocks are significantly eliminated. That is, after around five years, effects of favourable shocks such as outward shifts in export demand curves are realised almost entirely as real wage rates increase. This is consistent with macroeconomic modelling where the NAIRU is exogenous.

In the labour market policy runs in MyAGE_LM, the wage rate will adjust based on the following equation:

$$\frac{ATRW_t(o)}{ATRW_t^{base}(o)} - \frac{ATRW_{t-1}(o)}{ATRW_{t-1}^{base}(o)} = \beta(o)\left[\frac{D_t(o)}{D_t^{base}(o)} - \frac{L_t(o)}{L_t^{base}(o)}\right] \tag{3.60}$$

where

- $D_t(o)$ is the labour demand and $L_t(o)$ is the labour supply in occupation o;
- β is a positive parameter that controls the adjustment or sensitivity of the after tax real wage rate to the gap between labour supply $L_t(o)$ and demand $D_t(o)$ and "base" is the basecase forecast.

From equation (3.60), if a policy simulation causes the demand for labour to increase relative to the supply, then the labour market will not clear. There will be an increase between the year's *t-1* and *t* in the deviation in occupation *o's* after tax real wages. That is, if demand for labour increases relative to the supply, after tax real wages will increase relative to their base

values. Figure 3.6 provides a simple illustration of equation (3.60) for a model with a single employment activity.

Figure 3.6   Wage Adjustments in a Steady State with a Negative Labour Supply Shock
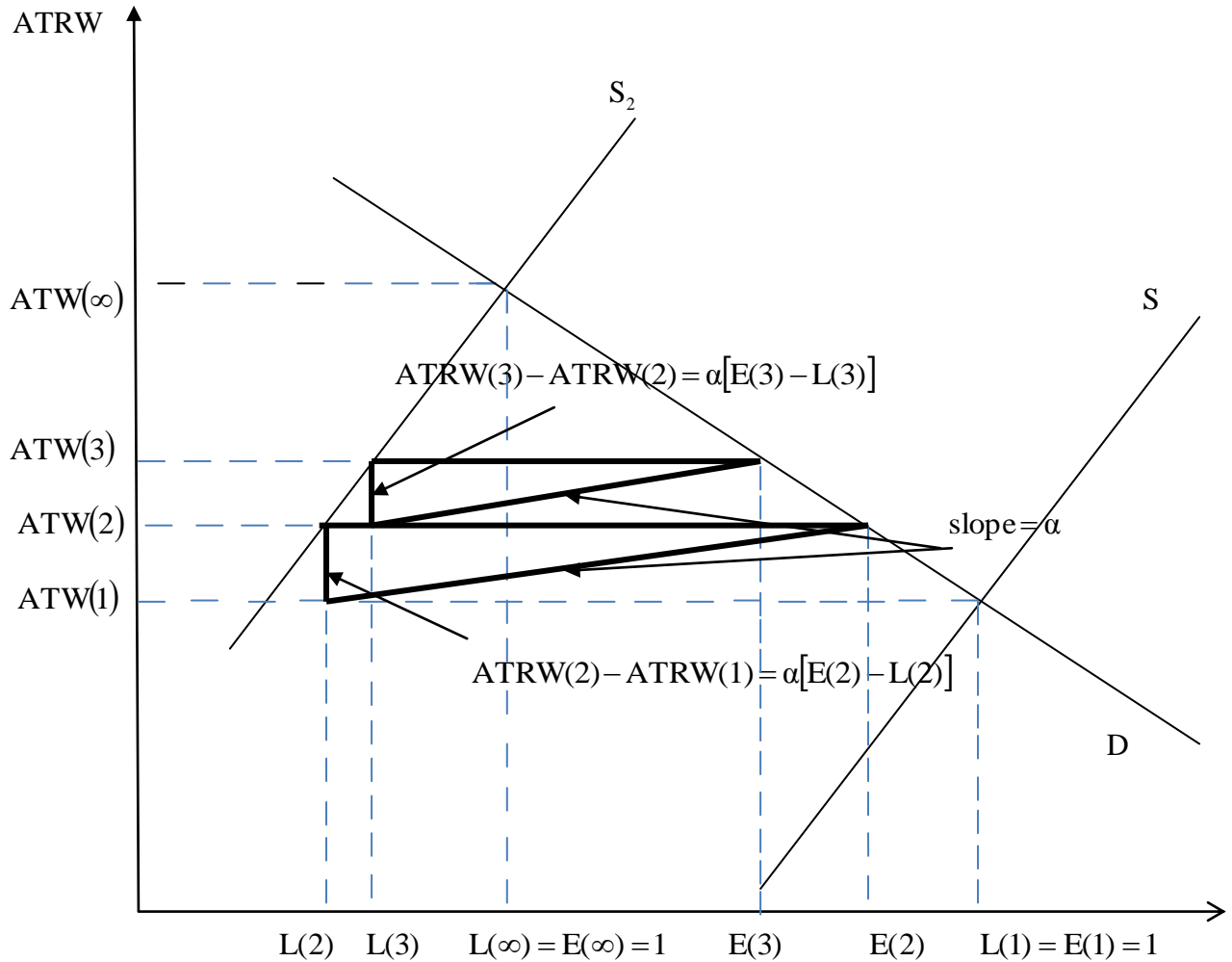
Source: Adapted from Dixon and Rimmer (2008).

In this illustration, but not in MyAGE_LM, it is assumed that there is only one type of labour and that the basecase is generated under steady-state holding technology, consumer preferences, foreign prices, capital availability, taxes and the size of the labour force and other variables affecting the demand and supply of labour unchanged from one year to another. In this steady state, labour demand curve is given by D and labour supply curve is

given by S. For simplicity, the after tax wage rate, employment and the supply of labour are assumed to be one in the steady state. This assumption allows the basecase forecasts from equation (3.60) to be eliminated. A policy that decreases the labour supply is considered. This shifts the supply curve from S in year 1 to S_2 in year 2, where it remains for all future years. With the assumption of no changes in the tax rates (so that changes in after-tax wage rates on vertical axis are also changes in pre-tax wage rates), employment decreases from $E(1)$ to $E(2)$ to ... $E(\infty)$, and labour supply decreases from $L(1)$ to $L(2)$, and then increases from $L(2)$ to $L(3)$, with real wages increasing from $ATW(1)$ to .... $ATW(\infty)$. The TABLO code implementing the wage adjustment process in MyAGE_LM is shown in excerpt 3.34.

Excerpt 3.34   Wage Determination

```
!=====================================================================!
!                            REAL WAGES                               !
!=====================================================================!

! PRE-TAX REAL WAGES!

Equation E_del_f_wage_c    ! Assumes no changes in labour supply!
  # Relates deviation in CPI-deflated pre-tax economy-wide wage to
deviation in employment #
  (RWAGE/RWAGE_OLD)*(real_wage_c - real_wage_c_o) =
        100*((RWAGE_B/RWAGE_OLD_B) -
(RWAGE_L_B/RWAGE_O_L_B))*del_unity
      + ALPHA1*(EMPLOY/EMPLOY_OLD)*(emp_hours - emp_hours_o)
 + del_f_wage_c;



Equation E_d_f_wage_o    ! Allows for change in the labour supply!
# Relates deviation in pre-tax wage for occupation occ to deviation
in emp (occ) #
(All,o,OCC)
(R_WAG(o)/R_WAG_OLD(o))
             *(r_wag_o(o) - r_wag_o_o(o)) =
 100*((R_WAG_B(o)/R_WAG_OLD_B(o))
                   - (R_WAG_L_B(o)/R_WAG_O_L_B(o)))*del_unity
+ ALPHA1_OCC(o)*{(EMP(o)/[EMP_OLD(o)+TINY])
                             *(e_hours_o(o) - e_hours_o_o(o))}
 - ALPHA1_OCC(o)*{(HOURSLR_D(o)/[HOURSLR_DO(o)+TINY])
                         *(emp_hourslrd(o)-emp_hourslrdo(o))}
 - 100*ALPHA1_OCC(o)*d_f_wage_o(o);
```

```
Equation E_r_wag_o # Real wage rate for consumers based on occ#
(All,o,OCC)
 V1LAB_I(o)*[r_wag_o(o) + p3tot] = Sum{i,IND,
V1LAB(o,i)*p1lab(o,i)};


Equation E_r_wag_o_o
  # Introduces forecast CPI-deflated pre-tax wage into policy
simulation #
(All,o,OCC) r_wag_o_o(o) = r_wag_o(o) + f_r_wage_oo(o);


Equation E_real_wage_c # Economy-wide real wage rate for consumers #
!OLD!
  V1LAB_OI*[real_wage_c + p3tot] =   Sum{i,IND,
V1LAB_O(i)*p1lab_o(i)};


Equation E_real_wage_c_o
  # Introduces forecast CPI-deflated pre-tax wage into policy
simulation #
  real_wage_c_o = real_wage_c + f_rwage_o;


!POST-TAX REAL WAGES !

Equation E_del_f_wage_pt    ! Assumes no changes in labour supply!  #

Relates deviation in CPI-deflated post-tax wage to deviat. in
employment #
  (RWAGE_PT/RWAGE_PT_OLD)*(real_wage_pt - real_wage_pt_o) =
   100*((RWAGE_PT_B/RWAGE_PT_O_B)-
(RWAGE_PT_L_B/RW_PT_O_L_B))*del_unity
    + ALPHA1*(EMPLOY/EMPLOY_OLD)*(emp_hours - emp_hours_o)
     + del_f_wage_pt;


Equation E_d_f_w_pt_o      ! Allows for change in the labour supply!
# Relates deviation in CPI-deflated post-tax wages based on occ.in
emp. #
(All,o,OCC)
(RWO_PT(o)/RWO_PT_OLD(o))
            *(rwag_pt_o(o) - rwag_pt_o_o(o)) =
 100*((RWO_PT_B(o)/RWO_PT_OB(o))
                    - (RWO_PT_L_B(o)/RWO_PT_O_LB(o)))*del_unity
+ ALPHA1_OCC(o)*{(EMP(o)/[EMP_OLD(o)+TINY])
                                *(e_hours_o(o) - e_hours_o_o(o))}
 - ALPHA1_OCC(o)*{(HOURSLR_D(o)/[HOURSLR_DO(o)+TINY])
                        *(emp_hourslrd(o)-emp_hourslrdo(o))}
 - 100*ALPHA1_OCC(o)*d_f_w_pt_o(o);
```

```
Equation E_f_rw_ptd
# Real post-tax wages for nonemployed, determined by average real
wage #
(All,p,UNEMP)
rwag_pt_o(p) = realw_pt + d_f_rw_ptd_A(p);



Equation E_realw_pt  # Ave real post-tax wage rate for work activ #
Sum(o,OCC, HOURS_I(o))*realw_pt = Sum(o,OCC,HOURS_I(o)*rwag_pt_o(o))
;

Equation E_rwag_pt_o # Post tax CPI deflated wage rate based on occ.
#
(All,o,OCC) rwag_pt_o(o) = r_wag_o(o) - TAX_L_RATE/(1 -
TAX_L_RATE)*tax_l_r;



Equation E_rwag_pt_o_o
   # Forecast post-tax CPI delflated wage based on occ in policy
sim # (All,o,OCC) rwag_pt_o_o(o) = rwag_pt_o(o) + f_rw_pt_o_o(o);



Equation E_real_wage_pt_o
  # Forecast post-tax CPI-deflated wage used in policy simulations #
  real_wage_pt_o = real_wage_pt + f_rwage_pt_o;



Equation E_tax_l_r_o
  # Forecast tax rate on wages based on occupations used in policy
sim #
    tax_l_r_o = tax_l_r + ftax_l_r_o;



Equation E_p1lab # Can be used to vary wage movements across
industries  #
 (ALL,o,OCC) (All,i,IND)
p1lab(o,i) = p3tot + f1lab_i + f1lab_o(i) + f1lab_occ(o) +
f1lab(o,i);


!=========================================================================!
!                             EMPLOYMENT                                  !
!=========================================================================!

Equation E_emp_hourslrdo
  # Transfers labor supply o from forecast to policy #
(All,o,OCC)
emp_hourslrdo(o) = emp_hourslrd(o) + f_hrslrd(o);
```

```
Equation E_e_hours_o # Employment based on occupation, hours #
(All,o,OCC)
HOURS_I(o)*e_hours_o(o) =  Sum{i,IND,HOURS(o,i)*x1lab(o,i)};



Equation E_e_hours_o_o
  # Introduces forecast employment based on occ into policy
simulation #
(All,o,OCC) e_hours_o_o(o)  = e_hours_o(o) + f_emp_oo(o);



Equation E_d_f_empj
# Direct adjustment of employment based on occ back to basecase
forecast #
(All,o,OCC)
 (EMP(o)/EMP_OLD(o))*(e_hours_o(o) - e_hours_o_o(o)) =
  100*{(EMP_B(o)/EMP_O_B(o)) - (EMP_L_B(o)/EMP_O_L_B(o))}*d_empj(o)
   + d_f_empj(o);



Equation E_d_ff_empaj
# Equation for moving level of shift variable in E_d_f_empj back to
zero #
(All,o,OCC)
  d_f_empj(o) = {-FEMPJ_B(o)+ FEMPJ_O(o)}*d_emp_sh_o(o)
+ d_ff_empj(o);



Equation E_emp_hours # Aggregate employment, hours #
  HOURSTOT*emp_hours = Sum{o,OCC,Sum{i,IND, HOURS(o,i)*x1lab(o,i)}};



Equation E_emp_hours_o # Introduces forecast employment into policy
simulation #
  emp_hours_o  = emp_hours + f_emp_o;

Equation E_d_f_empadj
  # Direct adjustment of employment back to basecase forecast #
  (EMPLOY/EMPLOY_OLD)*(emp_hours - emp_hours_o) =
  100*{(EMPLOY_B/EMPLOY_O_B) -
(EMPLOY_L_B/EMPLOY_O_L_B)}*d_empadj+d_f_empadj;



Equation E_d_ff_empadj
  # Equation for moving level of shift variable in E_d_f_empadj back
to zero #
  d_f_empadj = {-FEMPADJ_B+ FEMPADJ_O}*d_emp_sh +d_ff_empadj;
```

In the MyAGE model, there is only one version of the employment-wage adjustment specification which is at the aggregate level; *E_del_f_wage_c*. The wage variables and coefficients refer to pre-tax wages deflated by the CPI. There are no post-tax real wage rates and it is assumed that there are no changes in the labour supply. In the extension of the MyAGE model, MyAGE_LM makes three distinctions:

(1) Occupational disaggregation versus economy-wide real wages;

(2) Pre-tax real wages versus post-tax real wages and

(3) Labour supply specification versus no changes in the labour supply.

There are two versions of the employment-wage adjustment specification at the aggregate level; *E_del_f_wage_c* and *E_del_f_wage_pt*. In equation *E_del_f_wage_c*, the wage variables and coefficients refer to the economy-wide pre-tax wage rates deflated by the CPI. In *E_del_f_wage_pt*, the wage variables and coefficients refer to the economy-wide post-tax wage rate.

There are also versions of the employment-wage adjustment specification based on occupations; *E_d_f_wage_o* and *E_d_f_w_pt_o*. In equation *E_d_f_wage_o*, the wage variables and coefficients refer to the occupational pre-tax wage rates deflated by the CPI. In *E_d_f_w_pt_o*, the wage variables and coefficients refer to the occupational post-tax wage rate.

3.19.6.1   Economy-Wide Pre-Tax Real Wages and Employment (No Change in Labour Supply)

When the pre-tax real wages version is turned on, this assumes that the bargaining of wages is made in real pre-tax terms. Equation *E_del_f_wage_c* is activated in policy simulations, with *del_f_wage_c* being exogenous. The variables *real_wage_c_o* and *emp_hours_o* are the basecase forecast values for the real consumer wage and aggregate employment respectively. In policy simulations, equations *E_real_wage_c_o* are *E_emp_hours_o* are used to facilitate the introduction of basecase forecast values. In the basecase policy simulation, *f_rwage_o* and *f_emp_o* are exogenous. This allows *real_wage_c_o* and *emp_hours_o* to be exogenous

and therefore to track the forecast values of *real_wage_c* and *emp_hours* respectively. For policy simulation, *real_wage_c_o* and *emp_hours_o* become exogenous (with *f_rwage_o* and *f_emp_o* endogenous).

In early years of a policy simulation, the movement in aggregate employment is determined by *E_real_wage_pt*. In the first year, i.e., year *t*, for *E_d_f_empadj* to determine employment, *FEMPADJ* must move from its value in *t-1* to its forecast value *FEMPADJ_O* using the equation *E_d_ff_empadj*. In equation *E_d_ff_empadj*, *d_emp_sh* is set at 1 and *d_ff_empadj* set as zero. In year *t+1* and the following years, FEMPADJ is kept on its forecast values by exogenizing *d_f_empadj* at its forecast value and endogenising *d_ff_empadj*.

Equation *E_emp_hours* calculates the percentage change in aggregate employment and across all industries while equation *E_real_wage_c* describes the economy-wide real wages deflated by the consumer price index.

3.19.6.2   Occupational Pre-Tax Real Wages and Employment (No Change in Labour Supply)

To take into account the effects of different occupational types, equation *E_del_f_wage_c* is turned off by endogenising *del_f_wage_c* and turning on equation *E_d_f_wage_o* by exogenising *d_f_wage_o*. Similar to equation *E_del_f_wage_c*, the variables *r_wag_o_o* and *e_hours_o_o* are the basecase forecast values for occupational real consumer wage and employment respectively.

With the implementation of new equations taking into consideration different occupations *o*, in the basecase policy simulation, *f_r_wage_oo* and *f_emp_oo* are both endogenous (with *f_rwage_o* exogenous and *f_emp_o* endogenous). For the policy simulation, *r_wag_o_o* and *e_hours_o_ o* become exogenous (with *f_r_wage_oo* and *f_emp_oo* endogenous).

Equation *E_p1lab* allows for the indexing of labour wages to consumer price index (*p3tot*). The '*f1lab*' variables allow for deviations in wages relative to the CPI.

3.19.6.3   Economy-Wide Post-Tax Real Wages and Employment (No Change in Labour Supply)

In MyAGE_LM, instead of using the "sticky-wage adjustment equation with the assumption of only modelling labour demand, labour supply is included in both the pre and post tax real wage equations. When post tax real wages are used in policy simulations, it is assumed that nominal wage rates respond to not only movements in CPI and aggregate as well as occupational employment, but also the changes in the income tax rate. For example, when there is an increase in labour income tax rate (the government replaces the loss in tariff revenue from a cut in tariffs), this post-tax version is turned on. In this version, workers will try to maintain their real post-tax wage rates by demanding higher pre-tax wages.

In policy simulations when the economy-wide aggregate real post-tax wages is assumed, equation *E_del_f_wage_c* is de-activated by endogenizing *del_f_wage_c*. Instead, equation *E_del_f_wage_pt* is switched on by exogenizing *del_f_wage_pt.*

3.19.6.4   Occupational Post-Tax Real Wages and Employment (Change in Labour Supply)

Equation *E_d_f_wage_o* is de-activated by turning off (endogenizing) *d_f_wage_o(o)*. Instead, equation *E_d_f_w_pt_o* is activated by exogenizing and *d_f_w_pt_o(o)* as well as exogenizing *rwag_pt_o_o(o)*. The transfer of labour supply from forecast to policy is modelled by exogenizing the variable *emp_hourslrdo(o)* and endogenising *emp_hourslrd(o)*. This is shown in equation *E_emp_hourslrdo*. If the supply of labour, *emp_hourslrdo(o)* increases relative to the demand for labour, *e_hours_o_(o)*, from equation *E_d_f_w_pt_o*, it can be seen that the labour market does not clear. Thus, post-tax real wages, *rwag_pt_o(o)* would have to decrease to bring employment back to equilibrium. The speed of labour supply/demand adjustment for the different occupations depends on the parameter *ALPHA1_OCC(o)*.

Two additional new equations are introduced in the new wage adjustment section; real post-tax wages for those who are not employed (short run and long run unemployed), *E_f_rw_ptd* and the average real post-tax wage rate for activity *(act)*, *E_realw_pt*. In equation *E_f_rw_ptd*, the shifter for the real returns to unemployment, *d_f_rw_ptd_A(p) (p* is the set

for those who are unemployed) is exogenous in both forecast and policy simulations. Thus, the real post-tax tax wages for the unemployed, [*rwag_pt_o(p)*, *p* equals unemployed] is determined by average post tax real wages, *realw_pt*. In equation *E_realw_pt*, the average post-tax real wages for activity (*act*) is the share weighted sum of the real post-tax wages for those who are employed and unemployed, *rwag_pt_o(o)*.

Sections 3.19.6.1 to 3.19.6.4 illustrate the transfer of results from the baseline into policy simulations. In order to facilitate the transfer using these equations, a program in GEMPACK called SHOCKTRAN is included to allow the specification that, in the absence of other instructions, movements in exogenous variables in the policy computations for the year *t* would have the same values that they had (either exogenously or endogenously) in the forecast computations for year *t*.

In excerpt 3.33 of the TABLO code, it can be seen that equations *E_real_wage_c_o*, *E_r_wag_o_o*, *E_real_wage_pt_o*, *E_rwag_pt_o_o*, *E_emp_hours_o* and *E_e_hours_o_o* all have the form:

$$x\_o = x + fx\_o \tag{3.61}$$

where

x is a variable for example the percentage growth in real wages in which forecast results are required in policy simulations;

fx_o is a shift variable and

x_o is the variable that is given the forecast simulation value of x in policy simulations.

In the forecast computation in year *t,* each of the shift variables is set exogenously at zero. This means x_o has the same value as the forecast value of x. In the policy computations, when x_o is exogenous, the shifter fx_o is endogenous. Thus, through the use of SHOCKTRAN, x_o is automatically shocked, as required by the forecast value for x, e.g., forecast growth in real wages. That is, the forecast result for x_o is exactly the value needed as an exogenous shock for x_o in policy simulations.

In early years of a policy simulation, the movement in aggregate occupational employment is determined by *E_rwag_pt_o*. In year *t*, for *E_d_f_empj* to determine employment, *FEMPJ* moves from its value in *t-1* to its forecast value *FEMPJ_O*. This is done using equation *E_d_ff_empaj*. In equation *E_d_ff_empaj*, *d_emp_sh_o* is set at 1 and *d_ff_empj* is set at zero. In year *t+1* and the following years, FEMPJ is kept on its forecast value by turning on (exogenizing) *d_f_empj* at its forecast value and turning off (endogenising) *d_ff_empj*.

Equation *E_e_hours_o_o* calculates the percentage change in employment by occupation in the forecast, ready to transfer to the policy run. Equation *E_r_wag_o* describes the occupational real wages deflated by the consumer price index.

With wage adjustment equations; *E_del_f_wage_c*, *E_del_f_wage_pt, E_d_f_wage_o* and *E_d_f_w_pt_o* used, policy induced deviations in employment sometimes have a damped cycle and sometimes do not revert back to control in the long run, as explained by the following two examples:

Example 1

Simulation experience has shown that in the long run, the deviation in employment has the tendency of exhibiting either a small positive or negative deviation, which is caused by the basecase forecast interacting with the policy shock imposed. In an example in Dixon and Rimmer (2002 pp. 209), with a policy shock on the effects of decreasing costs on Australian wharves, there was a small positive long run deviation in employment even though real wages experienced a gradual increase. This is because the basecase forecast showed fast growth in Australia's trade. Hence, the decrease in the costs on the wharves provided an increasing benefit to the Australian economy. Based on the wage adjustment equation, this benefit caused an ever-increasing deviation in real wages and a permanent increase in employment. This is shown in Figure 3.7 below:

Figure 3.7   Long Run Positive Deviation in Employment and Real Wages

Percentage Change (Deviation from Basecase Forecast)
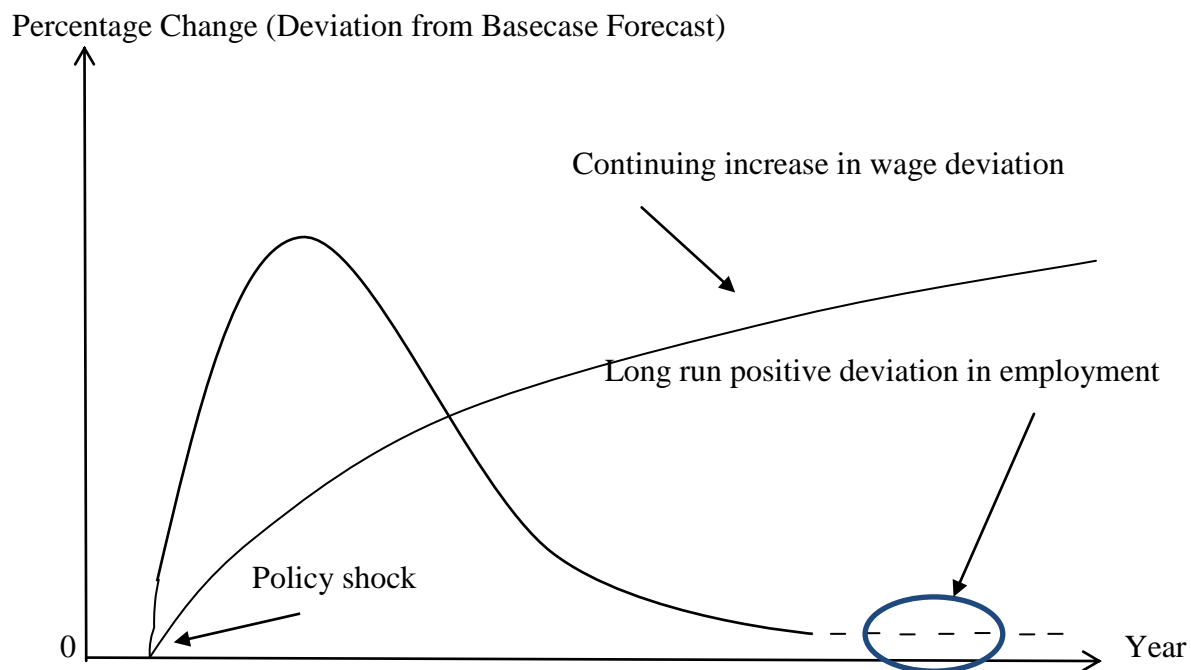
Example 2

Instead of asymptoting monotonically to zero effect, the deviation results for aggregate employment in MyAGE_LM simulations sometimes show damped oscillations, as illustrated in Figure 3.8. These cycles in policy deviations are of no practical importance, but can cause undue concern among policy makers. By using equations *E_d_f_empadj*, *E_d_ff_empadj*, *E_d_f_empj* and *E_d_ff_empaj* in excerpt 3.34, a smooth path for the employment deviations such as the dotted line in Figure 3.8 can be imposed after the first few years of a simulation.

Figure 3.8   Smoothing out Damped Cycles in Employment

Percentage Change (Deviation from Basecase Forecast)
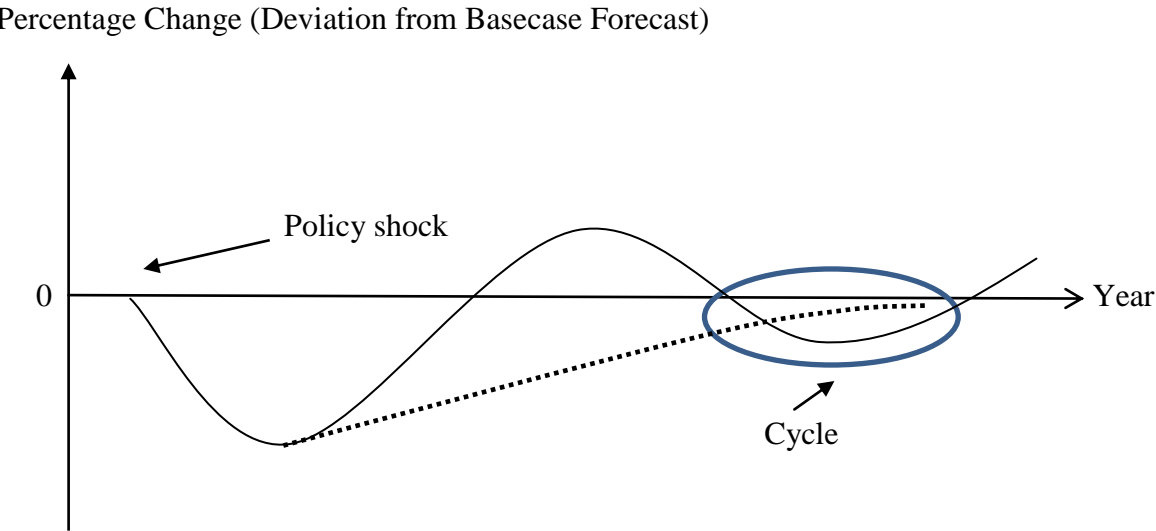
3.19.7 Who Gets the Jobs and What Happens to Those Who Don't

This section discusses people's activity during the year, i.e., those who are able to find employment and what happens to those who don't. Table 3.1 shows the possible labour flows in the MyAGE_LM model.

Table 3.1   Specifying Flows from Categories to Activities in MyAGE_LM

Activities / Categories	Employment Skilled Occupation	Employment Semi-Skilled Occupation	Employment Unskilled Occupation	Short-Run Unemployment Market	Long-Run Unemployment Market
Employment Skilled Occupation	1	Zero	Zero	2	Zero
Employment Semi-Skilled Occupation	Zero	1	Zero	2	Zero
Employment Unskilled Occupation	Zero	Zero	1	2	Zero
Short-Run Unemployment Market	1	1	1	Zero	3
Long-Run Unemployment Market	1	1	1	Zero	3
New Entrant to Labour Market	1	1	1	4	Zero

The numbers represent the different type of flows from a category *cat* at the start of year *t* to an activity *act* in year *t*.

Each type of flow from a start-of-year category to activity is described by an equation from sections 3.19.7.1 to 3.19.7.4. In Table 3.1, the rows represent the categories from which the flows originate and the columns represent the activities to which labour supply flows. Areas that contain "zero" indicate that such a flow is not permitted in MyAGE_LM. In linking (as shown in the downward slopping arrows in Figure 3.5) categories (*cat*) at the start of year *t* to activities (*act*) in year *t*, an equation for the flow from each category to activity $H_t(cat;act)$ is specified.

3.19.7.1 Flows from all Categories of Employment in Malaysian Occupations (Area 1 in Table 3.1)

Vacancies in employment activity (*act*) can be expressed as follows:

$$V_t(\text{act}) = E_t(\text{act}) - H_t[\text{act};\text{act}] \quad \text{for all Malaysian employment activities } (act) \qquad (3.62)$$

where

- $H_t[\text{act};\text{act}]$ is employment of people in category (*act*) in activity (*act*) and where

  $\text{act} \neq \text{cat}$;

- $V_t(\text{act})$ is vacancies and

- $E_t(\text{act})$ is total employment in activity (*act*).

Equation (3.62) shows vacancies in employment activity (*act*) in year *t* as employment in activity (*act*) of the year *t* minus the number of jobs filled by incumbents in the activity. The flow from category (*cat*) to activity (*act*) for $\text{cat} \neq \text{act}$ is given as:

$$H_t(\text{cat};\text{act}) = V_t(\text{act}) * \left[\frac{L_t(\text{cat};\text{act})}{\sum_{s \neq act} L_t(s;\text{act})} \right] \quad \forall \text{cat} \text{ and } \text{act} \neq \text{cat} \qquad (3.63)$$

where

- $L_t(\text{cat};\text{act})$ is the labour supply of people in category (*cat*) to activity (*act*) during year *t* with both (*cat*) and (*act*) and

- $H_t(\text{cat};\text{act})$ is the actual flow of people from start-of-year category (*cat*) to activity (*act*) during year *t*.

In equation (3.63), the flow of people from category (*cat*) to employment activity (*act*), where $[\text{cat} \neq \text{act}]$ is modelled as being proportional to the vacancies in activity (*act*) and the

share of category (*cat*) in the supply of labour to activity (*act*) from workers outside category (*act*). Thus, if workers in category (*cat*) account for 10 per cent of the workers outside of category (*act*) who want jobs in employment-activity (*act*), then people in category (*cat*) will fill 10 per cent of the vacancies in (*act*).

It is assumed that there will always be competition for jobs, that is, the number of people from outside of category (*act*) who plan to work in employment-activity (*act*) is greater to or equal to the number of vacancies $[V_t(act)]$ in *act*. This ensures that $H_t(cat; act)$ is less than or equal to $L_t(cat; act)$ for all categories cat $\neq$ act and all employment activities (*act*).

$$H_t(cat; cat) = CAT_t(cat) - \sum_{act \neq cat} H_t(cat; act) \quad \text{for all employment categories (cat)} \qquad (3.64)$$

As defined in equation (3.64), the number of incumbents from category (*cat*) who remain in activity (*cat*) $[H_t(cat; cat)]$ is defined as the number of people in category (*cat*) minus the workers who move out of activity (*act*), given in equation (3.63). From equation (3.63), the flow of people from category (*cat*) to employment activity (*act*) is less than or equal to $L_t(cat; act)$ for all *cat* $\neq$ *act*, that is, $H_t(cat; act)$ is less than or equal to $L_t(cat; act)$. Workers in employment category (*cat*) who plan on working in activity act $\neq$ cat but who are not able to move to (*act*) because of insufficient vacancies will remain in (*cat*).

3.19.7.2   Flows from Employment Categories to Unemployment Categories (Area 2 in Table 3.1)

$$H_t(cat; u) = \begin{cases} L_t(cat; u) + [\mu(cat) * CAT_t(cat)] & \text{for SR unemployment activity (u)} \\ 0 & \text{for LR unemployment activity (u)} \end{cases} \qquad (3.65)$$

for all employment categories (*cat*)

At the start of year *t*, workers in employment cannot move to long term unemployment activity. Should they move to being unemployed, it must be to short-term unemployment. Equation (3.65) shows that the number of people who move into short-run unemployment is

the sum of voluntary moves, $L_t(\text{cat}; u)$ and involuntary moves. Involuntary moves from employment category (*cat*) are modelled as a fraction $\mu(\text{cat})$ of the number of people in category (*cat*).

Usually, $\mu(\text{cat})$ is exogenous. However, it is possible that (3.65) in concurrence with (3.63) will give a value for $H_t(\text{cat}; \text{cat})$ in (3.65) that is greater than $E_t(\text{cat})$. If so, $V_t(\text{cat})$ would be negative. This is avoided by treating $\mu(\text{cat})$ as an endogenous variable. If $V_t(\text{cat})$ is greater than zero, then $\mu(\text{cat})$ equals an exogenously given minimum value determined by the rate at which workers are dismissed because of their performance or other factors that are unrelated to the overall demand for people in activity (*cat*). Alternatively, $\mu(\text{cat})$ moves appropriately above its minimum value to ensure that $V_t(\text{cat})$ equals zero. When $\mu(\text{cat})$ is above its minimum value, then there are involuntary flows form employment category (*cat*) to unemployment that are caused by overall shortage of jobs.

3.19.7.3 Flows from Unemployment Categories to Unemployment Activities (Area 3 in Table 3.1)

In MyAGE_LM, those workers in short-term unemployment who fail to obtain a job will flow to long-term unemployment. Also, workers in long term unemployed who fail to obtain a job remain in long term unemployment. This is given by equations (3.66a) and (3.66b):

$$H_t(\text{cat}; \text{act}) = 0 \quad \text{for } (\text{cat}) \text{ equal SR unemployment and } (\text{act}) \text{ equal SR or LR unemployment}$$

$$\text{(3.66a)}$$

$$H_t(\text{cat}; \text{act}) = CAT_t(\text{cat}) - \sum_{\text{act} \in \text{emp.act}} H_t(\text{cat}; \text{act}) \quad \text{for cat} = LR \text{ unemployment activity (u)} \quad \text{(3.66b)}$$

3.19.7.4   Flows from NEW Categories to Unemployment Activities (Area 4 in Table 3.1)

For new entrants who fail to secure a job, they are allocated to short-term unemployment activity and not allowed to flow to long-term unemployment. This is specified as:

$$H_t(cat;u) = \begin{cases} CAT_t(cat) - \sum_{act \in emp.act} H_t(cat;act) & \text{for } (cat) = new \text{ and } (u) = SR \text{ unemployment} \\ 0 & \text{for } (cat) = new \text{ and } (u) = LR \text{ unemployment} \end{cases} \quad (4.67)$$

3.19.7.5   Completing the Link from Categories to Activities

Sections 3.19.7.1 to 3.19.7.3 discuss the labour flows from categories at the start of year to activities in year t on the off diagonal matrix[16]. To complete the link from categories at start of year t to activities in year t, the following equation showing labour flows on the diagonal matrix is given in the form:

$$\sum_{cat} H_t(cat;act) = E_t(act) \quad (3.68)$$

for all unemployment activities.

The TABLO code for labour flows in MyAGE_LM is shown in excerpt 3.35 below.

Excerpt 3.35   **Labour flows from category *cat* to activity *act***

```
Equation E_vacant # Vacancies #
  (All,o,OCC)
  [VAC(o)+TINY]*vacant(o) = HOURS_O(o)*e_hours_o(o)
            - HRS_OIBSMJ(o,o)*x1lab_d(o,o) ;


Equation E_offerto # Offers to o from outside o #
(All,o,OCC) offerto(o)=
Sum(m,OCCP,  DUM6(m,o)*SH_QI(m,o)*lfcoffer(m,o) );
```

---

[16] A more detailed flow matrix showing both diagonal and non-diagonal matrix found in Table 4.5 of Chapter 4.

```
Equation E_x1lab_dA
 # Determines flows to  employment excluding diagonal flows #
(All,oo,OCCP)(All,o,OCC)
x1lab_d(oo,o)  = [vacant(o) + lfcoffer(oo,o)
   - offerto(o) ]    + (1-DUM6(oo,o))*1000*f_empl(o);


Equation E_f_empl
# Total flows from a work category: determines diagonal flows to
employment #
(All,oo,OCC)
  OFFER_FROM(oo)*lfcoffer_oi(oo) =
[Sum(o,OCC, HRS_OIBSMJ(oo,o)*x1lab_d(oo,o) ) +
Sum(qq,UNEMP,LFC_OFFER(oo,qq)*lfcoffer(oo,qq))
+ SACKFRAC*OFFER_FROM(oo)*lfcoffer_oi(oo)            ] ;


  Equation E_x1lab_dB
# Flows from employed to uemployed, voluntary and involuntary #
(All,oo,OCC)(All,qq,UNEMP)
[HRS_OIBSMJ(oo,qq)+TINY]*x1lab_d(oo,qq)
= [LFC_OFFER(oo,qq)*lfcoffer(oo,qq)+
  SACKFRAC*OFFER_FROM(oo)*DUMSACK(qq)*lfcoffer_oi(oo)];


   Equation E_x1lab_dC1  # Flows from unemployed to unemployed #
 (All,oo,UNEMP)(All,o,UNEMP)
[HRS_OIBSMJ(oo,o)+TINY]*x1lab_d(oo,o) =
    [ SH_B6(oo,o)*[  OFFER_FROM(oo)*lfcoffer_oi(oo)  -
    Sum(p,OCC,HRS_OIBSMJ(oo,p)*x1lab_d(oo,p))]  ];


 Equation E_x1lab_dC4
  # Flows from new to unemployed #
 (All,oo,NEWENT)(All,o,UNEMP)
[HRS_OIBSMJ(oo,o)+TINY]*x1lab_d(oo,o) =
      SH_B6(oo,o)*[  OFFER_FROM(oo)*lfcoffer_oi(oo)  -
    Sum(p,OCC,HRS_OIBSMJ(oo,p)*x1lab_d(oo,p))];
 Equation E_x1lab_obsB # Hours in unemployed activities #
(All,o,UNEMP)
HOURS_OSE_I2(o)* e_hours_o(o) =
Sum(oo,OCCP, HRS_OIBSMJ(oo,o)*x1lab_d(oo,o));


Equation E_x1lab_obsC # Hours in employed activities #
(All,o,OCC)
HOURS_OSE_I(o)* e_hours_o(o)
=Sum(oo,OCCP,HRS_OIBSMJ(oo,o)*x1lab_d(oo,o));
```

```
Equation E_x1lab_obs_l
 # Lagged employment in activity o #
(All,o,NONNEW)
[HOURS_OSE_L(o)]*x1lab_obs_l(o)=
100*[HRS_OSE_I_B(o) - HRS_OSE_L_B(o)]*del_unity ;


Equation E_f_empl2
# Total flows from a work category: determines diagonal flows to
employment #
(All,o,NONNEW)
 [OFFER_FROM(o)+TINY]*lfcoffer_oi(o)
 = 100*[0.99*HRS_OSE_I_B(o)-OFFER_FROM_B(o)]*del_unity;


Equation E_lfcoffer_oseB
  # People in category oo for oo = new entrant  #
(All,oo,NEWENT)
lfcoffer_oi(oo) = f_x1labose;


Equation E_ff_x11labose
 ff_x11labose= emp_hours +f_x1labose;
```

Equation *E_vacant* shows the vacancies in work activities. Vacancies, *vacant(o)* is defined as the number of jobs (employment activities), *e_hours_o(o)* minus the number of incumbents *x1lab_d(o,o)*. Offers from a category *o* from outside of *o*, *offerto(o)* is given by equation *E_offerto(o)* and defined as of the total supply of people in category *m* offering employment to *o*, *lfcoffer(m,o)* multiplied by the proportion (the share of *m* in non-diagonal offers) of people moving from occupation *m* to occupation *o*, *SH_QI(m,o)*. The flows (non-diagonal) to employment activity *o* from category *oo* is given by equation *E_x1ab_dA*.

The total flows (offer) from work category *oo* (diagonal flows) is determined by equation *E_f_empl*, where total supply from category *oo*, *lfcoffer_oi(oo)* is the sum of the flows from category *oo* to activity *o, x1lab_d(oo,o)*, the number of people who volunteer from being employed in category *oo* to become short term unemployed to activity *qq*, *lfcoffer(oo,qq)* and the proportion of people from category *oo* who are fired, given by:

*lfcoffer_oi(oo)*SACKFRAC*OFFER_FROM(oo)*

Equation *E_x1lab_dB* shows the flows from being in employment category *oo* to short run unemployed in category *qq*. The flows are defined as the sum of the number of people who volunteer to become short term unemployed in category *qq* from being employed in category *oo*, *lfcoffer(oo,qq)* and involuntary flows from employment category *oo* to short run unemployment activity *qq lfcoffer_oi(oo)*, where:

*[SACKFRAC*OFFER_FROM(oo)*DUMSACK(qq)*lfcoffer_oi(oo)].*

The flows from being unemployed and a new entrant from category *oo* to unemployed category *p* is given by the variable *x1lab_d(oo,p)* in equations *E_x1labdC1* and *E_x1labdC4* respectively. Equation *E_x1labdC1* and *E_x1labdC4* show that people who are employed or in new entrant in category *o lfcoffer_oi(oo)* will move to short-run unemployment (and people in short-run unemployment will move to long-run unemployment) if they fail to secure employment *x1lab_d(oo,p)*.

The total hours of people in unemployed and employed categories *o* and *oo* are shown in equations *E_x1lab_obsB* and *E_x1lab_obsC* respectively.

3.20   Conclusion

This chapter describes the core theoretical framework of MyAGE_LM, which is a single country model for the Malaysian economy based on a MONASH-style dynamic Applied General Equilibrium model for Malaysia. The MyAGE_LM model is used to focus on the labour market; more specifically the effects of a tariff shock to the different occupational wages and employment. The core equations describing the key features of MyAGE_LM is presented in Sections 3.2 to 3.19. The model incorporates nine different occupational types for each of the labour market adjustment equations.

CHAPTER 4

MYAGE_LM DATABASE

4.1　Introduction

The database for MyAGE_LM is sourced from the Centre of Policy Studies (CoPS), and consists of three main parts: (1) The input-output (I-O) data for the base year, (2) Behavioural parameters and (3) Data and parameters for the labour market specification. The next section describes MyAGE_LM's main database used to carry out policy simulations, while Section 4.3 shows how the original MyAGE_LM database is mapped into 30 sectors. The main parameters in the model are described in Section 4.4. Section 4.5 presents a detailed description on the construction of the matrices used to specify the labour market in MyAGE_LM adapted from Dixon and Rimmer (2003; 2008) and Dixon *et al*. (2010) and Section 4.6 concludes.

4.2　Structure of the Database

MyAGE_LM is a system of simultaneous equations. The input-output database provides the initial solution for the model. A large component of the initial solution can be represented by a disaggregated input-output database shown in Figure 4.1. Figure 4.1 maps out the structure of the required input-output database into three main parts: the absorption matrix, the production matrix and a matrix of taxes on international trade. The column headings in the absorption matrix show the following demanders:

(1) Domestic producers divided into *I* industries;

(2) Investors divided into *I* industries;

(3) A representative household;

(4) Aggregated foreign purchases of exports;

(5) Government demands and

(6) Changes in inventories.

Figure 4.1 MyAGE_LM Flows Database

		Absorption Matrix					
		1	2	3	4	5	6
		Producers	Investors	Household	Export	Government	Change in Inventories
	Size	$\leftarrow I \rightarrow$	$\leftarrow I \rightarrow$	$\leftarrow 1 \rightarrow$	$\leftarrow 1 \rightarrow$	$\leftarrow 1 \rightarrow$	$\leftarrow 1 \rightarrow$
Basic Flows	$\uparrow$ C x S $\downarrow$	V1BAS	V2BAS	V3BAS	V4BAS	V5BAS	V6BAS
Margins	$\uparrow$ C x S x M $\downarrow$	V1MAR	V2MAR	V3MAR	V4MAR	V5MAR	0
Taxes	$\uparrow$ C x S $\downarrow$	V1TAX	V2TAX	V13TAX	V4TAX	V5TAX	0
Labour	$\uparrow$ O x S $\downarrow$	V1LAB					
Capital	$\uparrow$ 1 $\downarrow$	V1CAP					
Land	$\uparrow$ 1 $\downarrow$	V1LND					
Production Tax	$\uparrow$ 1 $\downarrow$	V1PTX					
Other Costs	$\uparrow$ 1 $\downarrow$	V1OCT					

C = Number of commodities (30)[17]

I = Number of industries (30)

S = Source (2)

O = Number of Occupation Types (9)

M = Number of Commodities Used as Margins (3)

	Production Matrix
Size	$\leftarrow I \rightarrow$
$\uparrow$ C $\downarrow$	MAKE

	Tariff
Size	$\leftarrow 1 \rightarrow$
$\uparrow$ 1 $\downarrow$	V0TAR

---

[17] Number of elements in the set.

The first row in the absorption matrix, which is the "BAS" matrices (V1BAS, ...,V6BAS) shows the flows of commodities to all users. Each of these matrices has C x S rows, one for each C commodity from source S (imported or domestic). The flows are valued at basic prices. The basic price of a domestically produced good is the price received by the producer (price paid by user excluding sales taxes, transportation costs and other margins). The basic price of an imported good is the landed-duty paid price, i.e., the price at the port of entry just after the commodity has cleared customs.

The row which shows the "MAR" matrices (V1MAR, .., V5MAR) is the values of margin services used to facilitate the flows of commodities in the "BAS" matrices. The commodities used as margins are domestically produced trade, road transport, water transport services and insurance. Imports are not used as margin services. Each of the margin matrices has C x S x M rows which show the use of margin M commodities to facilitate flow of commodities C from sources S. It is assumed that the change in inventories in column 6 do not use any margins, as it only comprises of unsold products. Similar to the "BAS" matrices, all the flows in the "MAR" matrices are valued at basic prices.

The taxes row (V1TAX, .., V5TAX) shows sales tax on flows to different users (i.e., delivery of domestic and imported goods to producers, capital creators, households, exports and the government). For example, the element in V1TAX is a tax on the delivery of good C from source S for the use in current production as an input by industry I. Also, as in the case for the "MAR" matrices, it is assumed that there are no taxes on inventories. Tax rates can differ between users and sources. For example, the tax rate on a good used as an intermediate input for production can be lower than the tax rate for households on the same commodity.

In addition to intermediate inputs, production requires primary factor inputs which are labour, fixed capital and land. Labour is classified based on occupations. These factor inputs are shown in the "V1LAB", V1CAP" and "V1LND" rows. Industries are also required to pay production taxes ("V1PTX"), which comprise generally of taxes on the ownership or the use of factors of production. Examples of production taxes are licences and permits.

The two separate matrices are the "MAKE" and "V0TAR" matrices. The "MAKE" matrix is a C x I matrix which shows the value of the commodity C produced by industry I. The "MAKE" matrix need not be diagonal. An industry is able to produce several commodities

and one commodity can be produced by different industries. The "V0TAR" matrix consists of a vector of import duties by import commodity. They are used to calculate the tariff rates in the base year as the ratios between the tariff revenues and the relevant basic flows of imports on which the tariffs are levied.

4.3 Aggregation

In the original MyAGE database, there are 121 industries and commodities, along with 7 margins, 2 sources and 9 occupations. The database that is used in this thesis is an aggregated version of the original MyAGE database. The database for MyAGE_LM is aggregated into 30 commodities and industries, as well as 3 margins. The occupation and source sets remain unchanged. Table 4.1 below provides the classification of the aggregated sets.

Table 4.1   Classification of the Aggregated Sets in MyAGE_LM

Commodities (COM)	Industries (IND)	Source (S)	Occupation (OCT)	Margins (MAR)
1. Agriculture 2. CrdOilGas 3. OthMining 4. FoodBevTib 5. TCF 6 WoodPaper 7. PrintPubl 8. PetCoalChem 9. NonMetMin 10. MetalProds 11. OthMachEquip 12. MotorVehicle 13. TranspEquip 14. OthManuf 15. Recycling 16. EGW 17. Construction 18. TradeRepair 19. HotelRest 20. OthTransport 21. HWBrdgTunSer 22. Communicat 23. FinanceIns 24. OthBusServ 25. Dwellings 26. PubAdmDef 27. Education 28. Health 29. OthServices 30. Recreation	Same as Commodities	1. Domestic 2. Imported	1. LegSenOffMan 2. Professional 3. TechAssProf 4. Clerical 5. ServiceSales 6. SklAgriFish 7. CraftTraders 8. PlantMachOpr 9. ElementOcc	1. TradeRepair 2. OthTransport 3. HWBRDTuSer

4.4 Parameters

The main parameters used in the MyAGE_LM model are listed in Table 4.2.

Table 4.2   List of Parameters in MyAGE_LM Model

	COM/IND	SIGMA1 PRIM	SIGMA1 LAB	SIGMA0	SIGMA1	SIGMA2	SIGMA3	EXP_ELAS
1.	Agriculture	0.50	0.35	0.50	2.45	2.08	0.90	-4.91
2.	CrdOilGas	0.50	0.35	0.50	8.50	8.50	2.30	-13.65
3.	OthMining	0.50	0.35	0.50	0.90	0.90	3.76	-5.18
4.	FoodBevTib	0.50	0.35	0.50	2.92	2.31	3.01	-4.41
5.	TCF	0.50	0.35	0.50	3.77	3.75	2.95	-6.95
6	WoodPaper	0.50	0.35	0.50	3.07	2.95	2.87	-5.11
7.	PrintPubl	0.50	0.35	0.50	2.95	2.95	3.28	-5.24
8.	PetCoalChem	0.50	0.35	0.50	2.64	2.10	3.75	-5.69
9.	NonMetMin	0.50	0.35	0.50	3.19	3.30	4.27	-5.75
10.	MetalProds	0.50	0.35	0.50	3.60	3.75	2.80	-6.81
11.	OthMachEquip	0.50	0.35	0.50	4.29	4.12	4.27	-7.79
12.	MotorVehicle	0.50	0.35	0.50	2.80	2.80	2.80	-5.18
13.	TranspEquip	0.50	0.35	0.50	4.30	4.30	4.30	-8.16
14.	OthManuf	0.50	0.35	0.50	3.75	3.75	3.75	-7.15
15.	Recycling	0.50	0.35	0.50	3.75	3.75	3.75	-7.15
16.	EGW	0.50	0.35	0.50	2.80	2.80	2.80	-5.18
17.	Construction	0.50	0.35	0.50	1.90	1.90	1.90	-5.18
18.	TradeRepair	0.50	0.35	0.50	1.90	1.90	1.90	-4.00
19.	HotelRest	0.50	0.35	0.50	1.90	1.90	1.90	-3.92
20.	OthTransport	0.50	0.35	0.50	1.90	1.90	1.90	-5.18
21.	HWBrdgTunSer	0.50	0.35	0.50	1.90	1.90	1.90	-5.18
22.	Communicat	0.50	0.35	0.50	1.90	1.90	1.90	-3.79
23.	FinanceIns	0.50	0.35	0.50	1.90	1.90	1.90	-3.78
24.	OthBusServ	0.50	0.35	0.50	1.90	1.90	1.90	-5.18
25.	Dwellings	0.50	0.35	0.50	1.90	1.90	1.90	-5.18
26.	PubAdmDef	0.50	0.35	0.50	1.90	1.90	1.90	-5.18
27.	Education	0.50	0.35	0.50	1.90	1.90	1.90	-5.18
28.	Health	0.50	0.35	0.50	1.90	1.90	1.90	-5.18
29.	OthServices	0.50	0.35	0.50	1.90	1.90	1.90	-3.76
30.	Recreation	0.50	0.35	0.50	1.90	1.90	1.90	-4.00

The parameter SIGMA1PRIM shows the elasticity between primary factors: capital, labour and land. MyAGE_LM follows the ORANI model and sets the parameters SIGMA1PRIM equal 0.5 for all industries *i*. The second parameter SIGMA1LAB is the elasticity of substitution of labour between different occupations. The value of 0.35 is used for all industries in the Malaysian economy. The constant elasticity of transformation (CET) between industry outputs is given by SIGMA0 and set at 0.5 for all industries.

In MyAGE_LM, domestic and imported goods are assumed as imperfect substitutes, with the degree of substitutability governed by the Armington (1969) elasticities, given by SIGMA1. The parameters SIGMA2 and SIGMA3 are the Armington elasticities for investment and the household respectively. The elasticities for Malaysia are adopted from the GTAP 6.0

database (CoPS 2010). The elasticity EXP_ELAS is the foreign demand elasticity for Malaysian exports averaged across trade partners. The estimates of export demand elasticities are difficult to obtain and often differ between studies and models. The parameter values follow MyAGE, which are taken from the GTAP 6.0 database (CoPS 2010).

Other elasticities include the FRISCH parameter which is set at -3.2. It shows the relationship between households' total expenditure and their supernumerary expenditure in the Klein-Rubin utility function. The Frisch parameter is used to evaluate household's own and cross-price elasticities of demand and in calculating the change in the subsistence component of household consumption. As discussed in Section 3.5 in Chapter 3, the FRISCH parameter is the negative of the ratio between total final household expenditure and household supernumerary expenditure. Thus, as income increases, the proportion of income spent on subsistence will decrease, that is, the supernumerary proportion of household consumption should increase as income rises. MyAGE_LM has only one representative household. The value of the FRISCH parameter used is the same as in the MyAGE model that is adopted from the GTAP 3.0 database (CoPS 2010). The household expenditure elasticity in the demand equation is given by the parameter EPS.

4.5   Data and Parameters for MyAGE_LM Labour-Market Specification

4.5.1   Coefficients and Parameters

The matrices and parameters required for building the MyAGE_LM labour-supply database are illustrated in Table 4.3. The model requires separate matrices that describe activities undertaken during the base year, categories at the start of the base year, and matrices that show offers and actual flows from categories to activities. Each of the matrices is defined by a set of dimensions shown in Table 4.3. The sets include:

- ACT, which is the Malaysian labour market activities carried out during the year t and includes the nine occupational groups o (LegSenOffMan, Professional, TechAssProf,

Clerical, ServiceSales, SklAgriFish, CraftTraders, PlantMachOpr and ElementOcc), short-run (S) and long-run[18] (L) unemployment;

- CAT, which is the categories at the start of year t, and includes all employment by occupation o, short-run (S) and long-run (L) unemployment, as well as new entrants into the labour market (NEW) and

- NEWENT is the set for new entrants in the labour force.

---

[18] The terms short (long)-run and short (long)-term unemployed are used interchangeable without any loss in meaning.

Table 4.3   MyAGE_LM Labour Market Database

Symbol	Name	Dimension	
1. Sets			
OCC	Set OCC (occupations)	9 occupations	
IND	Set IND (industries)	30 industries	
NEMP	Set NEMP (not employed)	S, L and N	
UNEMP	Set (unemployed)	S and L	
NEWET	Set (new entrants)	1 new entrant	
OCCP	Set OCCP	OCC + NEMP	
NONNEW	Set NONNEW	OCC + UNEMP	
2. Coefficients			
HOURS_I	Number employed in all activities in year *t* (2005)	OCC	
HOURS_OSE_I2	Number unemployed, short and long run	UNEMP	
JOBS_OSE_C	Sum of HOURS_I and HOURS_OSE_I2	NONNEW	
HOURS_OSE_L	Number employed in all activities in year *t-1* (2004)	OCC	
RWAGE_PT	Post tax real wages	OCC	
VAC	Occupation specific vacancies	OCC	
BIGH	Actual flows from category cat to activity act	CAT*ACT	
LFCO	Planned flows from category cat to activity act	CAT*ACT	
3. Elasticities			
ALPHA1_OCC	Sensitivity of after tax real wages to employment		OCC
ELAS_LS	Substitution elasticity for workers between the types of labour		Scalar
SACFRAC	Fraction of workers getting fired		Scalar

The data that are used to construct the labour market database include the $ACT_{(o)}$ vector, which shows employment by occupation and unemployment by short and long-run in year *t*. That is, $ACT_{(o)}$ shows the number of workers in each labour market activity in year *t*. $ACT\_L_{(o)}$ shows lagged activities (i.e., activities in year *t-1*) and has a similar dimension to

$ACT_{(o)}$. Another data input is the $CAT_{(o)}$ vector. This shows the number of people in each labour market category c at the start of year t. Relative to the $ACT_{(o)}$ vector, $CAT_{(o)}$ contains an additional component called new entrant (NEW). This is exogenously introduced at the beginning of each year. $OFFER_{(c,o)}$ shows the planned flows from category c to activity o. This matrix shows what activities people in Malaysia would like to perform in year t. The actual flows matrix is given by $H_{(c,o)}$, showing the actual flows from category c to activity o. This matrix shows who is successful in obtaining employment and what happens to those who do not. The $VAC_{(o)}$ matrix is the occupation-specific vacancies in year t and is defined as the difference between the number of employment opportunities minus the number of jobs filled by incumbents.

The parameters used to construct the database are listed in Table 4.3. The ALPHA1_OCC parameters show the sensitivity of after tax real wages to employment based on occupations during the year of policy simulation, and is set at 0.5[19]. As discussed in Chapter 3 (equation *E_lfcoffer* in excerpt 3.35), the parameter ELAS_LS is the substitution elasticity in labour supply between the different types of labour, and SACFRAC is the proportion of workers in Malaysia who are sacked every year, set at 0.05.

In addition to the main sets shown in Table 4.3, sets based on different skilled occupational groups and new entrants used to construct the offer matrix are also shown in Table 4.4.

---

[19] Explanation for the function of ALPHA1_OCC is found in Section 3.19 of Chapter 3.

Table 4.4   Additional Sets for the MyAGE_LM Labour Market Database

Symbol	Name	Dimension
SKILL	Set SKILL (skilled occupation groups) (LegSenOffMan, Professional, TechAssProf)	3 occupations
SEMI_SKILL	Set SEMI_SKILL (semi-skilled occupation groups) (Clerical, ServiceSales, SklAgriFish, CraftTraders, PlantMachOpr)	5 occupations
UNSKILL	Set UNSKILL (unskilled occupation groups) (ElementOcc)	1 occupation
NEMP2	Set NEMP2 (not employed based on skills): • SSKL -Short- run skilled • SSSK -Short-run semi-skilled • SUNK -Short-run unskilled • LSKL - Long-run skilled • LSSK-Long-run semi-skilled • LUNK-Long-run unskilled • NSKL - New entrant skilled • NSSK - New entrant semi-skilled • NUNK - New entrant unskilled	SSKL, SSSK, SUNK, LSKL, LSSK, LUNK, NSKL, NSSK,NUNK
UNEMP2	Set UNEMP2 (unemployed based on skills)	SSKL, SSSK, SUNK, LSKL, LSSK, LUNK
Set NEWENT2	Set NEWENT2 (new entrants based on skills)	NSKL, NSSK,NUNK
Set OCCP2	Set OCCP2	OCC + NEMP2
Set NONNEW9	Set NONNEW9	OCC + UNEMP2

4.5.2　Deriving Matrices Used in MyAGE_LM Labour Market Specification

The activities vector, $\text{ACT}_{(o)}$, in MyAGE_LM is specified as employment in 2005 (base year) in nine different occupational groups and two types of unemployment. The occupational part of the activities vector is calculated by dividing the total wage bill for each occupation (RM million) with the average monthly pre-tax occupational real wages (RM'000). The 2005 Labour Force Survey report (LFS) for Malaysia does not classify those people who are unemployed into short-run or long-run unemployed. The assumption is made that 30 per cent of those unemployed in 2005 were short-run unemployed and 70 per cent were long-run unemployed.

Another data requirement is the lagged activity matrix $\text{ACT\_L}_{(o)}$ (i.e. activities in year *t-1*). In addition, a categories vector at the start of year *t* $\text{CAT}_{(o)}$ is also used because it indicates how many people survived from year *t-1* to year *t* (as shown in the upward slopping arrows in Figure 4.2). This vector also shows new entrants to the labour market at the beginning of year *t*. $\text{CAT}_{(o)}$ forms the basis for deriving planned and actual flows matrices (as shown in the downward slopping arrows in Figure 4.2).

The entries in $\text{CAT}_{(o)}$ show the number of people in the labour market category *o* at the start of year *t*. These entries depend on the number of people in each labour market activity *o* in year *t-1* and also the number of new entrants. Apart from the new entrants (which are determined exogenously), entries in $\text{CAT}_{(o)}$ for the start of year *t* are determined by equation 4.1 which calculates the number of people who survive from performing activities in year *t-1* to the start of year *t*.

$$\text{CAT}_{(o)} = \text{ACT\_L}_{(o)} * \text{T}_{(o)} \tag{4.1}$$

where

- $\text{CAT}_{(o)}$ is the number of people in the labour market category *o* at the start of year *t*;

- ACT_L$_{(o)}$[20] is the activity vector in year *t-1* and

- T$_{(o)}$ is a diagonal matrix which shows the proportion of people in activity *o* in year *t-1* who are allocated to category *o* at the start of year *t*. It is assumed that 1 per cent of people in each activity in year *t-1* die or retire, i.e., T$_{(o)} = 0.99$ for everyone in activity *o* in year *t-1*.

Only people from activities *o* in year *t-1* are allocated to categories *o* at the start of year *t*.
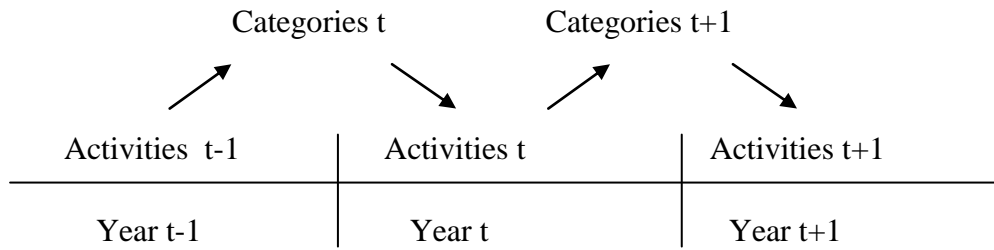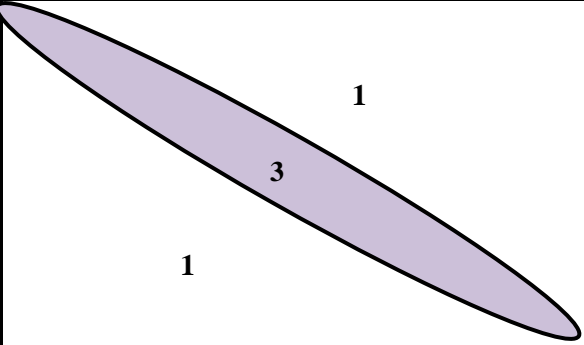
Figure 4.2   MyAGE_LM Labour-Market Dynamics

4.5.3   Matrices Describing the Planned Flows from Categories to Activities in MyAGE_LM

The OFFERS matrix shows peoples' desire to move from category *c* to activity *a*. It is assumed that nearly everyone wants to be employed, but it is not guaranteed that all offers from category *c* (all occupations, short and long run unemployed as well as new entrants) to activity *a* (all occupations) will be accepted. The offers that are accepted and those that are rejected are reflected in the actual flows matrix (H) which will be discussed in detailed in Section 4.5.4. The offers matrix is summarized in Table 4.5 (similar to the Table 3.1 in Chapter 3). The rows represent the categories from which the offers originate and the columns represent the activities to which these offers are made. Areas that contain "zero" indicate the offer cells that are not permitted in MyAGE_LM.

---

[20] ACT_L$_{(o)}$ is defined as $ACT_{t-1} = ACT_t * \frac{1}{1.01}$ (not an equation in the model, but a way of setting up the base data).

Table 4.5   **Specifying Offers (Labour Supplies) from Categories to Activities in MyAGE_LM**

Activities / Categories	Employment Skilled Occupation	Employment Semi-Skilled Occupation	Employment Unskilled Occupation	*Short-Run Unemployed	*Long-Run Unemployed
Employment Skilled Occupation		1		2	Zero
Employment Semi-Skilled Occupation	3			2	Zero
Employment Unskilled Occupation	1			2	Zero
*Short-Run Unemployed	4	4	4	Zero	5
*Long-Run Unemployed	4	4	4	Zero	5
New Entrant to Labour Market*	4	4	4	4	Zero

* Also based on the different skill levels (skilled, semi-skilled and unskilled)

In linking the categories at the start of year t to the activities in year t, an offer from each category c to each activity o, $OFFER_{(c,o)}$ is specified. The offers matrix $OFFER_{(c,o)}$ includes the offers from all categories (employment based on occupations, short and long-run unemployment as well as new entrants) to all activities (employment based on occupations, short and long run unemployment).

The occupations are divided into three occupational groups: skilled, semi-skilled and unskilled. The skill classifications are based on skill level and education attainment from the Malaysia Standard Classification of Occupation 2008 (Masco) publication. The relevant skills associated with each occupation are presented in Table 4.6. It can be seen that managers, professionals (skill level 4) and technicians and associate professionals (skill level 3) are classified as skilled occupations even though these occupations have different skill levels. Occupations with skill level 2 are considered semi-skilled and unskilled occupations have skill level 1. Thus, in MyAGE_LM, it is assumed that workers in a specific occupation

only offer to occupations with the same skill level. For example, managers can only offer to stay as managers or become either professionals or technicians and associate professionals. They cannot offer to supply labour to semi-skilled occupations such as clerical support workers. Similarly, clerical support workers can only offer to become service and sales workers, but not managers or elementary occupations[21].

Table 4.6   Skill Classification of Occupations Based on Education Attainment

Major Group Occupation	Skill Level	Education Level	Skill Classification
1. Managers 2. Professionals	4	Tertiary education leading to a University or postgraduate university degree Malaysian Skills Advanced Diploma (DLKM) Level 5-8	Skilled
3. Technicians and Associate Professionals	3	Tertiary education leading to an award not equivalent to a first University Level; Malaysian Skills Diploma (DKM) Level 4	Skilled
4.Clerical Support Workers 5. Service and Sales Workers 6. Skilled Agricultural, Forestry and Fishery Workers 7. Craft and Related Trades Workers 8. Plant and Machine Operators and Assemblers	2	Secondary or post-secondary education; Malaysian Skills Certificate (SKM) Level 1-3	Semi-Skilled
9. Elementary Occupations	1	Primary education	Unskilled

Source: Malaysia Department of Statistics (DOS)

---

[21] As shown in Table 3.1 in Chapter 3, the offer cells that are not permitted contain "zeros".

4.5.3.1 Planned Flows from Employment Category *o* to Employment Activity *m* (Non Diagonal Flows, Area 1 in Table 4.5)

For skilled and semi-skilled occupations, the planned flow, $\text{OFFER}_{(o,m)}$, from employment category *o* to employment activity *m*, $o \neq m$, is set in the initial data according to the following equation:

$$\text{OFFER}_{(o,m)} = \text{DELTA}_{(o)} * \text{CAT}_{(o)} * \left[\frac{\text{CAT}_{(m)}}{\text{BOT}_{(o)}} \right], \quad o \neq m \qquad (4.2)$$

where

- o, m belong to the same skill group; and

- $\text{BOT}_{(o)} = \sum_{mm \in G(o)} \text{CAT}_{(mm)}$, with G(o) being the set of occupations in the skill group to which *o* belongs excluding *o*. For example, if *o* is managers, then G(o) is professionals, technicians and associate professionals.

- $\text{DELTA}_{(o)}$ is the proportion of people who are willing to move from occupation *o* to employment activities *m*, $o \neq m$ (the share of workers looking for new occupations). $\text{DELTA}_{(o)}$ is set uniformly at 0.07. $\text{CAT}_{(o)}$ is the number of people in employment category *o* at the start of year *t*. Consequently, for skilled and semi-skilled occupations, we assume that 7 per cent of workers would like to move to a different occupation. For the unskilled occupation (elementary workers), we assume that workers have no plans to move to other occupations.

It is assumed that there is occupation persistence, where the majority of people employed in occupation *o* during the year *t-1* will choose to be employed in occupation *o* in year *t*. Only a small portion (assumed to be 7 per cent) of people will choose to supply their labour to a different occupation.

4.5.3.2 Planned Flows from Employment Category *o* to Unemployment Activity *S* (Area 2 in Table 4.5)

Voluntary flows from occupation *o* to short run unemployment *S* are given as follows:

$$\text{OFFER}_{(o,S)} = \text{CAT}_{(o)} * \text{VOL\_UNEMP\_S}_{(o)} \tag{4.3}$$

where

- is any occupation; and

- $\text{VOL\_UNEMP\_S}_{(o)}$ is the proportion of people that choose to move from being employed in occupation *o* to being short-run unemployed *S*. It is assumed that for the basecase data that 0.5 per cent of Malaysians voluntarily offer to become short-run unemployed.

In equation (4.3), it is also assumed that people in employment categories can only offer to become short term unemployed and not long-run unemployed.

4.5.3.3 Planned Flows from Employment Category *o* to Employment Activity *o* (Diagonal Flows, i.e., Area 3 in Table 4.5)

The diagonal flows are the number of people in occupation *o* at the start of year *t* minus those who choose to move away from occupation *o*. They may leave occupation *o* and offer to occupation *m*, or voluntarily choose to be short term unemployed S. This relationship is shown in equation:

$$\text{OFFER}_{(o,o)} = \text{CAT}_{(o)} - \sum_{m \neq o} \text{OFFER}_{(o,m)} - \text{OFFER}_{(o,S)} \tag{4.4}$$

4.5.3.4 Planned Flows from Unemployment and New Entrant Categories o to Employment Activities m (Area 4 in Table 4.5)

Offers from an unemployment or new entrant category o to an occupation m are set in the initial data by the following equation:

$$OFFER_{(o,m)} = DELTA\_1_{(o)} * CAT_{(o)} * \left(\frac{CAT_{(m)}}{\sum_{mm \in G1(o)} CAT_{(mm)}} \right) \quad (4.5)$$

In this equation, o refers to short or long-run unemployed people or new entrants in one of the three skill groups, skilled, semi-skilled and unskilled. If o refers to a group of people who are skilled, then G1(o) is the set of o occupations in the skilled group, that is, Managers, Professionals and Technicians Associate Professionals.

- $DELTA\_1_{(o)}$ determines the strength of offers from unemployment and new entrants category o at the start of the year. It is the share of people in category o who try to get a job ;and

- $CAT_{(o)}$ is the number of people in the unemployment (short-run, S and long-run, L) and new entrant category o at the start of year t. The expression $\left(\frac{CAT_{(m)}}{\sum_{mm \in G1(o)} CAT_{(mm)}} \right)$ is the share of occupation m in total occupations to which people in category o can make an offer. If 10 per cent of skilled people are employed in occupation Professionals, then 10 per cent of people in the skilled unemployed and new entrant categories who are making offers to employment will offer to the occupation Professionals.

With the assignment of the values for $DELTA\_1_{(o)}$, it is assumed that those people who are unemployed would have weak offers to employment activities. With this assumption, $DELTA\_1_{(o)}$ is set at lower values for unemployment categories compared to employment categories. Also, those in long term unemployment will have a lower probability of filling

vacancies and thus make weaker offers to employment activities compared to short-run unemployed people (although those in short run unemployment will have weaker offers than those who are employed). Thus, $\text{DELTA\_1}_{(o)}$ for long term unemployed people is set lower than for people in short term unemployment. New entrants are assumed to have the strongest offer towards an employment activity, with $\text{DELTA\_1}_{(o)}$ is set at 1.

4.5.3.5 Planned Flows from Unemployment and New Entrant Categories *o* to Unemployment Activity *u* (Area 5 in Table 4.5)

The planned flow from unemployment and new entrant category *o* to unemployment activity *u* is given in equation (4.6):

$$\text{OFFER}_{(o,u)} = \left(1 - \text{DELTA\_1}_{(o)}\right) * \text{CAT}_{(o)} * \text{SH\_B6}_{o,u} \tag{4.6}$$

where

- $\text{OFFER}_{(o,u)}$ is the number of offers from an unemployment or new entrant category *o* to unemployment activity *u*;

- $\left(1 - \text{DELTA\_1}_{(o)}\right)$ determines the strength of offers from *o* to unemployment;

- $\text{CAT}_{(o)}$ is the number of people in the employment and new entrant category *o* at the start of year *t* ; and

- $\text{SH\_B6}_{o,u}$ regulates the flows from the unemployment and new entrant categories *o* to the unemployment activity *u*, and takes the value of either 1 or 0. These values are determined so that new entrants are assumed to only offer to short-term unemployment activity *S*. They are not allowed to offer to long-term unemployment activity *L*. Those in short-term unemployment category *S* cannot offer to remain in short-term unemployment. If they wish to remain unemployed, they must offer to long-term unemployment activity *L*. People in long-term unemployment category *L* will offer to long-run unemployment activity *L*.

4.5.4 Deriving the Actual Flows Matrices Used in MyAGE_LM Labour Market Specification

In determining peoples' activity during the base year, an actual flows matrix $H_{(c,o)}$ is specified to capture the flow from each category c to each activity o. The matrix $H_{(c,o)}$ includes flows from all categories (employment, short-term and long-term unemployment as well as new entrants) to all activities (employment, short-term and long-term unemployment). The difference between the *OFFER* and *H* matrix is that the former shows what activities people would like to perform during the year t, while the *H* matrix shows who are successful in securing employment and what happens to those who are not successful.

Vacancies in work activities are defined as the number of jobs (employment activities) minus the number of incumbents. The base year values for occupation-specific vacancies are calculated through an iterative process. In the first approximation, vacancies are calculated as those who are fired, given by the following equation:

$$VAC\_1_{(o)} = ACT_{(o)} * SACFRAC \qquad o \in OCC \qquad (4.7)$$

where

- $VAC\_1_{(o)}$ is the first approximation of occupation-specific vacancies;

- $ACT_{(o)}$ is the occupation-specific activities; and

- $SACFRAC$ is the proportion of people who are fired from each occupation. This parameter is set at 5 per cent.

For a second approximation, vacancies are calculated as the number of people who are employed in an occupation during the year minus the number of incumbents. This is shown in the following equation:

$$VAC\_2_{(o)} = ACT_{(o)} - Incumbents \quad o \in OCC \quad and \quad (4.8)$$

$$Incumbents = CAT_{(o)} - EMP\_UNEMP_{(o)} - SH\_QI_{(o,m)} * VAC\_1_{(m)} \quad o \in OCC \quad (4.9)$$

where

- $VAC\_2_{(o)}$ is the second approximation of occupation-specific vacancies;

- $ACT_{(o)}$ is the number of people in each employment activity;

- $CAT_{(o)}$ is the number of people in each employment category at the beginning of the year;

- $EMP\_UNEMP_{(o)}$ is the number of people in employment category o moving to short term unemployment activity S, that is, the number of people who are fired from o plus the number who move voluntarily from o to unemployment; and

- $SH\_QI_{(o,m)} * VAC\_1_{(m)}$ is the absorption of people moving from occupation o to occupation m, i.e., the non-diagonal flows. $SH\_QI_{(o,m)}$ is the share of offers made to m from outside m accounted for by o.

The occupation specific vacancies are calculated via an iterative process. After a number of iterations, the occupation-specific values converge, which are then the final value for occupation specific vacancies in the initial database.

4.5.4.1 Actual Flows from Employment Category o to Employment Activity p

Equation (4.10) determines the diagonal and non-diagonal actual flows from any category o to an employment activity p in the initial database. $DUMQ_{(o,p)}$ is 1 if $o \neq p$ and 0 if $o = p$. Thus (4.10) determines the off diagonal flow of o to p as the number of vacancies in p multiplied by o's share of those vacancies. The diagonal flow from o to o is determined as

the number of people in category o less those who move to other occupations or to unemployment.

$$H_{(o,p)} = (1 - DUM6_{(o,p)}) * \left[CAT_{(o)} - \sum_{\substack{m \in OCC \\ m \neq p}} SH\_QI_{(o,m)} * VAC_{(m)} - EMP\_UNEMP_{(o)} \right]$$

$$+ \ DUM6_{(o,p)} * SH\_QI_{(o,p)} * VAC_{(p)} \quad \text{for all categories o and for all } p \in OCC \ (4.10)$$

4.5.4.2 Actual Flows from Employment Category o to Short Run Unemployment Activity *S*

Equation (4.11) determines the actual flows from employment category o to short-run unemployment activity *S*:

$$H_{(o,S)} = OFFER_{(o,S)} + SACKFRAC * CAT_{(o)} \qquad o \in OCC \qquad (4.11)$$

where

- $H_{(o,S)}$ is the flow of people that move from being employed in category o to become short-term unemployed in activity *S*;

- $OFFER_{(o,S)}$ is people who volunteer to move from being employed in employment category o to short-term unemployment activity *S*; and

- $SACKFRAC * CAT_{(o)}$ determines the involuntary flows from employment category o to short- run unemployment activity *S*.

4.5.4.3 Actual Flows from Unemployment Category and New Entrant Category *o* to Unemployment Activity *u* where *u= S* and *u=L*

The actual flow from unemployment and new entrant category *o* to unemployment category *u* is shown in equation (4.13).

$$H_{(o,u)} = \text{DUMSACK}_{(o,u)} * \left[\text{CAT}_{(o)} - \sum_{oo \in OCC} \text{SH\_QI}_{(o,oo)} * \text{VAC}_{(oo)} \right] \qquad (4.13)$$

where

- $H_{(o,u)}$ is the flows of people from unemployment and new entrant category *o* to unemployment category *u*;

- $\text{DUMSACK}_{(o,u)}$ is 1 or 0. It ensures that flows from unemployed categories *o* are always to a long-term unemployment activity *u*. On the other hand, if *o* is a new entrant category, then the setting of $\text{DUMSACK}_{(o,u)}$ ensures that all the flow of new entrants to unemployment is to a short run unemployment activity *u*.

4.6   Conclusion

This chapter provides an illustration of the structure of the MyAGE_LM database and also maps out the aggregated database to 30 industries and commodities from the original 121; as well as highlighting the main parameters in the model. The structure of the labour market database is described in detail. The following vectors and matrices are used to construct the labour market database:

- $\text{ACT}_{(o)}$, which shows the number of Malaysians in each employment and unemployment activity in year *t*, 2005.

- $\text{ACT\_L}_{(o)}$, which is the lagged version of $\text{ACT}_{(o)}$. It is the activity vector for 2004.

- $\text{CAT}_{(o)}$, which is the number of people in each employment, unemployment and new entrant category in year *t*.

- $\text{OFFER}_{(c,o)}$, which is the planned offers matrix, showing the planned flows from category c to activity o. This matrix shows what activities people in Malaysia would like to perform in year t.

- $\text{H}_{(c,o)}$, which is the actual flows matrix, showing the actual flows from category c to activity o. This matrix shows who is successful in obtaining employment and what happens to those who do not.

- $\text{VAC}_{(o)}$, which is the occupation-specific vacancies in year t. The typical component of this vector is the difference between the number of employment opportunities in an occupation and the number of jobs filled by incumbents in the occupation.

CHAPTER 5

DEVELOPING MYAGE_LM CLOSURES

5.1   Introduction

This chapter discusses the three closures used in the MyAGE_LM model: historical, forecast and policy closures. These are generated from a bland short run closure. In the short run closure, aggregate real wage rates, aggregate capital, technology, the average propensity to consume (APC), government expenditure and the positions for foreign demand curves for exports are exogenous. Aggregate employment, GDP, consumption, investment, exports, imports, rates of return on capital and investment/capital (I/K) ratios are endogenous. Section 5.2 uses a simple labour market back of the envelope (BOTE_LM) model to describe the short run closure and the derivation from it of the historical, forecast and policy closures. The details of these closures as they apply in the GEMPACK version of MyAGE_LM described in Chapter 3 (Theoretical Framework for MyAGE_LM) are set out in Sections 5.3 to 5.5. Concluding remarks are in Section 5.6.

The three closures are derived using a series of swap statements with the short-run closure as the starting point in each case. Historical closures are used to make estimations of the changes in consumer preferences, technology and other unobservable variables based on all data available (historical). The forecast closure is used to generate forecasts based on information for future periods on macroeconomic variables such as GDP and employment. Policy closures are used to generate policy-induced deviation from basecase forecasts.

5.2   Simple BOTE_LM Model to Represent MyAGE_LM

A back-of-the-envelope labour market (BOTE_LM) model is used to develop and explain the derivation of the historical closure. In the BOTE_LM model, it is assumed that the economy has two factors of production: capital and labour. The cost of employing a unit of labour equals the value to the employer of the marginal product of labour. Similarly, the cost of employing a unit of capital equals the value to the employer of the marginal product of

capital. Ten equations are specified to represent total output, the demand for labour, the demand for capital, export and import demands, and investment creation.

The first equation in the BOTE model is GDP identity in constant price terms:

$$Y = C + I + G + (X - M) \tag{5.1}$$

where

- Y is real GDP;

- I is aggregate investment;

- G is real government expenditure;

- X is real exports; and

- M is real imports.

The next equation is an economy-wide constant returns to scale production function relating real GDP to capital and labour inputs as well as a technology shift term:

$$Y = A * F(K, L) \tag{5.2}$$

where

- A is a technical coefficient allowing for Hicks-neutral technical change;

- K is the capital stock; and

- L is labour demand.

The sum of private consumption (C) and government expenditure (G) depends on average propensity to consume (APC) and GDP:

$$C + G = APC * Y \tag{5.3}$$

Imports in BOTE_LM are positively related to GDP, the ratio of the price of domestic goods to that of imports (P_{GDP} /PM) and an import domestic preference variable denoted as TWISTIMP[22]. In BOTE_LM, I assume that P_{GDP} is closely connected to the domestic currency[23] price of exports, PX. Thus, the (P_{GDP} /PM) ratio can be represented by the terms of trade (TOT). Then the demand for imports can be represented as:

$$M = f(Y, TOT, TWISTIMP) \qquad (5.4)$$

with TOT defined by:

$$TOT = PX/PM \qquad (5.5)$$

The relationship between the price of exports (PX) and the volume of exports (X) is given as:

$$PX = f(X, F_X) \qquad (5.6)$$

where

- F_X is a variable that allows for shifts in the export demand schedule.

Equation (5.6) is consistent with the assumption of Malaysia facing a downward slopping demand curve for its exports. By contrast, import prices (PM) are exogenous because it is assumed that Malaysia is a price taking economy. Downward-sloping demand curves for Malaysian exports are suggested by the idea that Malaysia supplies distinctive varieties of products such as palm oil, tourism, machinery and transport equipment and electric and electronic goods. Exogenous import prices are suggested by the idea that Malaysia is a small part of the demand for other country's products.

---

[22] In MyAGE_LM, a 1 per cent increase in an import/domestic twist variable causes an agent (household, industry or capital creator) to increase its ratio of imported to domestic purchases of an input by 1 per cent independently of changes in prices or activity level (See discussion in Section 3.18 of Theoretical Framework for MyAGE_LM).

[23] In BOTE_LM, I also assume that the nominal exchange rate is fixed at 1.

Investment depends positively on the rate of return to capital (ROR) and also moves independently of ROR through an investment shift variable, F_I:

$$I = f(ROR, F_I) \qquad (5.7)$$

This is the stylized version of the relationship between the rates of return and investment in equation (3.35) in Chapter 3 (Section 3.12.3). When aggregate investment is determined either exogenously or through an indexing relationship with some other macroeconomic variable, F_I is modelled to be endogenous to ensure that the movements in industry-specific investments sum to the independently determined levels of aggregate investment. The relevant industry-specific elements of F_I, can also be set endogenously to accommodate exogenous paths for industry-specific rates of investment growth. The shifter can also be set exogenously to model either an increase or decrease in investment at a given rate of return. In addition to the investment behavioural equation, (5.7), it is useful to have an equation defining the investment/capital ratio:

$$I/K = R\_IK \qquad (5.8)$$

The rate of return (ROR) is defined in the BOTE_LM model by $\left[ROR = Q/P_I - D\right]$ where

- Q is the factor payment of capital,
- P_I is the investment price index; and
- D is the depreciation rate[24].

Q is determined by the value of the marginal product of capital (MPK), written as $[MPK * P_{GDP}]$. The marginal product of capital (MPK) is negatively related to the K/L ratio and positively related to the technology variable (A). Thus, ROR is negatively related to the K/L ratio and positively related to the technology variable. It is also positively related to the ratio of product prices represented by P_{GDP} and the cost of units of capital represented by P_I.

---

[24] We can think of P_I as the asset price. Thus if an asset costs \$1000, has an annual rental value of \$150 (Q=150) and depreciates at 5 per cent a year (D=0.05), then ROR=0.1, i.e., 10 per cent.

Because P_I includes the price of imported capital inputs and (as noted earlier) I assume that P_{GDP} is closely related to the price of exports, P_{GDP}/P_I can be represented as a function of the TOT.[25] Thus, with D treated as a parameter, ROR can be written as:

$$ROR = f\left(\frac{K}{L}, A, TOT\right) \tag{5.9}$$

where

- the derivative of f with respect to K/L is negative, the derivatives with respect to A and TOT are positive.

The before-tax real wage (BTRW) is defined as $[W/P_C]$, where W is the nominal wage rate and P_C is the consumer price index. I assume that W is the value of the MPL $[W = P_{GDP} * MPL]$. The MPL is positively related to the K/L ratio and the technology variable (A). Thus, BTRW is positively related to the K/L ratio, the technology variable and P_{GDP}/P_C. Just as P_{GDP}/P_I can be represented as the function of TOT, P_{GDP}/P_C can also be represented as a function of the terms of trade (TOT). Consequently, BTRW can be written as an increasing function of K/L, A and the terms of trade. In addition, we include a shift variable TWISTLK representing biased technical change:

$$BTRW = g\left(\frac{K}{L}, A, TOT, TWISTLK\right) \tag{5.10}$$

In MyAGE_LM, positive (negative) movements in TWISTLK cause technology twists favouring the use of labour(capital) relative to capital(labour) without affecting overall input of primary factors per unit of activity in any industry. Hence, a 1 per cent increase in the labour/capital twist variable causes industry *i* to increase its ratio of labour to capital without changing its costs for a unit of activity (See discussion in Section 3.18 of Theoretical Framework Chapter).

---

[25] The relationship between the price deflator for GDP, the terms of trade and price deflators for expenditure aggregates such as investment and consumption is discussed in more detailed in Appendix A.5.

Equations (5.1 – 5.10) constitute the BOTE_LM model. For convenience, they are set out in Table 5.1. These equations explain the variables within a given year of a dynamic simulation.

Table 5.1   Equations of the BOTE_LM Model

$$Y = C + I + G + (X - M) \qquad (5.1)$$

$$Y = A * F(K, L) \qquad (5.2)$$

$$C + G = APC * Y \qquad (5.3)$$

$$M = f(Y, TOT, TWISTIMP) \qquad (5.4)$$

$$TOT = PX/PM \qquad (5.5)$$

$$PX = f(X, F_X) \qquad (5.6)$$

$$I = f(ROR, F_I) \qquad (5.7)$$

$$I/K = R\_IK \qquad (5.8)$$

$$ROR = f\left(\frac{K}{L}, A, TOT\right) \qquad (5.9)$$

$$BTRW = g\left(\frac{K}{L}, A, TOT, TWISTLK\right) \qquad (5.10)$$

In this short-run closure, capital (K) and real before tax wages (BTRW) are exogenous. For the accumulation of capital stock, it is assumed that it takes time for the investment carried out to come into effect, i.e., investment undertaken in year *t-1* only becomes operational at the start of year *t*. Thus, in the short-run, capital is fixed. In the MyAGE model, we can assume that real wages are sticky in the short-run (and flexible in the long-run). Hence, in the short-run, real wages will slowly adjust when there is a policy shock, giving rise to involuntary unemployment.

In terms of the BOTE_LM model, the starting short-run closure (endogenous and exogenous variables) is shown in Tables 5.2 and 5.3.

Table 5.2   Endogenous Variables in the Short-Run Closure of BOTE_LM

Endogenous Variables	Definition
Y	Real output
C	Real private consumption
I	Aggregate investment
X	Real exports
M	Real imports
L	Labour demand or employment
TOT	Terms of trade
PX	Foreign currency export price
ROR	Real rate of return on capital
R_IK	Investment/capital ratio

Table 5.3   Exogenous Variables in the Short-Run Closure of BOTE_LM

Exogenous Variables	Definition
APC	Average propensity to consume
G	Real government expenditure
TWISTIMP	Import/domestic twist variable
TWISTLK	Labour/capital twist variable
PM	Foreign currency import price
BTRW	Before tax real wage
A	Technical coefficient allowing for Hicks-neutral technical change
F_X	Shift in the export demand schedule
F_I	Investment shifter
K	Capital stock

5.3   Historical Closure

The exogenous variables in the historical closure include two types of variables: observables and assignables (Dixon and Rimmer 2002). Observable variables are variables for which movements can be observed from statistical sources for periods of interest. A motivation for carrying out a historical simulation is the updating of input-output tables. For example, if the period of interest is from 1987 to 1994, then using the observables from this period, a historical simulation can be carried out to update the input-output tables from 1987 to 1994. Assignable variables are naturally exogenous. In historical simulations, the defining feature of an assignable variable is that its movement can be assigned a value without contradicting anything that has been observed or assumed about the historical period.

Historical simulations are used to estimate changes in technology, positions of foreign demand curves for exports, changes in import demand preferences (TWIST variable), changes in consumer preferences (average propensity to consume) and the required rates of return to capital. These estimates can be valuable in two ways:

1. In decomposition simulations. Having completed the historical simulation, we can adopt the decomposition closure in which technology and tastes variables are exogenous. By setting these variables at the values estimated from the historical simulation, we can obtain results in the decomposition simulation for output, employment and other endogenous variables identical to those in the historical closure.

2. For forecast simulations. In these simulations, technology and taste changes determined from a historical simulation can be trended forward. In Chapter 6, this technique is used in forming the baseline forecast.

CoPS (2010) have carried out a historical simulation for 2006 to 2009 using the original version of MyAGE. This is a year-on-year simulation, that is, it produces a solution for 2007 starting from 2006, then a solution for 2008 starting from 2007 etc. Using BOTE_LM, I illustrate some macro aspects of their historical closure.

For historical closures, variables in which historical data are available are exogenized. Here, I will assume that we have observations for C, I, G, X, M, L and TOT. [26]All of these variables are endogenous in the short run closure for BOTE_LM. I also assume that observations are available for the exogenous variables G and PM, and that K can be calculated for each year t from the equation of the form:

$$K_t = K_{t-1}(1-D) + I_{t-1} \tag{5.11}$$

Incorporating data for C, I, G, X, M, L and TOT into a historical simulation requires endogenous/exogenous swaps. When carrying out swaps for variables, each of the variables on the left (exogenous variable) of the swap is replaced in the exogenous list of the existing closure (short run closure) with an endogenous variable on the right. Table 5.4 provides a summary of swaps carried out to develop a historical closure from the short run closure in the BOTE_LM model. Following Dixon and Rimmer (2002, pp.240), historical closures can be developed in steps. At the end of each step, a solution can be computed to check the validity

---

[26] Y can be deduced from the observations for C, I, G, X and M.

of the endogenous/exogenous swap. Developing the historical closure is complicated and unusual. Without a cautious step-by step approach, it is not possible to find a satisfactory historical closure that allows us to use all the data that are available. The step-by-step approach allows us to trace the sources that give unsatisfactory results which corrections can then be made.

For the BOTE_LM model, a possible sequence of steps is that shown in Table 5.4.

Table 5.4   Swaps to Develop the Historical Closure in BOTE_LM

Step	Short Run Closure		Historical Closure
1	BTRW	*swap*	L
2	APC	*swap*	C
3	F_I	*swap*	I
4	TWISTIMP	*swap*	M
5	A	*swap*	X
6	F_X	*swap*	TOT

Step 1 - Employment

In the BOTE_LM model, the first step is to exogenize aggregate employment by endogenizing the before-tax real wage rate using the following swap:

swap $BTRW = L$

Once aggregate employment is exogenized in step 1, Y is tied down via equation (5.2) (with both A and K exogenized).

Alternatively, for a historical closure, we could make the assumption that real wages are observable. In this case, they would remain as an exogenous variable. Then, in BOTE_LM, aggregate employment would be exogenized by endogenizing the labour/capital twist shifter in equation 5.10 using the following swap statement:

swap $TWISTLK = L$

Step 2 - Private Consumption

In this step of the BOTE_LM model (equation 5.3), aggregate private consumption (C) is exogenized by endogenizing the average propensity to consume (APC). This is shown as:

swap $APC = C$

Step 3 - Aggregate Investment

In this step, from equation (5.7) in the BOTE model, aggregate investment (I) is exogenized by carrying out a swap with the investment shifter (F_I). The swap is shown as:

swap $F_I = I$

Step 4 – Aggregate Real Imports

In step 4, information on aggregate imports is introduced via the endogenizing of the import/domestic twist variable (TWISTIMP). From equation (5.4) imports in BOTE_LM are exogenized using the following swap statement:

swap $TWISTIMP = M$

Step 5 – Aggregate Real Exports

When we exogenize X, Y is tied down via equation (5.1). However, from step 1, the value of Y is already calculated with A, K and L exogenized. The exogenization of X will cause Y to be over-determined. Hence, the determination of Y must be freed up in equation (5.2). Therefore, the appropriate swap to allow the exogenization of X is:

swap $A = X$

Step 6 - Terms of Trade

In this step, the terms of trade (TOT) is exogenized by endogenizing the export demand shift variable (F_X). From equations (5.5) and (5.6) in the BOTE_LM model, the swap is shown as:

swap $F_X = TOT$

Figure 5.1 is a useful diagram for understanding the swaps in steps 5 and 6.

Figure 5.1   Demand and Supply Curve for Exports: Development of Historical Closure
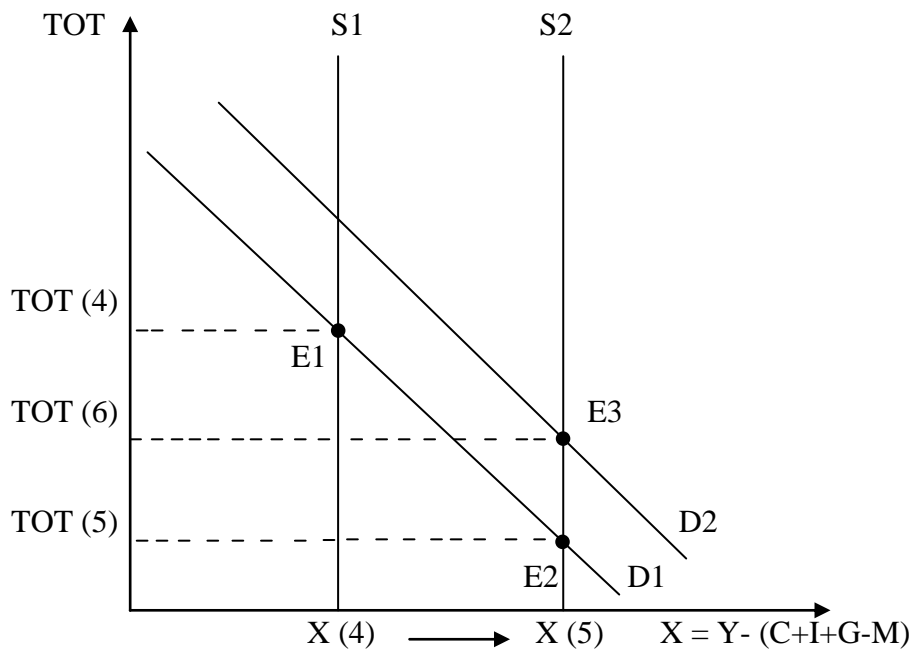
In Figure 5.1, the export demand curve is represented by equation (5.6) in the BOTE_LM model (D1 and D2). The export-supply curve is given by equation (5.1) (S1 and S2). The point E1 shows the terms of trade (TOT) at the end of step 4. In step 5, we exogenize exports (X) based on the observed information by endogenizing A. When aggregate exports are shocked, the supply curve shifts from S1 to S2 (point E2). However, the value of TOT in point E2 is not the observed value. Hence, to overcome this problem, we can exogenize the

terms of trade given the available information. The exogenization of TOT is carried out by endogenizing the shift in the export demand curve (F_X) via the swap in step 6 [swap $F_X = TOT$]. This shifts the demand curve from D1 to D2. Thus, from Figure 5.1, we can see that if exports are exogenized in step 5, we would get a TOT value that is not the observed value. To ensure we obtain the correct value for the observed TOT, we exogenize it and endogenize F_X in step 6. This shifts the demand curve up to D2. Hence, exports and the terms of trade (TOT) are exogenized in steps 5 and 6 by allowing the movements on both export supply and demand curves.

For the historical closure developed in BOTE_LM, each equation is associated with the determination of an endogenous variable. The exogenous values for capital stock (K) and aggregate employment (L) can be used to determine the value of technical progress (A) in equation (5.2). As mentioned, when real exports (X) is exogenized in step 5, and the values of private consumption (C), aggregate investment (I), government expenditure (G), and real import (M) are exogenous, then equation (5.1) can be used to obtain output (Y). However, Y is already determined by equation (5.2) from the swap in step 1. Thus, to avoid over-determining Y when exports are exogenized, we allow the determination of Y to be freed up by endogenizing A. With C, G and Y known, the value of the average propensity to consume (APC) can be determined from equation (5.3). From equation (5.4), the known value of Y (from equation 5.1) and exogenous values of M and TOT are used to determine TWISTIMP from equation (5.4).

Equation (5.5) calculates the price of exports (PX), with exogenous values of TOT and the price of imports (PM). With PX known (from equation 5.5) and X exogenous, equation (5.6) is used to obtain the value of the shift in the export demand schedule (F_X). The exogenous values of I and K are used to determine the investment/capital ratio (R_IK) in equation (5.8). With A known (from 5.2) and the exogenous values of I, K and L, the rates of return on capital can be determined in equation (5.9). Equation (5.7) calculates the investment shifter (F_I) using the exogenous value of aggregate investment (I) and known value of ROR (from 5.9). Finally, before tax real wages (BTRW) is calculated using the exogenous values of K, L, TOT and TWISTLK, as well as the known value of A obtained from equation (5.10).

5.4 Forecast Closure

The forecast closure is used to produce a baseline picture for the future of the economy. The values of most macro variables are set exogenously in accordance with available expert forecasts. In the case of Malaysia, these forecasts can be obtained from the Malaysian Central Bank, the Department of Statistics and other expert agencies. The majority of the disaggregated technology and preference variables in forecast closures are exogenous and are set from the extrapolations of estimates from historical simulations. In the forecast closure, the closure swaps are similar to the historical swaps but only at the macro level. As compared to historical simulations, there are only a few naturally endogenous industry and commodity variables that are exogenized. For example, in a historical closure, disaggregated employment (naturally endogenous) may be exogenous, while in the forecast closure, aggregate employment is exogenous but not disaggregated employment. Also, in forecast simulations, the endogenous technical change variables are limited to a few broad variables while in historical simulations, the endogenous technical change variables are very detailed. For example, the endogenous variables in the forecast closure allow for an all-industry primary-factor saving technological progress and capital/labour technological bias. In a historical closure, these variables may be endogenized for every industry.

There are four reasons why forecasting is important:

1. To satisfy client demands. Public and private sector clients for CGE services are interested in knowing where the economy is heading, and not only how it is affected when there is a policy shock.

2. To improve policy analysis, by generating policy effects as deviations around a realistic forecast. When a policy is implemented in 2012, policy makers are not interested in the effects on an economy with the 2010 structure (the latest year for which data may be available). What they are interested in is the effects on the future economy, say in 2015. The structure of the 2010 economy is not the best guess about the structure of the economy in 2015. For example, we may know that the motor vehicle industry in 2015 is likely to be a larger share of the economy than it was in 2010. We should take this into account in simulating the effects of a motor vehicle tariff cut. We can do this by using MyAGE_LM to calculate the effects of changes in trade policies as deviations around an explicit MyAGE_LM projection out to 2015,

starting from 2010. Without a projection, we run the risk of underestimating the economy-wide effects in 2015 of a cut in motor vehicle tariffs. This is because without a projection, we would be simulating the effects of a tariff cut on an industry which is unrealistically small.

3. To estimate adjustment costs, we need simulation results for highly disaggregated regions, industries and occupations. Forecasts are important because the adjustment cost related to any policy shock will depend on the growth prospects of winning and losing regions, industries and occupations. For example, if the losers are forecasted to have poor prospect even without policy shocks, then their adjustment to the policy would include an increase in worker retrenchment as well as capital wastage. However, if they are forecasted to have good prospects despite being losers, then their adjustment will involve decreases in the rates of hiring and investment without necessitating retrenchments and capital wastage.

4. To validate and improve the model. Baseline forecasts that account for the huge range of shocks to which the economy is subjected at any time, can be checked against actual outcomes. Baseline forecasts are developed using forecasts from expert organizations such as the Malaysia Department of Statistics (DOS) on macro variables (consumption, investment, government expenditure, exports, imports and employment) and build in trends in preferences, technologies and trade conditions obtained from historical simulations. To assess the validity of the forecast, the generated MyAGE_LM forecasts using an historical simulation and expert opinions are compared to what actually happens in the economy. This is to find out the 'true' movements in preferences, technologies and trade conditions for the forecast periods. Reasons for the discrepancies can then be analyzed and avenues for model improvements can be found (Dixon and Rimmer 2012).

Table 5.5 provides a summary of swaps carried out to develop the forecast closure from the short-run closure in the BOTE_LM model.

Table 5.5   Swaps to Develop the Forecast Closure in BOTE_LM Model

Step	Short Run Closure		Forecast Closure
1	BTRW	*swap*	L
2	APC	*swap*	C
3	F_I	*swap*	I
4	TWISTIMP	*swap*	M
5	A	*swap*	X
6	F_X	*swap*	TOT

The development of the forecast closure from the short run closure is also carried out in a step by step approach. In the first step, aggregate employment is exogenized by the endogenization of the real before tax wage rate using the swap statement [swap *BTRW = L*]. Exogenizing aggregate employment is used to determine the value of Y using equation (5.2). In the forecast closure, we could make the assumption that information is available for wages. Hence, we can exogenize aggregate before tax real wage. Then, we would exogenize the aggregate before tax real wage by swapping with the labour/capital shifter in equation (5.10) [swap *TWISTLK = L*].

The swap carried out in step 2 is the exogenizing of private consumption and the endogenization of the average propensity to consume given as [swap *APC = C*], while step 3 involves exogenizing aggregate investment [swap $F_I = I$]. In step 4, we introduce information on aggregate imports through the endogenizing of the import/domestic twist variable using the swap statement [*TWISTIMP = M*]. Aggregate exports are exogenized in step 5 by endogenizing technological change via the statement [swap *A = X*]. As discussed in the historical closure, this swap solves the problem of over-determining Y. With the exogenization of C, I, G, X and M, Y is tied down via equation (5.2). However, with technological change exogenous as well, Y would also be tied down via equation 5.1 with K and L exogenous. In order to allow Y from the supply side to adjust to equal Y from the expenditure side, we have to endogenize A. In the final step, we introduce information on the terms of trade by endogenizing the export demand shifter via the swap [swap $F_X = TOT$]. The swaps carried out in steps 5 and 6 are explained using Figure 5.1 in the section on the historical closure.

5.5   Policy Closure

In carrying out policy analysis, the objective is to estimate the effects of a policy shock in the model as deviations from a basecase forecast that provides a plausible scenario of the future structure of the economy (as mentioned in point 2 of the importance of forecasting in Section 5.4). The policy closure is very similar to the short-run closure, although there may be some difference at the micro level. The short-run closure is a comparative static closure, which is concerned with two pictures of the economy at the same time. At the macro level, the policy closure is identical to the short-run closure. Therefore, the policy closure will not be developed. The policy closure usually incorporates exogenous changes in technology, consumer preferences and positions of foreign demand curves for individual commodities, where the macro variables such as C, I, X, M and TOT are endogenous. In this closure, the policy variables are set at values that differ from those that they had in the forecasts. All the variables that are exogenous in the policy, apart from the variables of interest have the same values as in the baseline. Thus, the comparison between the policy and the baseline results reveals the effects of the policy.

An issue that must be confronted in the development of the policy closure for dynamic analysis but not in the short-run closure is the transfer of forecast movements for key labour market variables into the policy simulation. This was discussed in Chapter 3 Section 3.19. It involves the use of equations of the form:

$$x\_o = x + fx \qquad\qquad\qquad (5.12)$$

where

- x, x_o and fx are variables.

In the forecast simulation, fx is exogenous and un-shocked. x is a variable such as employment in a given occupation that is determined in the rest of the model. x_o is endogenous and simply adopts the forecast value for x. In the policy simulation, x_o is exogenous and fx is endogenous. No extra shock is given to x_o in the policy simulation and thus it adopts the movements it had in the forecast simulation. In this way, x_o carries the

forecast movements for x into the policy simulation. As explained in Section 3.19, this is important in the sticky wage specification. There we have:

$$\frac{W(o)}{W\_O(o)} - 1 = \frac{WL(o)}{WL\_O(o)} - 1 + \alpha(o)\left[\frac{E(o)}{E\_O(o)} - \frac{LS(o)}{LS\_O(o)}\right] \qquad (5.13)$$

where

- $W(o)$ is the real wage rate for occupation o in the policy simulation;
- $W\_O(o)$ is the real wage rate in the basecase forecast for occupation o;
- $WL(o)$ is the lagged real wage rate for occupation o in the policy simulation;
- $WL\_O(o)$ is the lagged real wage rate in the basecase forecast for occupation o;
- $E(o)$ is employment for occupation o in the policy simulation;
- $E\_O(o)$ is employment in the basecase forecast for occupation o;
- $LS(o)$ is the labour supply for occupation o in the policy simulation;
- $LS\_O(o)$ is the lagged labour supply in the basecase forecast for occupation o; and
- α is a positive parameter that controls the adjustment or sensitivity of the real wage rate to the gap between labour supply (LS) and demand (E).

In percentage form, equation (5.13) becomes:

$$w(o) - w\_o(o) = wl(o) - wl\_o(o) + \alpha(o)[e(o) - e\_o(o)] - \alpha[ls(o) - ls\_o(o)] \qquad (5.14)$$

In implementing this equation in the form similar to (5.12), we use:

$$w\_o(o) = w(o) + fw(o) \qquad (5.15)$$

$$e\_o(o) = e(o) + fe(o) \qquad (5.16)$$

$$ls\_o(o) = ls(o) + fls(o) \qquad (5.17)$$

In the basecase forecast, the shifters fw, fe and fls are exogenous. The variables w_o(o), e_o(o) and ls_o(o) are endogenous and record the forecast values for w(o), e(o) and ls(o). In the policy simulation, fw(o), fe(o) and fls(o) are endogenous. w_o(o), e_o(o) and fls_o(o) are exogenous, taking on the forecast values for w_o(o), e_o(o) and ls_o(o).

5.6   Conclusion

This chapter describes the development of the different closures used in the MyAGE_LM model based on a simple BOTE model in Section 5.2. The historical, forecast and policy closures are developed using a short-run closure as the starting point. In the historical closure, the main criterion for exogenous variables is observabilty; variables that have observable data are exogenized. As shown in Section 5.3, such variables include output, input, demand and prices. Historical closures (used to update input-output database) are chosen such that all historical data available can be used to estimate changes in technology, consumer preferences and other unobservable variables. In the forecast closure, the closure is chosen such that all available information for a future period can be used to carry out forecasts. In Section 5.4, variables that are forecastable such as employment and output are exogenized. The policy closure discussed in Section 5.5 is used to generate deviations in forecast from a policy shock. Based on the closures highlighted above, we can then use the closures to carry out a policy shock in the form of a tariff cut in the motor vehicle industry in Malaysia.

CHAPTER 6

MYAGE_LM POLICY SIMULATION RESULTS

6.1   Introduction

The aim of this chapter is to present results of a policy simulation showing the effects of a tariff cut in the motor vehicle industry on the labour market in Malaysia, i.e., wages and employment. As mentioned in Chapter 3, The MyAGE_LM model involves the introduction of the nine different types of occupational groups into the labour market. Instead of using aggregate real wages and employment in the equations describing the labour market adjustment process, a corresponding equation for each occupation is used.

In the next section, we provide a description of how the MyAGE_LM tariff cut policy simulation is set up. Section 6.3 provides an in-depth analysis of the macro results using a back-of-the envelope (BOTE) model. Section 6.4 discusses results for the motor vehicle industry. Policy results for the other industries are discussed in Section 6.5, while Section 6.6 investigates the effects of the tariff cut on the nine different occupations based on the detailed theoretical specification (Chapter 3) and database (Chapter 4) of MyAGE_LM. We conclude this chapter in Section 6.7 with general comments regarding the labour market effects in Malaysia from a tariff cut in in the motor vehicle industry.

6.2   Description of the Tariff Cut Policy Simulation

The policy simulation carried out in the MyAGE_LM model aims to produce a set of results that demonstrates the impact of a proposed tariff cut policy or perturbed scenario on the Malaysian economy over a period of time. Results are calculated as percentage deviations from the baseline, i.e., what otherwise would have happened had the policy not been implemented. The policy simulation is carried out as a reduction in import tariff in the motor vehicle industry in Malaysia with the introduction of a wage sensitive labour supply function. Instead of using aggregated real wages and employment, for each of the equations describing the labour market adjustment process, a corresponding equation for incorporating the occupation set is included.

In the policy simulation, the import tariff is cut by 5 per cent in the motor vehicle industry. The 5 per cent cut in the tariff rate reduces the landed duty paid price by 0.5117 per cent[27]. In the MyAGE_LM TABLO code, this is done by shocking the vector shifter on the power of tariffs (*f_t0imp*) of motor vehicles with a decrease in 0.5117. A cut in import tariff means that there will be a decrease in total government revenue.

In the MyAGE_LM TABLO code, the endogenous replacement of tariff revenue via income tax can be shown using the following equation:

Excerpt 6.1   Endogenous Replacement for Loss in Tariff Revenue

```
Equation E_ftax_l_imp
#Endogenous replacement of lost tariff revenue via individual income
tax#
VGOVREV ("PIT")*[tax_l_r + ftax_l_imp] =
-Sum{c,COM,V0IMP(c)*t0imp(c)};
```

N.B: VGOVREV is the value of government revenue; "PIT" is personal income tax; V0IMP(c) is the basic value of imports for commodity *c* (including tariffs) and *t0imp(c)* is the power of tariffs (1-tariff rate/100) for commodity *c*.

In the policy year; 2010, we endogenize the tax on labour income (*tax_l_r*) and exogenize the shifter that activates equation *E_ftax_l_imp, ftax_l _imp*. Normally, this equation is turned off through the endogenization of *ftax_l_imp*. In the year in which the tariff rate is cut, the equation is activated using the following two swap statement:

swap   *tax_l_r = ftax_l _imp*

---

[27] A detailed explanation of how this value is calculated is found in the Appendix A.6

6.3   Macro Results

6.3.1   Summary of Macro Results

The macro simulation results are shown in Figures 6.1 to 6.6. Before explaining the results in detail using a back of the envelope (BOTE) model, the figures are summarized in the following points, along with concerns that arise:

- Figure 6.1 shows a short run decrease in aggregate employment (*emp_hours*), aggregate average post tax real wage rate (*realw_pt*) and labour supply (*ls_tot*). In the long run, average real wages increase while labour supply returns to its baseline path.

- Figure 6.2 shows a positive short run deviation in aggregate investment (*x2tot_i*) and capital rental (*p1cap_i*). In the long run, aggregate investment is above basecase forecast while there is a long run negative deviation for *p1cap_i*. The investment price index (*p2tot_i*) shows a negative deviation in the short run which is sustained in the long run. Aggregate capital stock (*x1cap_i*) adjusts slowly in the short run and continues to increase in the long run.

- Figure 6.3 shows a negative deviation in real GDP (*x0gdpexp*) in the short run but a positive deviation in the long run. The deviation in real GNE (*x0gne*) in positive in both the short run and the long run. We note a strong positive deviation in GNE in the short run because of the strong positive short run deviation in aggregate investment from Figure 6.2.

- Although real GDP falls in the short run, aggregate private consumption (*x3tot*) exhibits a positive deviation in Figure 6.4 and is sustained in the long run. We need to explain the positive deviation in consumption.

- Figures 6.5 and 6.6 show that the tariff cut stimulates imports (*x0cif*) in the short run and causes real devaluation (*p0realdev*) and terms of trade (*p0toft*) improvement. These movements are maintained in the long run (except for the deterioration in the terms of trade). On the other hand, exports decline in the short run but increase in the long run. We need to explain the short run negative deviation in exports (*x4tot*) and the increase in the terms of trade from the tariff cut.

Figure 6.1   Aggregate Employment, Labour Supply and Average Post-Tax Real Wages (% Deviation from Basecase Forecasts)
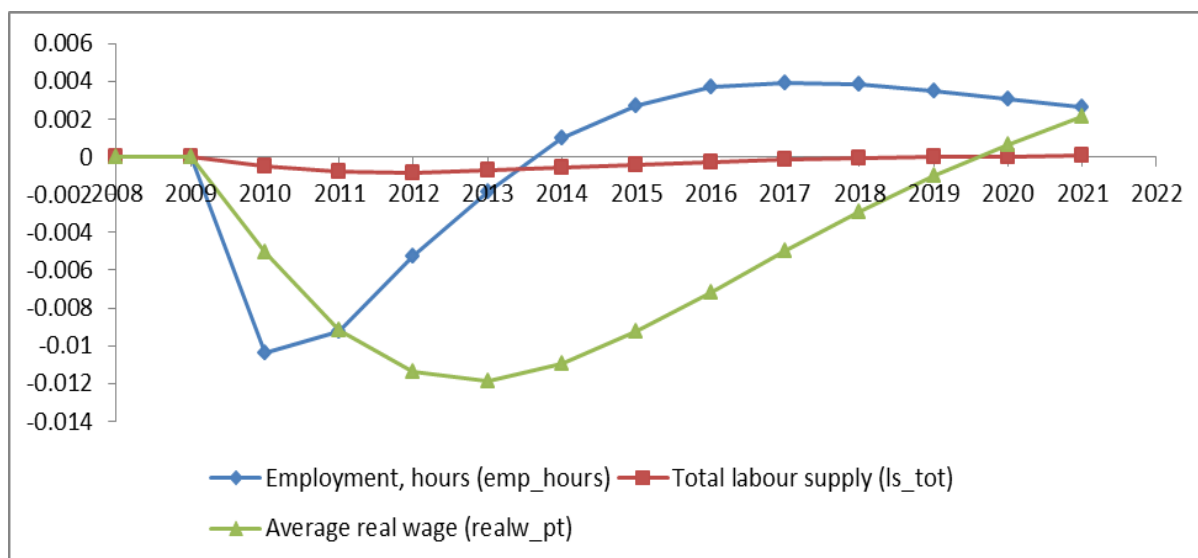
Figure 6.2   Aggregate Capital, Investment, Capital Returns and Asset Price for a Unit of Capital (% Deviation from Basecase Forecasts)
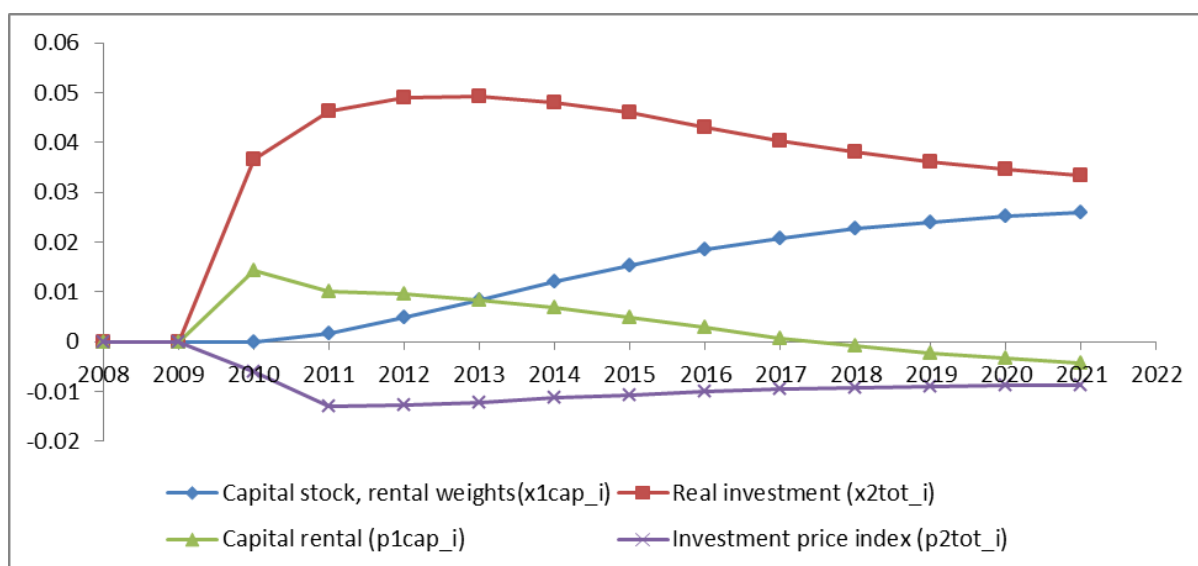
Figure 6.3   Real GDP and Real GNE (% Deviation from Basecase Forecasts)
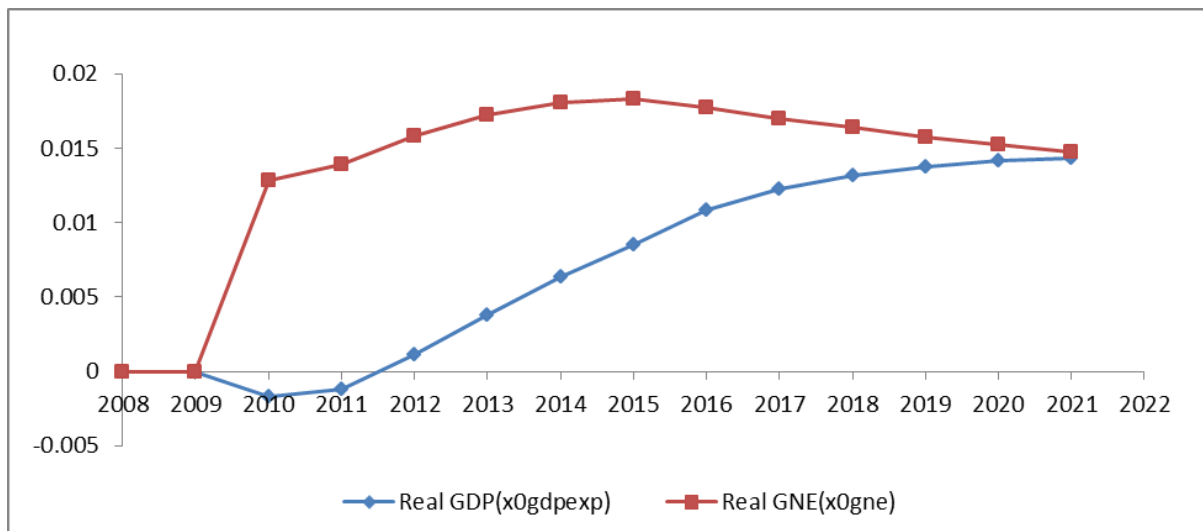
Figure 6.4   Aggregate Real GDP and Real Household Consumption

(% Deviation from Basecase Forecasts)
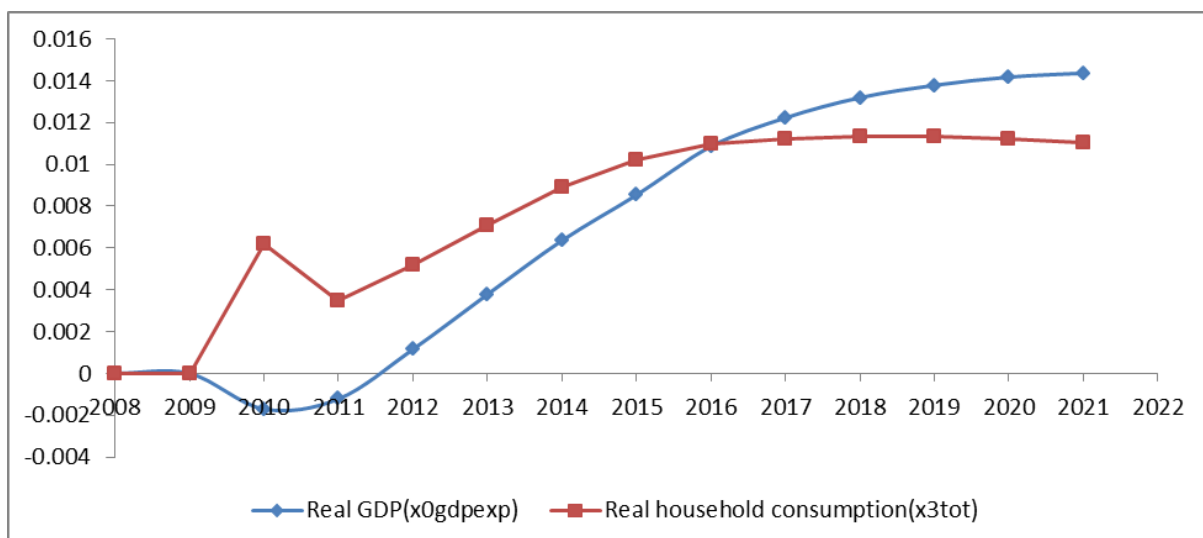
Figure 6.5   Aggregate Exports and Import Volume (% Deviation from Basecase Forecasts)
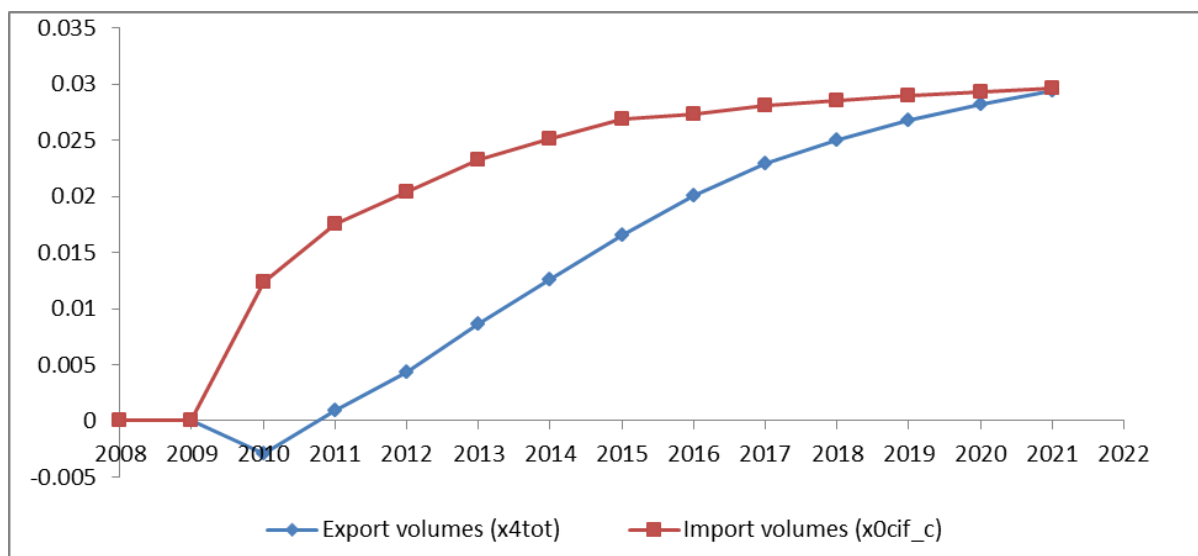
Figure 6.6   Real Devaluation and Terms of Trade (% Deviation from Basecase Forecasts)
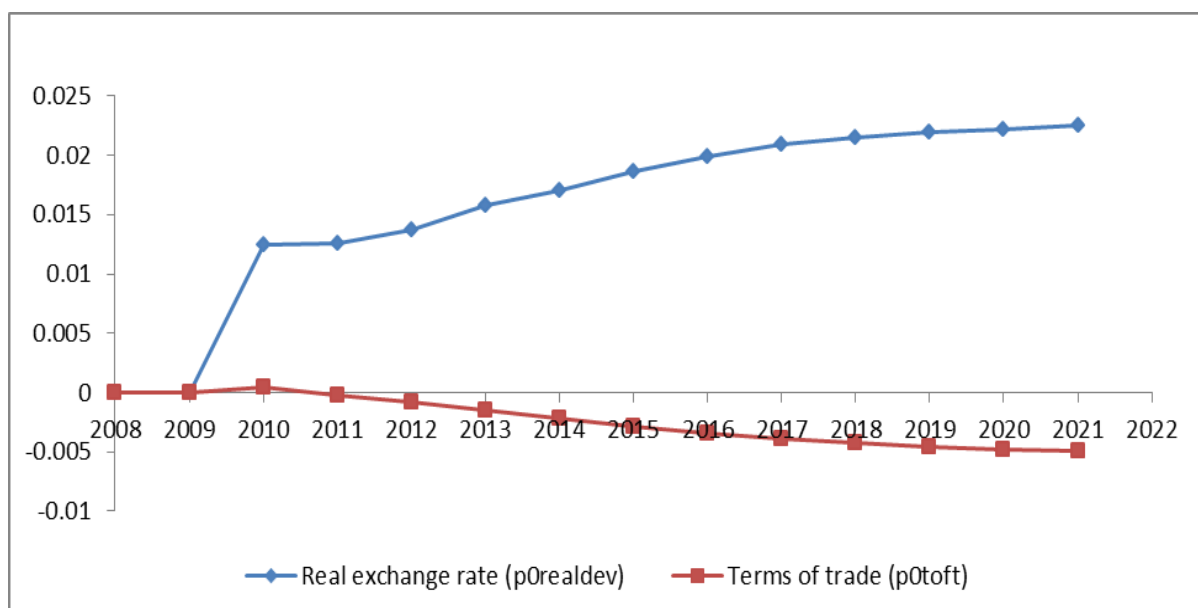
In explaining the simulation results in detail, a back of the envelope (BOTE) model adopted from Dixon and Rimmer (2002) is used. The BOTE model is a very useful tool to support the interpretation of macro results in the MyAGE_LM simulations. The BOTE calculations are important in the development, understanding and application of MyAGE_LM. There are a few reasons for the importance of using the BOTE analysis:

- BOTE calculations are used to check for data handling and other coding errors.

- We can use BOTE calculations to identify the principal mechanisms and data items underlying certain results, which is important in explaining results to decision makers and policy advisors. They are not familiar with the details of a large CGE model such as MyAGE_LM, and we should not expect them to accept results on a black box basis.

- The BOTE analysis is used for sensitivity analysis. The calculations allow clients to assess the sensibleness of results and to work out how these results would be affected by alternative assumptions and different parameter values.

- We can obtain theoretical insights from BOTE calculations. CGE models integrate detailed structural and dynamic information that is beyond standard theoretical analysis. Such models reveal new theoretical insights, and using BOTE calculations are useful for deriving these theoretical insights.

In the BOTE model, the Malaysian economy is assumed to produce one good (rice) and import one good (motor vehicle). The production of rice is assumed to be via a constant-return-to-scale (CRS) production function of capital and labour inputs. It is also assumed that rice and motor vehicles are both consumption and investment goods. The units of consumption and investment are formed as Cobb-Douglas production functions. In addition, it is assumed that the costs per-unit of employing capital and labour are equal to the values to the employer of their marginal products. The equations used in the BOTE model are listed below:

6.3.2 BOTE Equations

$$P_c = \left(P_r T_{rc}\right)^{\alpha_{rc}} \left(P_v T_{vc}\right)^{\alpha_{vc}} \tag{6.1}$$

$$P_i = \left(P_r T_{ri}\right)^{\alpha_{ri}} \left(P_v T_{vi}\right)^{\alpha_{vi}} \tag{6.2}$$

$$W^{Pre} = P_r . MPL \tag{6.3}$$

$$W^{Post} = \frac{W^{Pre}}{TL} \tag{6.4}$$

$$Q = P_r . MPK \tag{6.5}$$

$$W^{Real} = \frac{W^{Post}}{P_c} \tag{6.6}$$

$$R = \frac{Q}{P_i} \tag{6.7}$$

where

- P_i and P_c are the purchasers' prices of a unit of consumption and investment;

- P_r and P_v are the basic price of rice and the c.i.f price of motor vehicle;

- T_{rc}, T_{vc}, T_{ri} and T_{vi} are the powers (one plus the tax rate) of the taxes (including tariffs) that apply to consumption purchasers of rice and motor vehicles and the investment purchasers of rice and motor vehicles;

- Q and W^{Post} are the factor payments, where Q is the rental rate and W^{Post} is the post- tax real wage;

- MPL and MPK are the marginal products of labour and capital;

- W^{Real} is the post-tax real wage rate;

- TL is labour income tax;

- R is the rate of return on capital, which equals the rental price of capital divided by the asset price for a unit of capital; and

- α's are positive parameters that reflect the shares of rice and motor vehicle consumption and investment, where $\alpha_{rc} + \alpha_{vc} = 1$ and $\alpha_{ri} + \alpha_{vi} = 1$.

An explanation for each equation is as follows:

- Equation (6.1) shows that the purchaser's price for a unit of consumption is a function of the basic price of rice (taking into account the power of the tax on rice in consumption) and the basic price for a unit of motor vehicle (taking into account the power of the tax on motor vehicles in consumption).

- Equation (6.2) shows that the purchaser's price for a unit of investment is a function of the basic price of rice (taking into account the power of the tax on rice in investment) and the basic price of motor vehicles (taking into account the power of the tax on motor vehicles in investment).

- Equation (6.3) shows the value to the firm from hiring an additional unit of labour. This equation shows that firms will hire up to the point where wages equal the marginal product of labour (MPL). For example, let $W^{Pre} = 5$ and $P_r = 1$. From equation (6.3), the MPL equals 5. If MPL<5, then the value to the firm from hiring an additional unit of labour is less than 5, and the firm will hire less workers. If MPL>5, then the opposite holds and firms will employ more workers.

- Equation (6.4) is the equation defining post tax real wages, which equals pre-tax wages taking into account labour income tax.

- Equation (6.5) shows the value to the firm from hiring an additional unit of capital. Similar to equation (6.3), if the marginal product of capital (MPK) is lower than the equilibrium rate, then the firm will hire less units of capital and vice versa.

- Equation (6.6) shows real wages equals post-tax wages deflated by the CPI.

- Equation (6.7) shows the rate of return to capital, which equals the capital returns divided by the investment price index. This equation shows the rate of return from a

unit of investment. For example, the cost of purchasing a property, i.e., cost of investment, is RM2 million. With an annual interest of RM200000 earned on renting out the property, the rate of return is 20 per cent. In this BOTE model, I ignore depreciation and taxes on capital income. These are taken into account in MyAGE_LM.

Using equations (6.1) to (6.7) gives the marginal products of labour and capital as[28]:

$$MPL\left(\frac{K}{L}\right) = W^{Real}.TL.\left(\frac{P_v}{P_r}\right)^{\alpha_{vc}}.T_c \qquad (6.8)$$

$$MPK\left(\frac{K}{L}\right) = R.\left(\frac{P_v}{P_r}\right)^{\alpha_{vi}}.T_i \qquad (6.9)$$

$$T_c = T_{rc}^{\alpha_{rc}}.T_{vc}^{\alpha_{vc}}; \quad T_i = T_{ri}^{\alpha_{ri}}.T_{vi}^{\alpha_{vi}} \qquad (6.10)$$

where

- T_c and T_i are the average powers of the taxes on consumption and investment.

In equation (6.8), MPL is an increasing function of K/L. It is also a function of real wages, labour income tax, terms of trade and the power of the tax on investment. In equation (6.9), MPK is a decreasing function of K/L. It is also a function of the rate of return, terms of trade and the power of the tax on investment. Equation (6.10) shows the average power of the tax on consumption and investment.

6.3.2.1   Short Run Results for 2010

Figures 6.1 to 6.6 show the policy impacts on macroeconomic variables in Malaysia. In each case, impacts are expressed as percentage deviations from the basecase forecasts. From

---

[28] Derivation of equations (6.8) and (6.9) is found in Appendix A.7.

equations (6.8) and (6.9), it can be seen that the marginal products of capital, (MPK) and labour, (MPL) are both functions of the K/L ratio. MPL is an increasing function of K/L while MPK is a decreasing function of K/L. As indicated in Section 6.2, in MyAGE_LM, the government replaces the loss in tariff revenue from a cut in the motor vehicle tariff rate by increasing the labour income tax[29]. In terms of the BOTE model, this has the effect of increasing TL and decreasing the average power of the tax on consumption goods, T_c (which includes tariffs). So, what happens to $TL*T_c$? We can show that the percentage reduction in T_c is smaller than the percentage increase in TL, that is, we can show that $TL*T_c$ increases in equation (6.8).

Explaining the Increase in TL*T_c in Equation (6.8)

There are two factors that contribute to the increase in $TL*T_c$:

1. The size of the relevant tax bases and

2. How much tariff revenue is collected on consumption goods relative to investment goods.

Revenue is calculated as:

Revenue (i) = Base(i) *(T(i)-1) (6.11)

where

- Base(i) and T(i) are the base and power for any tax i.

Ignoring change in the base, we find that:

$$\Delta\,\mathrm{Revenue}(i) = \mathrm{Base}(i)*\Delta\,\mathrm{T}(i) \tag{6.12}$$

As mentioned above, the Malaysian government maintains revenue neutrality. The loss in tariff revenue must be replaced by an increase in personal income tax. Thus, we require:

$$\mathrm{Base}(1)*\Delta\,\mathrm{T}(1) = -\mathrm{Base}(2)*\Delta\,\mathrm{T}(2) \tag{6.13}$$

where

- Base(1) and Base(2) are the total wage bill and household expenditure respectively;

- T(1) and T(2) are the powers of the labour income tax, TL and tax on consumption, $\mathrm{T_c}$ respectively.

We can re-write equation (6.13) as:

$$\mathrm{V1LAB\_OI}*\Delta\,\mathrm{TL} = -\mathrm{V3PUR}*\Delta\,\mathrm{T_c} \tag{6.14}$$

where

- V1LAB_OI is the total wage bill; and

- V3PUR is household expenditure.

Equivalently,

$$\mathrm{V1LAB\_OI}*\mathrm{TL}*tl = -\mathrm{V3PUR}*\mathrm{T_c}*tc \tag{6.15}$$

where

- *tl* and *tc* are percentage changes in TL and T_c.

The values of V1LAB_OI and V3PUR in the MyAGE_LM database for the base year, 2010 are RM212176 million and RM365800 million respectively. The values of TL and T_c are 1.054 and 1.058 respectively. We can see that V1LAB_OI*TL is approximately 60 per cent of the value of V3PUR*T_c. With the assumption that the base values of the total wage bill and total household expenditure remain unchanged, for equation (6.15) to hold, we would expect the percentage change in TL to be about 1.7 times the percentage change in T_c, but with opposite signs, that is:

$$tl = \left(\frac{-\text{V3PUR} * \text{T}_c}{\text{V1LAB\_OI} * \text{TL}} \right) * tc = -1.7tc \tag{6.16}$$

In deriving (6.16), we assume that the entire tariff falls on consumption goods. However, about 99 per cent of the motor vehicle tariff is on investment goods. [The value of imports of motor vehicles for consumers, (V3BAS) and investment, (V2BAS) are RM113.53 and RM9011.17 million respectively]. Since the increase in TL must cover the loss of revenue from the tariff reduction on both consumption and investment goods, we should revise (6.16) as follows:

$$tl = \left(\frac{1}{0.01} \right) * \left(\frac{-\text{V3PUR} * \text{TC}}{\text{V1LAB\_OI} * \text{TL}} \right) * tc = 100 * (-1.7tc) = -170 * tc \tag{6.17}$$

On looking at the MyAGE_LM results for the tariff cut in 2010, we see that the percentage change in the rate on tax on labour income (*tax_l_r*) is 0.85. This translates into a percentage increase of 0.04 per cent in the power of the tax [$tl = 0.85*(0.054/(1+0.054))$].

To work out the percentage change in T_c, we start by noting that the loss of tax revenue from households from a 5 per cent decrease in the motor vehicle import tariff as a percentage of total consumption expenditure is calculated as:

[5 per cent of initial tariff rate of 11.4 per cent*value of imports of motor vehicles to households in the base year; 2010]/total household expenditure; in the base year, 2010:

$$= \left[\frac{0.05*0.114*113.53}{365800} \right] *100 \quad \approx 0.0002 \text{ per cent} \tag{6.18}$$

The reduction in tax rate on households is approximately 0.0002 percentage points. Hence the reduction in the power of the consumption tax (T_c) is approximately 0.0002 per cent.

Thus, we can see that the percentage increase in TL (0.04 per cent) is about 170 times the decrease in the power of the consumption tax T_c (0.0002 per cent). This explains why $TL*T_c$ increases in equation (6.8).

We now look at the terms of trade in equation (6.8); the export price of rice relative to the c.i.f price of motor vehicles, i.e., P_r/P_v. In the MyAGE_LM model, we treat Malaysia as a small country on the import side, that is, c.i.f. import prices in foreign currency are assumed to be exogenous (there would be no effect on P_v). On the other hand, as mentioned in the MyAGE_LM Closure chapter (Chapter 5, Section 5.2), we recognize that Malaysia has significant shares of world markets for some products such as palm oil and produces distinctive varieties of other products such as tourism, machinery and transport equipment, and electric and electronic goods. Thus, we assume that the expansion of exports would decrease their world prices and generate decline in the terms of trade (*p0toft*) for Malaysia and vice versa. This means that the deviation path of the terms of trade is associated with the deviation path in aggregate exports. In the MyAGE_LM tariff-cut simulation, we see that there is not much short run movement in exports (Figure 6.5, to be discussed later in this section) and consequently not much movement in the terms of trade, with a percentage change in the first year of only 0.0005.

Next, we note that W^{Real} in equation (6.8) is sticky in the short run. That is, it will adjust slowly to eliminate the deviations between the policy and the basecase forecast level of

employment. In the short run, W^{Real} declines by only 0.005 per cent. With little movement in W^{Real} and in the terms of trade, we can see that the dominant effect on the right hand side of equation (6.8) is the increase in $TL * T_c$. This increases the marginal product of labour, and consequently K/L will increase. Since K adjusts slowly, in order for K/L to increase in the short run, the demand for labour, L has to decrease. This is shown in Figure 6.1, where aggregate employment moves below control in the year 2010, which is the year of the tariff cut.

Estimating the Percentage Change in Employment (L) from Equation (6.8)

As discussed above, the dominant effect of equation (6.8) is the increase in $TL * T_c$ because of sticky real wages and little movement in the terms of trade. We can see that the marginal product of labour (MPL) increases by 0.0348 per cent [$mpl = w^{real} + t_l + t_c + \alpha_{vc}(toft) =$ -0.005 + 0.04 − 0.0002 + 0.0005 α_{vc}][30]. We know that in the short run, K is fixed and in order for MPL to increase, aggregate employment (L) has to decrease, but by how much? To estimate the change, we start with the following production function given as:

$$Y = A\left[\delta K^{-\rho} + (1-\delta)L^{-\rho}\right]^{-\frac{1}{\rho}} \qquad (6.19)$$

where

- Y is real GDP;
- A is a technical coefficient allowing for Hicks-neutral technical change;
- K is the capital stock;
- L is labour demand;
- ρ has a value $-1 < \rho \neq 0$; and
- δ is a positive parameter.

---

[30] α_{vc} is between 0 and 1. With the terms of trade movement being only 0.0005 we can ignore this last term.

Differentiating equation (6.19) with respect to L gives the following:

$$\frac{\partial Y}{\partial L} = A\left[\delta K^{-\rho} + (1-\delta)L^{-\rho}\right]^{\left(-\frac{1}{\rho}\right)-1}\left(\frac{-1}{\rho}\right)(1-\delta)L^{-\rho-1}(-\rho) \qquad (6.20)$$

The percentage change in equation (6.20) is given in equation (6.21):

$$mpl = \left(\frac{-1}{\rho}-1\right)\left(-\rho k * s_K - \rho l * s_L\right) - (\rho-1)*l \qquad (6.21)$$

$$= (1+\rho)(s_K k + s_L l) - (\rho+1)*l \qquad (6.22)$$

where

- mpl is the percentage change in the marginal product of labour;
- k is the percentage change in K;
- l is the percentage change in L;
- s_K is the capital share in the returns to capital and labour and s_L is the labour share in the returns to capital and labour defined as[31]:

$$s_K = \frac{\delta K^{-\rho}}{\delta K^{-\rho} + (1-\delta)L^{-\rho}} \qquad (6.23)$$

$$s_L = 1 - s_K \qquad (6.24)$$

By simplifying equation (6.22) we obtain equation (6.25):

$$mpl = (1+\rho)\left[s_K k - s_K l\right] \qquad (6.25)$$

We define the following:

$$(1+\rho) = \frac{1}{\sigma} \qquad (6.26)$$

---

[31] We show how s_K is defined in Appendix A.8.

$$\therefore \quad \sigma = \frac{1}{1+\rho} \tag{6.27}$$

Thus, we obtain an expression for the percentage in the marginal product of labour:

$$mpl = \frac{s_K}{\sigma}\left(k - l\right) \tag{6.28}$$

As mentioned above, we know $mpl = 0.0348$; $k = 0$, $\sigma = 0.5$ (from the MyAGE_LM database). The capital share (s_K) is given in the MyAGE_LM database as {[V1CAP / (V1LAB + V1CAP)] = 513531/ (212176 +513531) = 0.7}. By substituting these values into equation (6.28) of the BOTE model, we obtain the percentage change in employment, $l = -0.025$. However, in Figure 6.1, aggregate employment decreases (*emp_hours* = -0.0103 per cent), which is less than what we would expect from the BOTE model in equation (6.28). What explains this discrepancy?

Modifying (6.3) to Account for Taxes on Intermediate Inputs

A possible explanation for the discrepancy between the employment results from the MyAGE_LM simulation and the BOTE model is that the decrease in tariffs also caused a decrease in the cost of intermediate inputs used in production. However, in the BOTE model, there are no intermediate inputs used in production. Thus, in this stylized model, we make an adjustment to equation (6.3) by adding an output tax:

$$W^{\text{Pre}} = \frac{P_r}{T_g}.\text{MPL} \tag{6.3a}$$

where

- T_g is the average power of the tax on output;
- MPL is the marginal product of labour; and
- W^{Pre} is the before-tax real wage rate.

To justify (6.3a), we consider an example. If P_r = RM10; W^{Pre} = RM45.5 and T_g =1.1 (10 per cent tax rate), then the employer will hire workers until MPL = 5. If MPL <5, then the amount of money that the employer gets net of tax is (RM10/T_g =1.1)*MPL which is less than RM45.5. Hence the employer will reduce the labour force. Similarly, if MPL>5, then the amount of money that the employer gets net of tax is (RM10/T_g =1.1)*MPL which is greater than RM45.5, and the employer will increase the labour force. Thus, equation (6.3a) is the equilibrium condition in our BOTE model. This leads quickly to:

$$ MPL\left(\frac{K}{L}\right) = W^{Real}.TL.\left(\frac{P_v}{P_r}\right)^{\alpha_{vc}}.T_c.T_g \tag{6.8a} $$

where

- TL is labour income tax;

- T_c is the average power of the tax on consumption;

- P_r and P_v are the basic price of rice and the c.i.f price of motor vehicle;

- W^{Real} is the post-tax real wage rate; and

- α_{vc} is the positive parameter.

In MyAGE_LM, we have taxes on intermediate inputs. Rather than equation (6.3a), equilibrium in the labour market can be more realistically represented as:

$$ W^{Pre} = \left(P_r - \sum_{int} P_{int,r}.A_{int,r}.T_{int}\right).MPL \tag{6.3b} $$

where

- $A_{int,r}$ is the use of intermediate input, *int*, per unit of output of rice, *r* ;
- $P_{int,r}$ is the basic price of intermediate input, *int*; and

- T_{int} is the power of the tax on intermediate inputs.

Thus, the term $\sum_{int} P_{int,r}.A_{int,r}.T_{int}$ is the sum of the cost of the intermediate inputs including the tax.

In the tariff experiment, in MyAGE_LM, T_{int} falls. In terms of (6.3a), this is equivalent to a fall in T_g. So how do we show that equation (6.3a) can be used as a proxy for equation (6.3b) to take into account taxes on intermediate inputs of production? Consider another example. Looking at the terms in the bracket in equation (6.3b), let P_r =RM13.1; $\sum_{int} P_{int,r}.A_{int,r}.T_{int}$ =RM4 and T_{int} = 1.1. Hence, we have:

$$\left(P_r - \sum_{int} P_{int,r}.A_{int,r}.T_{int} \right) = RM9.1 \tag{6.3c}$$

When there is a decrease in the power of tax on intermediate inputs, i.e., T_{int} is 1.05, the price net of cost of intermediate inputs in equation (6.3c) increases to RM9.3. The increase in net price is 2.2 per cent (from RM9.1 to RM9.3). This arises from the 4.5 per cent $\left[\left(\dfrac{1.1 - 10.5}{1.1} \right) * 100 \right]$ decrease in the cost of the intermediate input. In a model without explicit allowance for intermediate inputs, we could get a similar increase in the net price of rice by introducing a cut in the power of the production tax (T_g) of 2.2 per cent.

From the two examples above, we see that the decrease in T_g by 2.2 per cent is equivalent to the decrease in T_{int} by 5 per cent: both increase the value to employers per unit of output of rice by 2.2 per cent. Thus, we see that equation (6.3a) in the BOTE can be used as a proxy for equation (6.3b) in the MyAGE_LM model.

So, how do we translate a 5 per cent reduction in the tariff on intermediate inputs of cars $\left(T_{int,mv}\right)$ into a reduction in the average power of the tax on output, $\left(T_g\right)$ in our BOTE model? The increase in the net price of output to employers is given by:

$$\frac{P_{int,mv}.A_{int,mv}.\Delta T_{int,mv}}{\left(P_r - \displaystyle\sum_{int} P_{int,r}.A_{int,r}.T_{int}\right)}*100 = x \tag{6.3d}$$

where

- x is the percentage change in net price from the decrease in the tariff on intermediate inputs of motor vehicles, $T_{int,mv}$; and
- The term $P_{int,mv}.A_{int,mv}.T_{int,mv}$ is the cost of the intermediate inputs to all industries of imported motor vehicles.

In equation (6.3d), we assume that the change in tariffs does not affect $P_{int,mv}$ and P_r.

From equation (6.3d), we see that when calculating the percentage change in $T_{int,mv}$, we are comparing the change the in the imported motor vehicle intermediate input tax with GDP at factor cost. Consequently, in terms of the BOTE model, we need to choose T_g^{new} such that the percentage change in $\left(\dfrac{P_r}{T_g^{new}}\right)$ from the decrease in T_g^{new} is also x, i.e.,

$$\frac{\Delta T_g}{T_g}*100 = x \tag{6.3e}$$

We need to know how big is imported motor vehicles as an intermediate input to production is [Sum{i,IND,V1BAS("*imp*")}]. The percentage change in $T_{int,mv}$ is calculated as:

[5 per cent of initial tariff rate (11.4 per cent)*value of imported motor vehicle used as intermediate input of production (RM12134.9 million) in the base year; 2010]/[GDP (RM755944 million) in the base year; 2010]:

$$= \left[\frac{0.05*0.114*12134.9}{755944} \right]*100 \quad = 0.01 \text{ per cent} \tag{6.29}$$

Thus, from equation (6.29), we can see that the 5 per cent decrease in tariffs on intermediate inputs of motor vehicle can be translated into a 0.01 per cent reduction in the power of the production tax, T_g in the BOTE model. Going back to equation (6.8a), we can recalculate mpl. We obtain $mpl = 0.0248$ [$mpl = w^{real} + t_l + t_c + \alpha_{vc}(toft) + t_g$ = -0.005 + 0.04 − 0.0002 + 0.0005 α_{vc} - 0.01][32]. Also, we know that $k = 0$, $\sigma = 0.5$ and $s_K \approx 0.7$. Thus, with the introduction of the tax on intermediate inputs for imported motor vehicles, we find the percentage change in aggregate employment of $l = -0.018$ per cent, which is calculated as $\left[l = \left(-\frac{mpl}{s_K/\sigma} \right) = -\frac{0.0248}{1.32} \right]$ from the BOTE model, is close to the MyAGE_LM simulation results of $l = -0.01$.

GDP and Efficiency Triangle

Given that employment decreases by 0.0103 per cent, what would we expect to happen to GDP? To work this out, we use the following equation:

$$y = s_k k + s_l l \tag{6.30}$$

where

- s_k and s_l are the shares of capital and labour in returns to primary factors; and

- y, k and l are percentage changes in output (GDP) and inputs of capital and labour.

---

[32] α_{vc} is between 0 and 1. With the terms of trade movement being only 0.0005 we can ignore this last term.

In the short run, k equals zero. We can calculate the value for s_l:

$$s_l = \left(\frac{\text{V1LAB}}{\text{V1LAB} + \text{V1CAP}} \right) \tag{6.31}$$

$$= \left(\frac{212176}{212176 + 513531} \right) = 0.3 \tag{6.32}$$

where

- V1LAB and V1CAP are the values of labour and capital in RM million respectively.

We would expect the percentage change in GDP to about -0.003 [s_l * the percentage change in employment, *emp_hours* = 0.3*(-0.01)]. In fact, the percentage change in GDP in MyAGE_LM is -0.0017. This discrepancy of 0.0013 per cent (-0.003 compared with -0.0017) is substantially explained by the efficiency effect, given in the following equation (with reference to Figure 6.7):

$$\text{Efficiency area} = \frac{1}{2}\left[\left(P_{MV}^{I} - 1\right) + \left(P_{MV}^{F} - 1\right)\right] * \left[M_{MV}^{F} - M_{MV}^{I}\right] \tag{6.33}$$

where

- P_{MV}^{I} is the initial power of tariff for motor vehicle in the basecase forecast period[33];

- P_{MV}^{F} is the final power of tax after the 5 per cent cut in the power[34];

- M_{MV}^{I} is the quantity of imports of motor vehicles in the base year, 2010, measured by the c.i.f value [$V0CIF^{I}$ (*MotorVehicle*) = RM17053.72 million]; and

- M_{MV}^{F} is the final quantity of imports of motor vehicles in 2010 in the policy calculated as:

---

[33] The calculation of the initial power of tax is shown in Appendix A.6.
[34] The calculation of the final power of tax is shown in Appendix A.7.

M_{MV}^{F} = V0CIF^{I} (*MotorVehicle*) *(1+ percentage change in motor vehicle imports in policy

(*x0imp*$_{mv}$)/100)

= RM17053.72 *(1+0.32/100) = RM17108.3 million

Figure 6.7   Efficiency Gain from Removal of Motor Vehicle Tariff Cut: Partial Equilibrium Approach

Tariff Inclusive Price
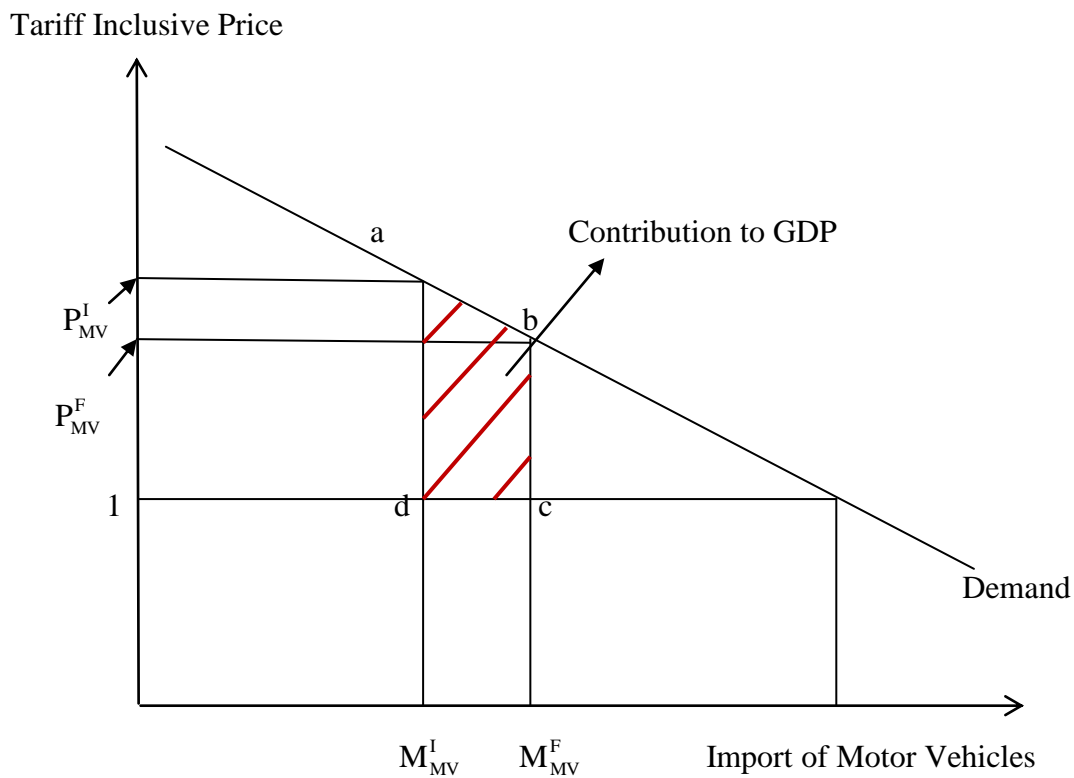
From Figure 6.7, with P_{MV}^{I} = 1.114; P_{MV}^{F} = 1.1083; M_{MV}^{I} = 17053.72 and M_{MV}^{F} =17108.3, we can calculate the area *abcd* using equation (6.33):

$$\text{Efficiency area } (abcd) = \frac{1}{2}[0.114 + 0.1083] * [17108.3 - 17053.7] = 6.1 \qquad (6.33a)$$

The percentage contribution of the efficiency gain from a cut in tariff in the motor vehicle industry to GDP is calculated as:

$$\frac{abcd}{\text{GDP}} = \frac{6.1}{756060} * 100 \qquad (6.33b)$$

$$= 0.0008 \approx 0.001 \text{ per cent} \qquad (6.33c)$$

This value is close to the discrepancy of 0.0013 per cent indicated above. With the calculation of the change in GDP associated with changes in factor use along with the efficiency gain from the cut in motor vehicle tariffs, we obtain the value for the percentage change in GDP as (-0.003 + 0.001 = -0.002). This result is very close to the result obtained in the MyAGE_LM simulation; $x0gdpexp$ = -0.0017 per cent.

Aggregate Investment

Investment is a function of the rate of return, R. An increase in the expected rate of returns on capital increases investment (I). We see that in the MyAGE_LM simulation results, investment increases in the short run ($x2tot\_i$ = 0.037 per cent), which means R has to increase for investment to increase. From equation (6.9) in the BOTE model, we find that K/L increases in the short run because employment declines, and this decreases MPK. With little movement in in the terms of trade, we can see that for an increase in R (hence investment), the dominant effect on the right hand side of equation (6.9) is the decrease in T_i (around 90 per cent of imported motor vehicles are used in investment). In the simulation for MyAGE_LM, R increases in the short run, and as seen from Figure 6.1, K edges upwards.

Explaining the Increase in the Rate of Return on Capital, R

Using the production function in equation (6.19), and differentiating with respect to K gives the following:

$$\frac{\partial Y}{\partial K} = A \left[\delta K^{-\rho} + (1-\delta) L^{-\rho} \right]^{\left(-\frac{1}{\rho}\right)-1} \left(\frac{-1}{\rho} \right) \delta K^{-\rho-1} (-\rho) \qquad (6.20a)$$

The percentage change in equation (6.20a) is given below:

$$mpk = \left(\frac{-1}{\rho} - 1\right)\left(-\rho k * s_K - \rho l * s_L\right) - \left(\rho - 1\right) * k \qquad (6.21a)$$

$$= \left(1 + \rho\right)\left(s_K k + s_L l\right) - \left(1 + \rho\right) * k \qquad (6.22a)$$

where

- mpk is the percentage change in the marginal product of capital;
- k is the percentage change in K;
- l is the percentage change in L;
- s_K is the capital share in the returns to capital and labour, and s_L is the labour share in the returns to capital and labour defined in equations (6.23) and (6.24) respectively above:

Simplifying equation (6.22a), we obtain the following equation (6.25a):

$$mpk = \frac{s_L}{\sigma}\left[l - k\right] \qquad (6.25a)$$

where

$$\left(1 + \rho\right) = \frac{1}{\sigma} \qquad (6.26a)$$

Substituting the values of $k = 0$, $l = 0.01$ (from the MyAGE_LM simulation result), $\sigma = 0.5$, $s_K = 0.7$ and $s_L = 0.3$ ($1 - s_K$) into equation (6.25a), we obtain the value of $mpk = -0.006$ per cent.

To work out the percentage change in T_i in equation (6.9), we start by noting that the loss of tax revenue from investment from a 5 per cent decrease in the motor vehicle import tariff as a percentage of total value of investment is calculated as:

[5 per cent of initial tariff rate*value of imports of motor vehicles for investment (V2BAS("*imp*") in the base year; 2010]/total value of investment (V2PUR) in the base year; 2010:

$$= \left[\frac{0.05 * 0.114 * 9011.17}{158014} \right] * 100 \quad = -0.03 \text{ per cent} \tag{6.30}$$

The reduction in power of the tax on investment is approximately 0.03 per cent. We can see from equation (6.9) that in the absence of a significant terms of trade movement, the rate of return increases because the decrease in the power of tax on investment, T_i (-0.03 per cent) outweighs the decrease in *mpk* (-0.006 per cent). Hence, there is an increase in investment in the short run, as shown in Figure 6.2.

Explaining the Decrease in Investment Price Index (p2tot_i) Relative to CPI (x3tot)

Also, from Figure 6.2, at first instance, we observe an unexpected result, where there is a decrease in the investment price index (*p2tot_i*) relative to the consumer price index (*p3tot*). Motor vehicles are a higher proportion of consumption than for investment. It is only 6 per cent of total investment in the economy V2BAS("*MotorVehicle*") and 11 per cent of total consumption V3BAS("*MotorVehicle*"). We would expect a decrease in tariffs in the motor vehicle industry to increase the investment price index relative to the consumer price index. However, from the decrease in tariffs, with the consumer price index fixed at its forecast level, the investment price index of motor vehicle is found to have decreased relative to the CPI, even though it is a smaller proportion of investment than household consumption (*p2tot_i* = - 0.00607 per cent).

One reason for this result is the difference between the domestic and import shares of motor vehicle in investment and consumption. Domestic motor vehicles comprise 99.73 per cent of total consumption of motor vehicles {V3BAS ("*dom*")} and imported motor vehicles {V3BAS ("*imp*") only comprise 0.27 per cent. Investment uses around 90 per cent of imported {V2BAS ("*imp*")} and 10 per cent of domestic motor vehicles {V2BAS ("*dom*")}. Thus, a decrease in tariffs in the motor vehicle industry would decrease the price of

investment relative to the consumer price index. This offsets the expectation that the tariff cut would increase the investment price index relative to the consumer price index because of a lower proportion of motor vehicles in investment as opposed to consumption.

We have shown that in the short run, with little movements in W^{Real} and in the terms of trade, the dominant effect on the right hand side of equation (6.8) is the increase in $TL*T_c$. This increases the marginal product of labour, and consequently increases K/L. Since K adjusts slowly, in order for K/L to increase in the short run, the demand for labour, L has to decrease.

In addition, from Figure 6.1, it can also be seen that the effect of the decrease in tariff in the motor vehicle had very little effect on total labour supply in the economy (total labour supply decreases only 0.0005 per cent in the short run), where the graph shows movements in labour supply being very damped.

From Figure 6.4, we observe a positive deviation in aggregate consumption (*x3tot* = 0.0062 per cent), even though real GDP decreases (*x0gdpexp* = -0.0017 per cent from Figure 6.3). What contributes to the increase in aggregate consumption?

Explaining the Increase in Household Consumption

Using the usual policy closure by Dixon and Rimmer (2002), aggregate consumption is tied down by household disposable income (*hdy*), which consists of GDP less tax revenue plus transfers. The equation showing the relationship between consumption and *hdy* is as follows:

C = APC*HDY   (6.31)

where

- C is aggregate consumption;

- APC is the average propensity to consume; and

- HDY is household disposable income.

From equation (6.31), real household consumption can be written as:

$$\frac{C}{CPI} = APC * \frac{HDY}{CPI} \qquad (6.32)$$

We can re-write equation (6.32) as:

$$\frac{C}{CPI} = APC * \frac{HDY}{PGDP} * \frac{PGDP}{CPI} \qquad (6.33)$$

where

- PGDP is the GDP price deflator; and

- CPI is the consumer price index.

The main component in the HDY equation is GDP. Thus, in equation (6.33), the term $\left(\frac{HDY}{PGDP}\right)$ can be proxied by real GDP.

By converting into percentage form, equation (6.33) becomes:

$$(c - cpi) = apc + (hdy - pgdp) + (pgdp - cpi) \qquad (6.34)$$

In the MyAGE_LM simulation results, we know that *apc*=0; *hdy*=0.0062 per cent; *pgdp* = 0.0069 per cent and *cpi* = 0. Substituting the values into the terms on the right hand side of equation (6.34), we obtain the value of *c* = 0.0062 per cent, which is the same as the value in the simulation results. Also, the percentage movement in (HDY/PGDP) does turn out to be close to the movement in real GDP, where $(hdy - pgdp = $ -0.0007 per cent$)$, which is close in value to $(x0gdpexp = $ -0.0017 per cent$)$.

From equation (6.34), we can see that real consumption increases ($c\text{-}cpi$ = 0.0062 per cent) even though real GDP falls ($hdy - pgdp$ = -0.0007 per cent). This can be explained by the increase in the GDP price deflator, $pgdp$ relative to the consumer price index, cpi where ($pgdp\text{-} cpi$ = 0.0069 per cent). Why?

To understand movements in the expenditure deflators, we define the percentage change in GDP price deflator in the following equation:

$$p_{gdp} = s_c p_c + s_i p_i + s_g p_g + \left(s_x p_x - s_m p_m \right)$$

(6.35)

where

- p_c is the percentage change in consumer price index;
- p_i is the percentage change in investment price index;
- p_g is the percentage change in price deflator for government expenditure;
- p_x is the percentage change in export price index;
- p_m is the percentage change in import price index; and
- s_c, s_i, s_g, s_x s_m are the shares of consumption, investment, government expenditure, export and import in GDP respectively.

If trade is assumed to be balanced, then $s_x = s_m$. Since there is little movement in the terms of trade $\left(p_x - p_m \right)$, equation (6.35) can be simplified to:

$$p_{gdp} = s_c p_c + s_i p_i + s_g p_g$$

(6.36)

We have already explained the decrease in p_i relative to p_c (because of the high proportion of imported motor vehicles in investment relative to consumption). With p_c = 0, the contributing factor for the increase in p_{gdp} is the increase in p_g. In the simulation results, we find an increase in the price deflator for government expenditure, p_g ($p5tot = 0.03$). This is because based on the MyAGE_LM database, the government sector does not use any motor

vehicles. So, a cut in the motor vehicle import tariff would increase p_g relative to p_c. Hence, the reason why consumption increases even though we observe a decrease in real GDP is because consumer goods have become cheaper in comparison to the price of government goods.

Explaining the Balance of Trade Deficit

Aggregate consumption and investment are around 46 per cent and 22.5 per cent of GDP respectively. As stated above, in the short run, the decrease in motor vehicle tariff increases consumption, C by 0.0062 per cent and investment, I by 0.037 per cent. The contribution of increases in C and I is 0.011 per cent of GDP [(0.46*0.0062) + (0.225*0.037)]. With GDP decreasing (*x0gdpexp* = -0.0017 per cent), and with government spending fixed, the increase in C+I must result in the real trade balance moving towards a deficit.

There are three ways in which (X-M) could decrease:

(1) Exports decrease more than imports;

(2) Exports increase less than imports and

(3) Exports decrease but imports increase.

In the MyAGE_LM tariff cut simulation, option (1) does not make sense, since imports should not decrease when the price of the imported good falls relative to that of the domestic good. In most tariff reduction simulations, option (2) applies. A decrease in tariffs causes real devaluation (exchange rate falls), which in turn boosts exports. However, trade balance deficit from the MyAGE_LM simulation results takes the form of option (3), where we see that in the short run, aggregate imports increase (*x0cif_c* = 0.012 per cent) but exports decrease (*x4tot* = -0.003 per cent) (Figure 6.5). The decrease in exports increases the export price index (*p4tot* = 0.0199 per cent), and causes the terms of trade to increase. Looking at Figure 6.6, we can see a small positive deviation in the terms of trade (*p0toft* = 0.005 per cent).

The negative deviation in aggregate exports (*x4tot* = -0.003 per cent) in the short run is another unexpected result. With a positive deviation in real devaluation in the short run

(*p0realdev* = 0.0125 per cent), we would expect a boost in exports. So why does exports decrease even though there is a real devaluation?

Explaining the Decrease in Aggregate Exports with Real Devaluation

A possible reason is that the cut in motor vehicle tariffs increases the cost of exports, such that the benefit of a real exchange rate devaluation is outweighed by higher export cost. How does this happen?

We start by looking at the definition of the percentage change in the real exchange rate:

$$p0realdev = p0cif\_c - p0gdpexp \qquad (6.37)$$

where

- *p0realdev* is the percentage real devaluation;

- *p0gdpexp* is the percentage change in the GDP deflator; and

- *p0cif_c* is the percentage change in the c.i.f import price index in RM.

In equation (6.37), *p0cif_c* is a proxy for the rate of inflation in foreign countries adjusted by the exchange rate and *p0gdpexp* is a proxy for inflation in the cost of producing exports in Malaysia. It turns out that in the MyAGE_LM simulation of a motor vehicle tariff cut, *p0gdpexp* does not represent accurately what happens to the cost of producing exports. A cut in import tariffs is a cut in indirect taxes. The effect of a motor vehicle tariff cut on production of any commodity (apart from motor vehicles) depends on the extent to which motor vehicles are used as an input to the production of the commodity compared with the labour input. The cost of motor vehicles goes down, but as will be explained shortly, the cost of labour goes up. For Malaysia, motor vehicles are a very small part of the inputs to export production. Thus, the cost of exports for Malaysia goes up relative to the cost of producing goods in general, that is, the export price index rises relative to the GDP deflator. This means that *p0realdev* as defined in equation (6.37) overstates the competitive improvement for exporters associated with a cut in motor vehicle tariffs.

To understand this argument fully, we need to explain why labour cost goes up when tariffs are cut and we need to look at motor vehicles as an input to export production compared to motor vehicles as an input to production of non-export commodities. We start with labour cost.

(1)   Higher Labour Cost

As discussed above, with the government balancing its budget, the loss in tariff revenue from a tariff cut in the motor vehicle industry is replaced with an increase in labour income tax. Firms incur an increase in labour cost as workers would demand higher pre-tax wages to compensate for the increase in income tax. We know that in the short run, wages are sticky in post-tax terms; therefore higher income taxes lead to higher real pre-tax wage rates. In the MyAGE_LM simulation results, we can see a positive deviation in the pre-tax real wage rate (*real_wage_c* = 0.044 per cent).

However, could this effect of higher labour cost be offset by a reduction in consumer prices from the cut in tariffs? No. As mentioned earlier, households barely consume imported motor vehicles. The consumption of domestic motor vehicles {V3BAS ("*dom*")} is 99.66 per cent of total motor vehicle consumption, while imported motor vehicles {V3BAS ("*imp*") is only 0.0034 per cent. Hence, a reduction in motor vehicle import tariffs is likely to increase the consumer price index (*p3tot*) relative to; for example the investment price index (*p2tot_i*), since a large proportion of imported motor vehicles are used in investment (89.57 per cent) compared to for consumption.

(2)   Motor Vehicles as Inputs of Production

In the short run, pre-tax real wages increase. This is bad for activities that use alot of labour relative to imported motor vehicles. Export sectors fit this description. Looking at (Sales Aggregate; "Exports"), we can see that Malaysia's export-oriented industries include CrdOilGas (52.54 per cent) WoodPaper (42.76 per cent), OthMachEquip (43.75 per cent) and OthManuf (44.01 per cent) industries. Together, these four industries account for 63.48 per cent of Malaysia's exports, calculated as:

[(V4BAS, "CrdOilGas" + V4BAS, "WoodPaper" + V4BAS, "OthMachEquip" + V4BAS, "OthManuf")/V4BAS]

=   [(RM71841.4million   +   RM24775.7million   +   RM332164.4million   + RM6045.5)/RM 684969.6 million].

In the MyAGE_LM database for intermediate inputs (V1BAS), we see that these industries scarcely use motor vehicles in their inputs to production. An example is the OthMachEquip industry. It is the largest export industry accounting for 48.5 per cent of total exports [(V4BAS, "OthMachEquip"/ V4BAS) = 332164.4/684969]. This industry hardly uses any motor vehicles as inputs. Imported motor vehicles account for about 1.1 per cent of its total cost and domestic motor vehicle account for another 1.1 per cent. When motor vehicle import tariffs are cut, these export-oriented industries are relatively hurt, as they do not really benefit from the cut in tariffs since they hardly use motor vehicles as inputs of production.

Hence, this explains how the cost of exports increase (reflected in the higher percentage deviation where $p4tot$ = 0.0199 per cent) relative to the GDP deflator, which has a lower percentage deviation ($p0gdpexp$ = 0.0069 per cent). If the real devaluation is calculated using the percentage change in exports prices, then we would obtain an increase in the real exchange rate (exchange appreciation because $p0realdev = p0cif\_c - p4tot = 0.019 - 0.0199 = -0.0008$ per cent). This would not overstate the competitive improvement in Malaysia's export industries from the cut in motor vehicle tariffs.

At this stage, we have understood the following aspects of the short run results summarized in point form below:

1. Employment (*emp_hours*) falls;

2. Real pre-tax wages (*real_wage_c*) rise;

3. Average post-tax real wages (*realw_pt*) fall;

4. Real GDP (*x0gdpexp*) falls;

5. Real investment (*x2tot_i*) increases;

6. Real consumption (*x3tot*) increases;

7. Trade balance (*x4tot – x0cif_c*) moves towards a deficit;

8. Imports rise (*x0cif_c*) and exports (*x4tot*) fall;

9. Terms of trade (*p0toft*) improves and

10. Real exchange rate (*p0realdev*) falls.

6.3.2.2   Long- Run Results for 2021

Having analyzed and understood the short run results of a tariff cut in motor vehicles, we now look at the long- run MyAGE_LM simulation results for the tariff cut. A starting point is the marginal product of capital equation from the BOTE model highlighted at the beginning of this section:

$$MPK\left(\frac{K}{L}\right) = R.\left(\frac{P_v}{P_r}\right)^{\alpha_{vi}}.T_i \tag{6.9}$$

In the long run, the rate of return on capital, R goes back to control. Investors are willing to invest more in industry *i* in response to increases in *i*'s expected return. However, they are cautious. In any given year, the capital supply functions limit the growth in industry *i*'s capital stock such that disturbances in industry *i*'s rate of return are eliminated gradually. We can see this relationship between the expected equilibrium rate of return for industry *i* to the current rate of growth of capital in industry *i* given by the inverse logistic function in Figure 3.4 (Chapter 3 Section 3.12). If the expected rate of return in industry *i* in year *t* in the policy run is higher than that in the basecase, then capital growth in industry *i* will be higher in the policy run than in the basecase; investors will supply capital at a level above the level required to generate capital growth at the basecase rate. This will make capital stock abundant and the K/L ratio will rise with an associated decrease in MPK. In this way, expected rates of return in the policy run are forced back to their basecase path. A similar story operates in the opposite direction if the policy shock initially reduces the expected rate of return in industry *i*. Then the consequent slowdown in investment in industry *i* eventually returns the expected rate of return to its basecase path.

The next term on the right hand side of (6.9) is $\left(\dfrac{P_v}{P_r}\right)$. This is the reciprocal of the terms of trade. With Malaysia being a small country (high export demand elasticities and exogenous c.i.f import price), a cut in motor vehicle tariffs has little effect on the terms of trade. Thus, with R unaffected in the long run by the cut in motor vehicle tariffs, and $\left(\dfrac{P_v}{P_r}\right)$ little affected, the dominant movement on the right hand side of equation (6.9) is the decrease in T_i (average power of the tax on investment). T_i falls quite sharply because imported motor vehicles are a higher proportion in investment than domestic vehicles; 89.35 per cent of imported motor vehicles are used in investment and account for 5.5 per cent (RM9011.17 million/RM164225 million) of the total cost of investment. With T_i decreasing in the long run, MPK has to decrease. We know that aggregate employment, L returns to control in the long run (facilitated by the decrease in W^{Real}). Therefore, for MPK to decrease, the capital stock, K has to increase. This is shown in Figure 6.1, where there is a positive deviation in K in the long run.

Also, in the long run, the balance of trade tends towards surplus when investment is falling. When we refer to investment falling, from Figure 6.2, we mean that investment stays above basecase forecast, but moves back towards the basecase. So why does investment fall in the long run?

Explaining Why Investment Falls in the Long Run, that is, Moves Back towards the Basecase

To explain why investment falls in the long run, we start by referring back to the equation for the accumulation of capital stock which assumes that investment undertaken in year *t* becomes operational at the start of year *t+1* in Chapter 3 (Section 3.12.3) given as:

$$K_{i,t+1} = K_{i,t}\left(1 - D_i\right) + I_{i,t} \qquad\qquad (6.38)$$

where

- $K_{i,t}$ and $K_{i,t+1}$ are industry *i*'s capital stock in years *t* and *t+1*;

- D_i is the depreciation rate of capital in industry i (assumed to be a parameter); and

- $I_{i,t}$ is the quantity of new capital created for industry i during year t.

Equation (6.38) can be used to trace out the time paths of industry capital stocks with the given starting point value for capital in year $t=0$, as well as a mechanism for explaining investment through time.

We know that with a positive deviation in the capital stock, there is a big increase in the percentage deviation in investment (Figure 6.2). In the long run, as the growth in capital stock stabilizes at the basecase rate, the deviation in investment fall; the economy now no longer needs extra investment to allow for the deviation in capital to grow. Nevertheless, investment stays above its basecase path reflecting higher levels of replacement investment ($D_i * K_{i,t}$).

With falling investment, this weakens the real exchange rate (Figure 6.6), which boosts exports relative to imports (Figure 6.5). The balance of trade tends towards surplus. In addition, there is also a positive deviation in both GDP and aggregate consumption in the long run.

Explaining the Positive Percentage Deviation in Consumption in the Long Run

In the long run, the deviation in aggregate consumption, *x3tot* is 0.011 per cent. What contributes to the deviation in consumption?

(1)   Efficiency Gain

From the short run results above, we found an efficiency gain of about 0.001 per cent of GDP. The efficiency gain in the long run is re-calculated using equation (6.33):

$$\text{Efficiency area} = \frac{1}{2}\left[\left(P_{MV}^{I}-1\right)+\left(P_{MV}^{F}-1\right)\right]*\left[M_{MV}^{F}-M_{MV}^{I}\right] \tag{6.33}$$

where

- P_{MV}^I is the initial power of tariff for motor vehicle in the basecase forecast period;

- P_{MV}^F is the final power of tax;

- M_{MV}^I is the quantity of imports of motor vehicles in the base year, 2021, measured by the c.i.f value [$V0CIF^I$ (*MotorVehicle*) = RM33323.17 million]; and

- M_{MV}^F is the final quantity of imports of motor vehicles in 2021 in the policy calculated as:

M_{MV}^F = $V0CIF^I$ (*MotorVehicle*) *(1+ percentage change in motor vehicle imports in policy (*x0imp_{mv}*)/100)

= 33323.2*(1+0.35/100) = RM33439.83 million

With P_{MV}^I = 1.114; P_{MV}^F = 1.1083; M_{MV}^I = 33323.17 and M_{MV}^F = 33439.83, the efficiency area is calculated as:

$$\text{Efficiency triangle} = \frac{1}{2}[0.114+0.1083]*[33439.8-33323.2] = 12.96 \qquad (6.33d)$$

The percentage contribution of the efficiency gain from a cut in tariff in the motor vehicle industry to GDP is calculated as:

$$\frac{abcde}{\text{GDP}} = \frac{12.96}{1237331}*100 \qquad (6.33e)$$

$$= 0.001 \text{ per cent} \qquad (6.33f)$$

With consumption being 53.2 per cent of GDP, in the long run, this efficiency gain translates into a consumption increase of around 0.002 per cent (0.001/0.532).

(2)   Terms of Trade Loss

In the long run, the terms of trade (*p0toft*) decreases by 0.005 per cent. In basecase data for 2021, the share of exports in GDP is 87.29 per cent (V4TOT/V0GDPEXP = 1079722.5/1236972.58) and the share of imports in GDP is 78.13 per cent (V0CIF_C/V0GDPEXP = 966421.38/1236972.58). A terms-of-trade decline of 0.005 per cent is equivalent to a loss in GDP of 0.0041 per cent [0.005*(0.8729+0.7813)/2]. With household consumption representing 53.2 per cent of GDP, this translates into a loss of real consumption of 0.0077 per cent [0.0041/0.532].

(3)   Budget effect

In the year of the policy, i.e., 2010, the Malaysian government balances its budget by replacing the loss in tariff revenue with an increase in labour taxes. However, instead of allowing this direct tax to vary for the rest of the simulation period, in the MyAGE_LM simulation, we cut motor vehicle tariffs and only allowed labour taxes to balance the government budget in the year of the policy. We kept the deviation of the labour tax rate from its basecase forecast at 0.8548 per cent for the rest of the simulation period. It is only in the policy year (2010), that this increase in labour taxes balances the loss in tariff revenue from the tariff cut.

Imports of motor vehicles grow quite rapidly in the baseline. In the MyAGE_LM results, we see that the imports of motor vehicles (*x0imp*, "MotorVehicle") grew by 53.4 per cent [cumulative growth in the base (1.4944/0.974)=1.534] between 2010 and 2021, compared with GDP growth of 26.5 per cent [cumulative growth in the base (1.333/1.054) =1.265]. This means that a given cut in tariffs sacrifices more revenue in 2021 than in 2010. So, a 0.8548 percentage deviation in labour taxes is not enough in 2021 to compensate for the 5 per cent cut in motor vehicle tariffs. With the imports of motor vehicles increasing at a fast rate, along with the labour tax deviation maintained at 0.8548 per cent, the loss in tariff revenue is replaced less and less adequately by income taxes throughout the simulation period. In the long run, this benefits the households, as they manage to gain from not having to pay increasing income taxes. This can be shown in the example below:

Short run – Year 2010

Tariff Revenue

Tariff revenue in the basecase forecast (pre-policy); V0TAR = RM2174.5 million

Tariff revenue in the policy; V0TAR = RM 2074.5 million

Change in revenue with 5 per cent cut in motor vehicle tariff rate

= RM2074.5 million - RM2174.5 million

 = -RM 99.9 million

Government Revenue from Collection of Personal Income Tax (PIT)

Personal income tax in the basecase forecast (pre-policy); VGOVREV("*PIT*") =

RM 11048.3 million

Personal income tax in the policy; VGOVREV("*PIT*") = RM 11147.3 million

Government revenue collected in the form of personal taxes

 = RM11147.3 million – RM 11048.3 million

= RM 99 million

We can see that the loss in tariff revenue is replaced with the increase in labour taxes. The government balances its budget.

Long Run – Year 2021

Tariff Revenue

Tariff revenue in the basecase forecast (pre-policy); V0TAR = RM3924.8 million

Tariff revenue in the policy; V0TAR= RM3744.7 million

Change in revenue = RM3744.7 million -RM 3924.8 million = -RM180.1 million

Government Revenue from Collection of Personal Income Tax (PIT)

Personal income tax in the basecase forecast (pre-policy); VGOVREV("*PIT*") = RM17807.2 million

Personal income tax in the policy; VGOVREV("*PIT*") = RM17970.6 million

Change in government revenue collected in the form of personal taxes

= RM17970.6 million - RM17807.2 million

= RM163.4 million

We can see that in the long run, the loss in tariff revenue from the one off cut in motor vehicle tariffs in the policy year; 2010 is RM180.1 million. However, with the labour tax rate kept constant throughout the simulation period, extra government revenue collected from personal income tax is RM163.4 million, which is not enough to balance the budget deficit from the tariff revenue loss. This benefits the household and gives a little bit of a tax break from having to pay higher taxes, enabling them to increase consumption. By how much? The change in the ratio of government deficit to GDP (*d_def_gdp_r*) is 0.000041. This is translated into an increase of 0.0077 per cent in consumption [(0.000041/0.532)*100].

So then why are labour taxes not varied? The varying of labour taxes causes simulation instability. As explained, the increase in labour taxes decreases post tax real wages. With higher taxes, workers will demand higher pre-tax wages from the employer, resulting in a larger negative deviation in employment. Also, as explained above, because imported motor vehicles are 0.27 per cent of consumption, the cut in tariffs is not reflected in the CPI (*p3tot*). This results in workers being unhappy with the increase in labour taxes. In addition, with the government's budget going towards deficit, the continued increase in labour taxes continues to decrease employment (firms are now hiring less workers), leading to more instability. That is why the simulation is carried with the increase in labour taxes in the policy year and held constant for the rest of the simulation period.

(4)   *Devaluation effect*

The fourth factor contributing to the positive deviation in consumption is the devaluation effect. Malaysian households own assets in foreign currency. In 2021, the baseline assets in foreign currency is (F$)1592922 million and households earn 7 per cent (ROIFOREIGN_P = 0.007) on those assets. In the long run, the cut in motor vehicle tariffs causes the exchange rate (*phi*; $Foreign/$RM) to be 0.022 per cent lower than it otherwise would have been. On the baseline assets, this increases interest in Malaysian currency by 0.022 per cent. This is worth (F$) 24.53 million (0.00022*1592922*0.07), and is available for consumption. With consumption being 53.2 per cent of GDP (V0GDPEXP = RM 1237330) million; this translates into a 0.0037 per cent increase in consumption $\left[\dfrac{24.53}{(0.532*1237330)} *100 \right]$

(5)   *Extra Savings*

The final factor contributing to the positive deviation in consumption is the extra savings by households from the policy year; 2010, right up to the end of the simulation period i.e., the long run. Why is there extra savings? An explanation is the efficiency gain effect calculated above. From 2010 up till 2021, there is an accumulative efficiency effect. As households gain from the efficiency effect each year, they save more as well.

The MyAGE_LM results show that Malaysia saves an extra RM553.68 million throughout the simulation period up to the long run. This is shown as the sum of the change in household saving (*d_Saving_P*) from 2010 to 2021. In 2021, this earns around RM38.76 million (553.68*0.07). Translating this into a percentage change in consumption gives $\dfrac{\left[\dfrac{38.76}{1237330} \right]}{0.53} *100 = 0.006 \, \text{per cent.}$

Adding up the contributions of all the factors above:

Efficiency Gain   + 0.002

Terms of Trade Loss   - 0.0077

Budget effect	+ 0.0077
Devaluation effect	+ 0.0037
Extra Savings	+ 0.006

Total effect	**+ 0.0117**

We can see that the five factors give a total contribution to consumption of 0.0117 per cent. This value is very close to the long run value of household consumption in the MyAGE_LM simulation results ($x3tot$ = 0.011 per cent). We can also see that the main contributor to the increase in household consumption in the long run comes from the extra savings; 0.006 per cent.

Similar to the short run results, we can summarize the long run results from the tariff cut in motor vehicles below:

1. Employment (*emp_hours*) returns to control;

2. Real pre-tax wages (*real_wage_c*) rise;

3. Average post-tax real wages (*realw_pt*) rise;

4. Real GDP (*x0gdpexp*) rises;

5. Real investment (*x2tot_i*) increases;

6. Real consumption (*x3tot*) increases;

7. Trade balance (*x4tot – x0cif_c*) barely affected;

8. Imports *(x0cif_c)* and exports (*x4tot*) both rise;

9. Terms of trade (*p0toft*) deteriorates and

10. Real exchange rate (*p0realdev*) falls.

In addition to the short run and long run results, there are a few other interesting points to note from the simulation results.

1. From in Figure 6.1, even though employment moves back to control in 2013, real pre and post-tax wages (*real_wage_c* and *realw_pt*) continues to increase, and there is an overshooting of employment for the rest of the simulation periods (the K/L ratio decreased up to the year 2013, where the overshooting occurred).

   One reason for this overshooting is because of the increase in labour demand relative to the supply. When there is an increase in the demand for labour relative to the supply, the Malaysian labour market is not in equilibrium anymore. Hence, average post tax real wages would adjust by increasing relative to its basecase forecast. We can see that there is a significant positive deviation in post-tax average real wages in the long run.

2. In addition, from Figure 6.1, it can also be seen that the effect of the decrease in tariff in the motor vehicle had very little effect on total labour supply in the economy (total labour supply decreases only by a mere 0.0005 per cent in the short run), where the graph shows labour supply being very damped.

The short-run and long-run macro results are summarized in Table 6.1:

Table 6.1   Summary of Macro Effects of Removing Motor Vehicle Tariffs in 2010: Short-Run and Long-Run MyAGE_LM Simulation Results

Variable		MyAGE_LM Symbol	Percentage Changes	
			Short Run	**Long Run**
1.	Employment	*emp_hours*	-0.01	0.002649
2.	Total labour supply	*ls_tot*	-0.0005	0.00005
3.	Real pre-tax wage rate	*real_wage_c*	0.044	0.0484
4.	Average post-tax real wage	*realw_pt*	-0.005	0.00211
5.	Real GDP	*x0gdpexp*	-0.0017	0.01437
6.	Real GNE	*x0gne*	0.013	0.01478
7.	Capital stock, rental weights	*x1cap_i*	-0.00018	0.026
8.	Real investment	*x2tot_i*	0.037	0.033
9.	Household consumption	*x3tot*	0.0062	0.0111

10.	Export volumes	x4tot	-0.003	0.0295
11.	Import volumes	x0cif_c	0.012	0.0296
12.	Capital rental	p1cap_i	0.014	-0.0043
13.	Investment price index	p2tot_i	-0.006	-0.0088
14.	Export price index	p4tot	0.01986	0.0171
15.	Import price index	p0cif_c	0.01938	0.022
16.	GDP price deflator	p0gdpexp	0.0069	-0.00044
17.	Government price index	p5tot	0.03	0.0127
18.	Consumer price index	p3tot	0	0
19.	Real exchange rate	p0realdev	0.0125	0.0225
20.	Trems of trade	p0toft	0.0005	-0.0049

6.4   Motor Vehicle Industry Results

The tariff cut in the motor vehicle industry causes a decrease in the supply of domestic motor vehicles to the domestic market, as there is a substitution towards imported motor vehicles (Figure 6.9). As shown in Figure 6.8, following the tariff cut for the year 2010, in the short run, the sales in Malaysia of domestically produced motor vehicles to local market (*x0dom_lm*) is 0.067 per cent below their forecast level, while the imports of motor vehicles (*x0imp*) is 0.32 per cent above their forecast level. This is a 0.386 per cent decrease in the domestic/import sales ratio {100*[{(1-0.00067)/(1+0.0032)}-1]}. It arises from a change in the relative prices. By 2021, the sale of domestically produced motor vehicles to local market (*x0dom_lm*) is 0.099 per cent below their forecast level, while the imports of motor vehicles (*x0imp*) is 0.35 per cent above their forecast level. This is a 0.447 per cent decrease in the domestic-to-import sales ratio {100*[{(1-0.00099)/(1+0.0035)}-1]}.

The main user of motor vehicle is the motor vehicle industry itself (it uses 51.93 per cent of its own good as inputs to production. In the policy simulation, we cut the motor vehicle import tariff rate by 5 per cent. The 5 per cent cut in tariff reduces the landed duty paid price by 0.5117. A cut in tariffs causes a contraction in the motor vehicle industry, with a negative deviation in output for from the point of the shock and the rest of the simulation periods. The contraction of the motor vehicle industry is sufficient to cause the path of the deviation of total domestic sales to be below basecase forecast. Also, in Figure 6.11, the path of the

deviation of total domestic sales (*x0dom*) is above the total local sale of domestically produced motor vehicles (*x0dom_lm*) for all simulation periods. This is because exports of motor vehicles are not affected by tariffs.

In 2010, the basic price of imported motor vehicles (*p0imp*, "MotorVehicle") in the policy simulation is 0.49 per cent below it's basecase forecast value (Figure 6.10). With a lower price of imports, there is a reduction of 0.16 per cent in the basic price of domestic motor vehicles (*p0dom*, "MotorVehicle"). This is because the domestic motor vehicle industry benefits from a decrease in the cost of its main input, automotive parts. Bringing the results of (*p0imp*, "MotorVehicle") and (*p0dom*, "MotorVehicle") together, in 2010, the 5 per cent reduction in tariffs decreases $p0imp/p0dom$ by 0.33 per cent {100*[(1-0.0049)/(1-0.0016)-1]}. By 2021, with (*p0imp*, "MotorVehicle" = -0.49 per cent) and (*p0dom*, "MotorVehicle" = -0.092 per cent), the tariff cut reduces $p0imp/p0dom$ by 0.39 per cent {100*[(1-0.00488)/(1-0.00092)-1]}.

For households in 2010, the reduction in the basic prices of domestic (*p3*, "MotorVehicle", "*imp*") and imported (*p3*, "MotorVehicle", "*dom*") motor vehicles are 0.47 and 0.15 per cent respectively. In the policy simulation, the reduction in the import/domestic ratio of purchaser's prices to households is 0.32 per cent {100*[(1-0.0047)/(1-0.0015)-1]}. In 2021, with (*p3*, "MotorVehicle", "*imp*" = -0.4733 per cent) and (*p3*, "MotorVehicle", "*dom*" = -0.088 per cent), the reduction in the import/domestic ratio of purchaser's prices to household is 0.39 per cent {100*[(1-0.004733)/(1-0.00088)-1]}. The substitution elasticity between imported and domestic motor vehicles in MyAGE_LM is 2.8. Hence, we find a 1.088 per cent $\left\{100*\left(1-(1-0.0039)^{2.8}\right)\right\}$ reduction for households in their ratio of purchasers of domestic to imported motor vehicles. As calculated earlier, the decrease in the overall domestic/import sales ratio is 0.447 per cent. This reflects an import reducing change in the composition of demand for motor vehicles. The car industry (which has a negative deviation in output and uses a significant proportion of motor vehicles) uses more imported motor vehicles compared to other users, i.e., households. The motor vehicle uses 81.38 per cent of imported motor vehicles as intermediate inputs of production (V1BAS, "MotorVehicle", "*imp*"), while households consume 0.25 per cent of imported cars (V3BAS, "MotorVehicle", "*imp*").

Having explained the deviation results for the domestic/import ratio in the sales of motor vehicles, the simulation results for total domestic sales (domestically produced plus imported motor vehicles, *x0loc*) are looked at. In 2010, a 5 per cent decrease in tariff increases total sales (imported and domestic) in Malaysia by 0.03 per cent, and remained at around 0.013 per cent above basecase forecast for the rest of the simulation years (Figure 6.8).

With the tariff cut in 2010, the purchaser's price of motor vehicle to household decreases; 0.47 per cent for imported moter vehicles (*p3*, "MotorVehicle", "*imp*"). This causes household to increase their demand for imports, (*x3*, "MotorVehicle", "*dom*") by 0.98 per cent via a substitution towards more imports of motor vehicle (Figure 6.12). We also observe a small increase in household consumption of domestically produced motor vehicles, (*x3*, "MotorVehicle", "*dom*") by a very small percentage; 0.076 per cent. This is because of a decrease in 0.16 per cent for domestic prices, (*p3*, "MotorVehicle", "*imp*") in Figure 6.10.

In addition, there is also a decrease in the rental price of capital from the policy shock of 0.88 per cent, which decreases investment. In the long run, the exports of motor vehicles will be above control because of the increase in real devaluation.

Figure 6.8   **Sale of Imports, Domestic and Total Sales of Motor Vehicles (% Deviation from Basecase Forecasts)**
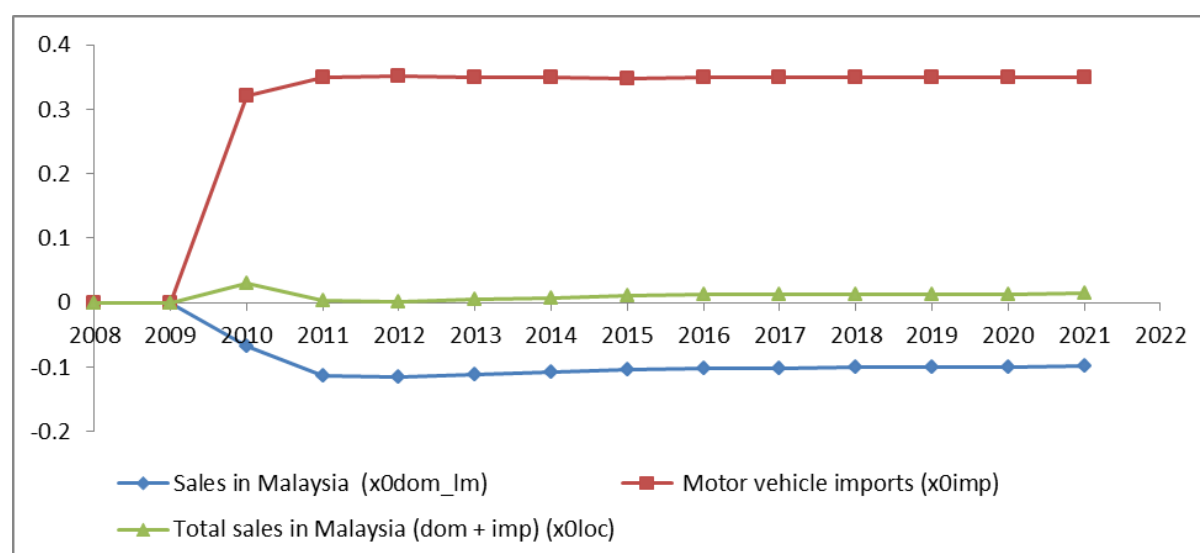
Figure 6.9   Export Demand and Imports of Motor Vehicle

(% Deviation from Basecase Forecasts)
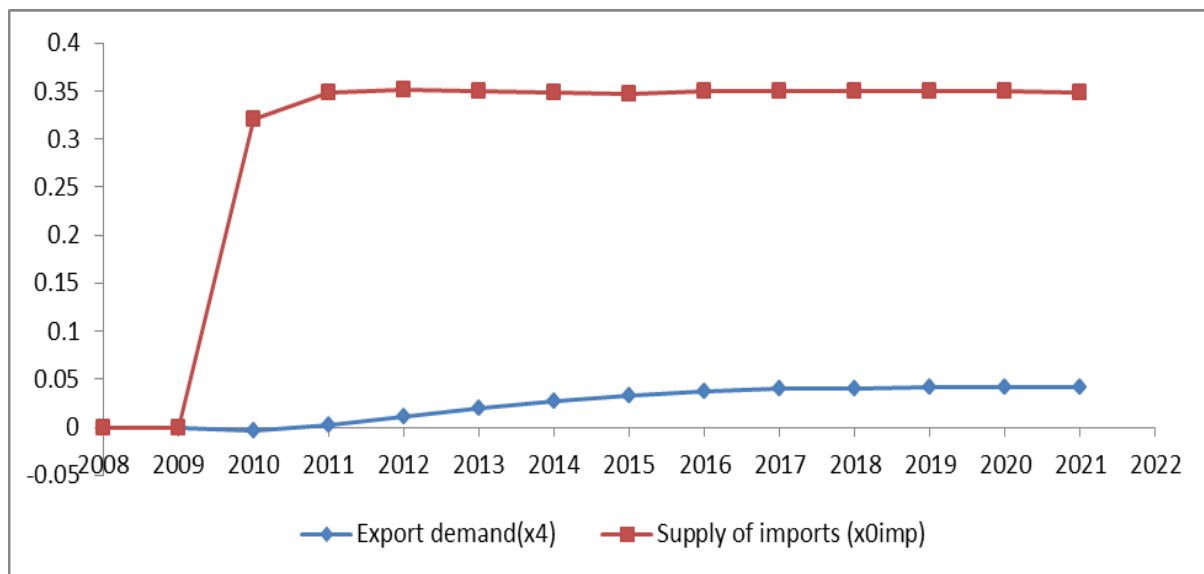
Figure 6.10   Basic Price of Domestic and Imported Motor Vehicles

(% Deviation from Basecase Forecasts)
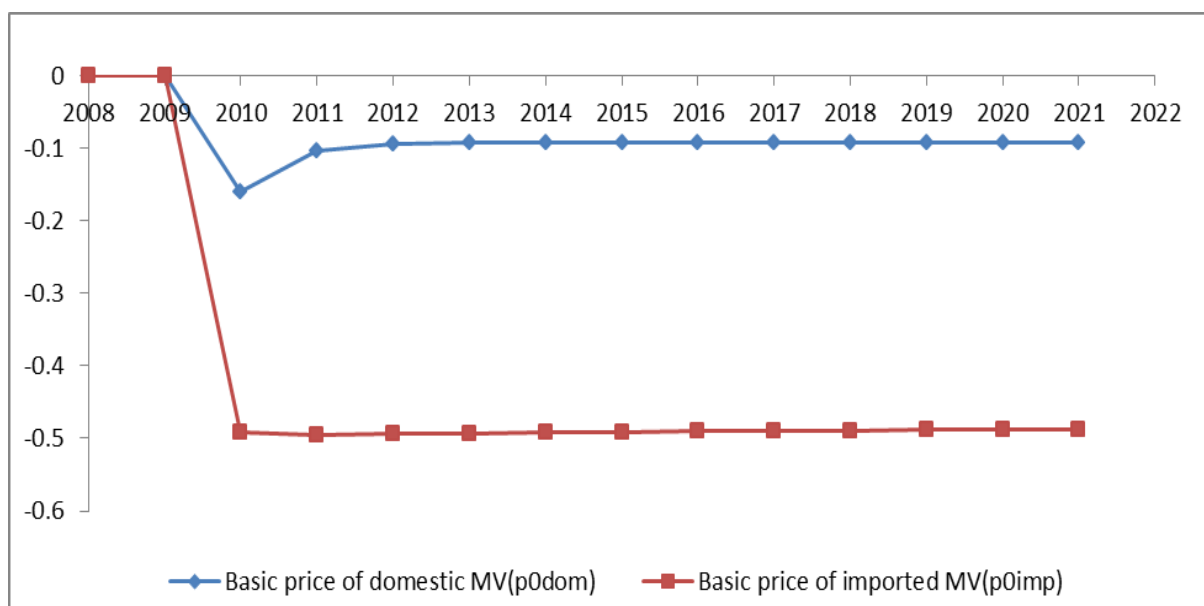
Figure 6.11   Output and Domestic Sales of Motor Vehicles

(% Deviation from Basecase Forecasts)
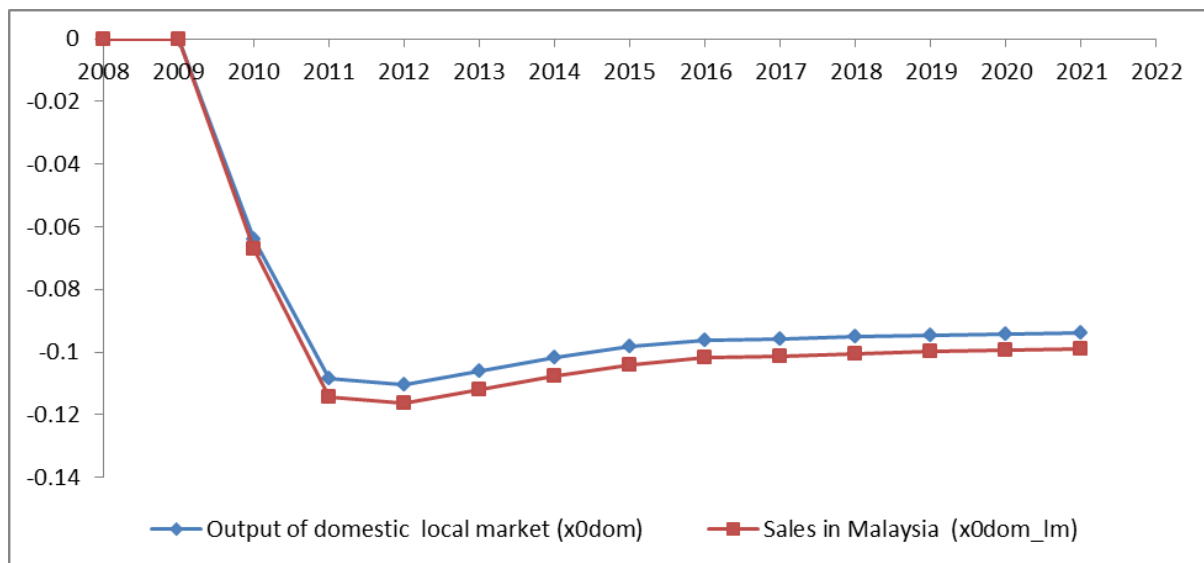
Figure 6.12   Houshold Demand for Domestic and Imported Motor Vehicles

(% Deviation from Basecase Forecasts)
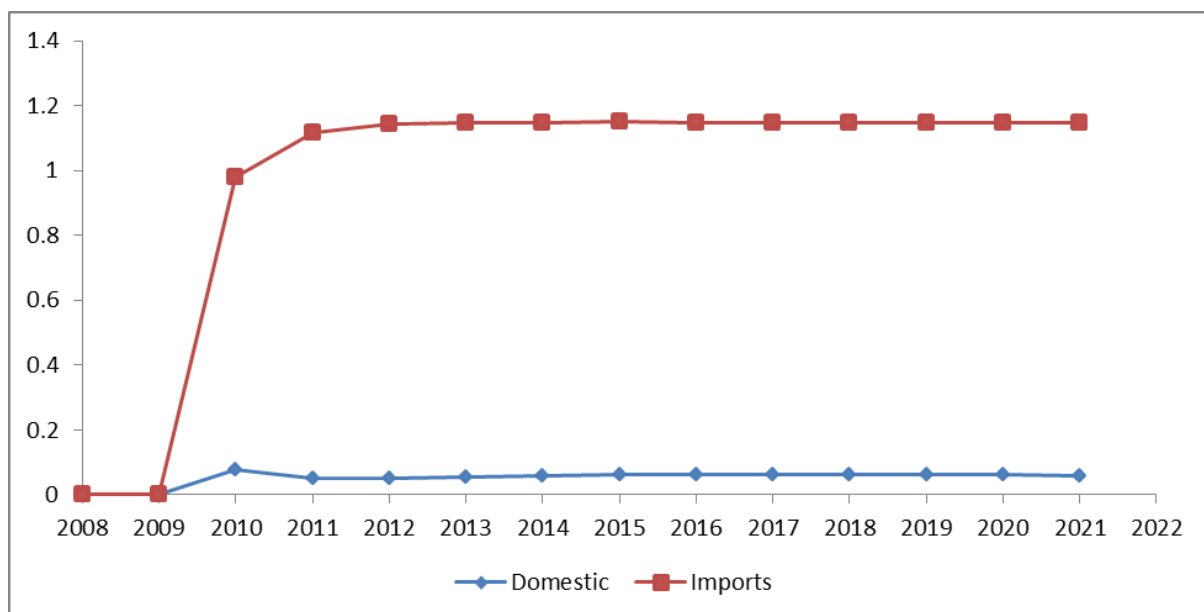
6.5 Explaining Output Results for Industries/Commodities

In the short run, with the cut in motor vehicle tariff, we observe a decrease in output for most industries (*x0ind*). To understand industry results, we need to know the industry sales as well as the cost structures. Looking at the MyAGE_LM database, we can see that Malaysia's export-oriented industries include CrdOilGas (52.54 per cent of product is exported), WoodPaper (42.76 per cent), OthMachEquip (43.75 per cent) and OthManuf (44.01 per cent). As discussed in the macro results, these export-oriented industries experienced an increase in their costs relative to other industries from the 5 per cent tariff cut in motor vehicles. This is because the export oriented industries happen to be relatively light users of motor vehicles.

In the long run, i.e., 2021, as the economy recovers, most industries experience an increase in output (with real devaluation boosting exports), with the exception of the motor vehicle industry, which remains below control for all simulation periods. Also, as discussed in the macro results, most imported motor vehicles in Malaysia are used for investment. Industries that have a higher proportion of investment expenditures on imported motor vehicles experience a reduction in the cost of a unit of capital, *p2tot_i*. To show this, we use the following regression equation:

$$p2tot_{(i)} = 0.018 - 0.33 * \text{IMP\_SH}_{\text{INV,MV}(i)} \qquad R^2 = 0.989 \qquad (6.34)$$

where

- $p2tot_{(i)}$ is the percentage deviation in investment price index (cost of investment) for industry *i* in the long run, i.e., 2021; and
- $\text{IMP\_SH}_{\text{INV,MV}(i)}$ is the share of imported motor vehicles in the total investment expenditure in the basecase forecast for 2021.

From equation (6.34) we can see that *p2tot* is around 99 per cent explained by the share of imported motor vehicles in their investment expenditures when we regress $p2tot_{(i)}$ against $\text{IMP\_SH}_{\text{INV,MV}(i)}$. We also know from the macro results that in the long run, the rate of

return, R returns to basecase forecast. So, for R to be fixed, the rental rate of capital (*p1cap*) moves in a similar way to *p2tot*. Rental is part of production cost. If the rental rate goes down, then the price of the commodity produced in industry *i* will decrease. This is shown in the regression in equation (6.35), where we regress the domestic price of commodity *i* (*p0dom*) against the capital share of imported motor vehicle in investment cost:

$$p0dom_{(i)} = 0.025 - 0.13 * K_{SH\_}IMP\_SH_{INV,MV(i)} \qquad\qquad R^2 = 0.74 \qquad\qquad (6.35)$$

where

- $p0dom_{(i)}$ is the percentage deviation in the price of goods produced by industry *i* ;and
- $K_{SH\_}IMP\_SH_{INV,MV(i)}$ reflects the share of capital in the costs of industry *i* and the share of imported cars in the cost of investment in the basecase year, 2021. $K_{SH\_}IMP\_SH_{INV,MV(i)}$ is calculated by multiplying $K_{SH(i)}$ with $IMP\_SH_{INV,MV(i)}$, where $K_{SH(i)} = (V1CAP(i)/MAKE(i))$.

From the regression in (6.35), we see that $p0dom_{(i)}$ is 74 per cent explained by $K_{SH\_}IMP\_SH_{INV,MV(i)}$. Many sectors in Malaysia are highly trade exposed. Thus the demand elasticities are quite high (elasticity of demand ranges from -3.78 to -13.65). If the domestic price of a commodity decreases, this can explain a strong increase in the output of that commodity.

For the interpretation of industry results in MyAGE_LM, we try to explain the output movement for each industry as a function of the share of its investment cost accounted for by imported motor vehicles. This is done using the following regression:

$$x0dom_{(i)} = 0.016 + 0.015 * IMP\_SH_{INV,MV(i)} \qquad\qquad R^2 = 0.012 \qquad\qquad (6.36)$$

where

- $x0dom_{(i)}$ is the percentage deviation in the output of good *c* in industry *i*; and

- IMP_SH$_{INV,MV(i)}$ is the share of imported motor vehicles in the total investment expenditure, sum(V2BAS, i, "MotorVehicle", imp) in the base year of 2021.

The regression in (6.36) shows that the movement in domestic output for industry i is only 1.2 per cent explained by the share of imported motor vehicle in investment cost. Thus, we need to make a refinement to IMP_SH$_{INV,MV(i)}$.

1st Refinement to IMP_SH$_{INV,MV}$

In the first refinement, we take into account the share of rental in an industry's cost. We now regress $x0dom_{(i)}$ against K$_{SH}$_IMP_SH$_{INV,MV(i)}$:

$$x0dom_{(i)} = 0.015 + 0.088 * K_{SH\_}IMP\_SH_{INV,MV(i)} \qquad R^2 = 0.071 \qquad (6.37)$$

With a R-squared of only 0.071, the regression in (6.37) shows that $x0dom_{(i)}$ is only 7.1 per cent explained by K$_{SH}$_IMP_SH$_{INV,MV(i)}$.

2nd Refinement to IMP_SH$_{INV,MV(i)}$

In the second refinement, we recognize that the effect on output from a reduction in the domestic price depends on the elasticity of demand for the product. As mentioned, in the MyAGE_LM model, the elasticity of demand is high for trade exposed commodities. We first need to measure trade exposure. Trade exposure is measured as the sum of export share in sales and import share in sales in the domestic market. We obtain a measure of trade exposure using the following steps:

1. We calculate the import share, IMP_SH$_{(i)}$, using the following equation:

$$IMP\_SH_{(i)} = \frac{V0IMP_{(i)}}{MAKE_{(i)} + V0IMP_{(i)} - V4BAS_{(i)}} \qquad (6.38)$$

where

- $IMP\_SH_{(i)}$ is the import share for industry i, calculated as the share of the value of imports on total cost for industry i (taking into account the value of imports minus the basic value of exports);

- $V0IMP_{(i)}$ is the basic value of imports for industry i;

- $MAKE_{(i)}$ is the total cost of production for industry i; and

- $V4BAS_{(i)}$ is the basic value of exports for industry i.

2. From the import share, $IMP\_SH_{(i)}$, we create another variable taking into account the capital shares of imported cars in total investment cost, $K_{SH}\_IMP\_SH_{INV,MV(i)}$ (from equation 6.35). Combining the two gives $IMP\_SH_{(i)}*K_{SH}\_IMP\_SH_{INV,MV(i)}$.

3. Next, the export share, $X\_SH_{(i)}$, which is the share of exports on total cost, is calculated as:

$$X\_SH_{(i)} = \frac{V4BAS_{(i)}}{MAKE_{(i)}} \tag{6.39}$$

4. From steps 1 to 3, we can estimate a trade exposure variable, $TRADE_{(i)}^{EXPOSURE}$:

$$TRADE_{(i)}^{EXPOSURE} = X\_SH_{(i)} + IMP\_SH_{(i)}*K_{SH}\_IMP\_SH_{INV,MV(i)} \tag{6.40}$$

5. Finally, we convert the trade exposure variable to take into account capital share of imported motor vehicles in the total cost of investment:

$$\text{TRADE\_EXPOSURE}_{(i)}^{\text{New}} = \text{TRADE}_{(i)}^{\text{EXPOSURE}} * \text{IMP\_SH}_{(i)} * \text{K}_{\text{SH}}\_\text{IMP\_SH}_{\text{INV,MV}_{(i)}} \qquad (6.41)$$

Regressing industry output, $x0dom_{(i)}$ against trade exposure, TRADE_EXPOSURE$_{(i)}^{New}$

With the new trade exposure variable, $\text{TRADE\_EXPOSURE}_{(i)}^{\text{New}}$, we re-run the regression by regressing $x0dom_{(i)}$ on $\text{TRADE\_EXPOSURE}_{(i)}^{\text{New}}$:

$$x0dom_{(i)} = 0.012 + 1.28 * \text{TRADE\_EXPOSURE}_{(i)}^{\text{New}} \qquad\qquad R^2 = 0.51 \qquad (6.42)$$

We can see that the value of the R-squared has increased significantly from 0.071 to 0.51. The regression in (6.42) shows that the domestic output, $x0dom_{(i)}$ is 51 per cent explained by the trade exposure (taking into account capital share of imported cars in total investment cost). We can then plot the graph for the actual MyAGE_LM domestic output ($x0dom_{(i)}$) deviation (for the baseline forecast in year 2021) and the fitted $x0dom_{(i)}$, shown in Figure (6.13).

Figure 6.13   Effect of Cut in Motor Vehicle Tariffs on Industry Output 2021 (Percentage Deviations): MyAGE_LM Industry Output vs. Fitted Industry Output from Equation (6.42)
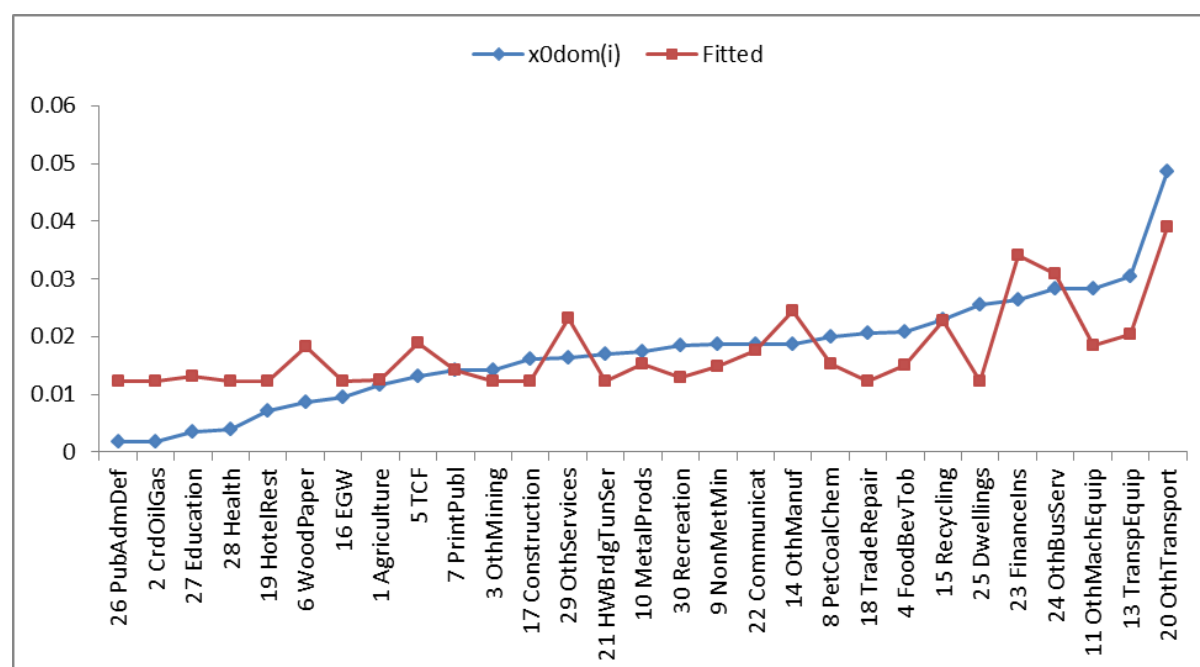
The points on the graph show the effects of the cut in motor vehicle tariffs on industry output in 2021 in MyAGE_LM and the fitted industry output. Equation (6.42) shows a positive relationship between trade exposure; $\text{TRADE\_EXPOSURE}_{(i)}^{\text{New}}$ and domestic output; $x0dom_{(i)}$. From Figure 6.13, looking at the MyAGE_LM results for $x0dom_{(i)}$, we can see that the industry that has the lowest deviation in output is the PubAdmDef industry (0.0017 per cent). This is because this industry does not export (not export-oriented) or use any motor vehicles. Thus it does not benefit from the reduction in motor vehicle tariffs. This industry is also very labour intensive (around 85 per cent), and as discussed in the macro results, the cut in motor vehicle tariffs increased labour cost, which is bad for industries that use a lot of labour. The other labour intensive industries such as Education, Health, and HotelRest all experienced small deviations in output. These industries are labour intensive and do not benefit from the cut in tariffs because of higher cost of labour (government balances budget by replacing loss in tariff revenue with higher labour taxes, and employees demand higher pre-tax real wages).

In general, the export-oriented industries do relatively well. Examples are OthMachEquip (export share of total cost of 83.85 per cent and $x0dom = 0.28$ per cent) and TranspEquip

(share of 76.1 per cent and *x0dom* = 0.19 per cent). At first glance, it is surprising to see that the third highest export-oriented industry, CrdOilGas (export share of 69.75 per cent) experienced a very small deviation in output (*x0dom* = 0.0018 per cent). The reason is that the CrdOilGas industry depends on a very high share of fixed factor; land (64.5 per cent). It has a very steep supply curve. Hence, even with real devaluation, this industry is not able to increase output as much, which explains the relatively small deviation in output compared to the other export-oriented industries. The Agriculture industry also has a modest deviation in output because it depends on 30 per cent of land.

Another point that stands out is the output for the Dwellings industry. This industry produces shelter using housing stock as its principle input. It is very capital intensive (99.94 per cent). With household consumption increasing relative to basecase in the long run, so too does the demand for Dwellings. However, output is constrained by fixed capital supply in the short run. Hence the increase in the demand for Dwellings is initially reflected in a positive deviation in Dwellings rental but little deviation in dwellings output. In the long run, investment in dwellings produces a growing dwellings deviation in output (0.0017 per cent). We now look at the fitted output deviation line in Figure 6.13. From the regression carried out in (6.42), the domestic output, $x0dom_{(i)}$ is 51 per cent explained by the trade exposure (taking into account capital share of imported cars in total investment cost). Based on the discussion on the MyAGE_LM industry results discussed above, we carry out another regression to take the following into account:

1. *Government Share in Total Cost, GOV_SH$_{(i)}$*

Figure 6.13 shows that the industry that experienced the smallest deviation in output is the PubAdmDef industry; it has no exports. We introduce a measure of government share in total cost calculated as:

$$GOV\_SH_{(i)} = \frac{V5BAS_{(i)}}{MAKE_{(i)}} \tag{6.43}$$

where

- $V5BAS_{(i)}$ is the government basic price for industry *i*.

2. *Share of Sales to Household* $CON\_SH_{(i)}^{NEW}$

$$CON\_SH_{(i)}^{NEW} = HHD\_CON_{SH(i)} * K_{SH}\_IMP\_SH_{INV,MV(i)} \qquad (6.44)$$

where

- $HHD\_CON_{SH(i)}$ is the share of sale towards household as a share of total cost $\left(HHD\_CON_{SH(i)} = \dfrac{SALE\_HHD_{(i)}}{MAKE_{(i)}} \right)$. We then take into account the share of capital in imported motor vehicle in total investment expenditure.

3. *Land,* $LAND\_SH_{(i)}$

The CrdOilGas industry has a significant proportion of fixed factor land. So we take into account the share of land in total output, $LAND\_SH_{(i)}$, calculated as:

$$LAND\_SH_{(i)} = \frac{V1LND_{(i)}}{MAKE_{(i)}} \qquad (6.45)$$

where

- $V1LND_{(i)}$ is land for industry *i*.

4. *Labour Share,* $LAB\_SH_{(i)}$

As discussed in the macro result, the cut in tariffs increase the cost of labour. This would be bad for industries that are labour intensive. We include another variable; $LAB\_SH_{(i)}$, to take into take into account labour intensity. This variable is the share of labour on total cost, calculated as:

$$LAB\_SH_{(i)} = \frac{V1LAB_{(i)}}{MAKE_{(i)}} \qquad (6.46)$$

where

- $V1LAB_{(i)}$ is the total wage bill for industry i.

5. Share of Imported Motor Vehicles in Total Cost of Intermediate Input, $IMP\_SH_{(i)}^{INTER\_NEW}$

We also take into account the share of imported motor vehicles used a share of intermediate input cost. With imported motor vehicles used as intermediate inputs of production, the cut in tariffs benefit the industry that uses imported motor vehicles because of the reduction in costs. We also take into account the share of capital in imported cars in total intermediate costs. This variable is calculated as:

$$IMP\_SH_{(i)}^{INTER-NEW} = IMP\_SH_{(i)}^{MV,INTER}.K_{SH(i)} \tag{6.47}$$

where

- $IMP\_SH_{(i)}^{MV,INTER}$ is the share of imported motor vehicles used as intermediate inputs of production on total cost, defined as $\left(IMP\_SH_{(i)}^{MV,INTER} = \dfrac{V1BAS_{(i)}^{IMP\_MV}}{MAKE_{(i)}} \right)$;

- $V1BAS_{(i)}^{IMP\_MV}$ is the share of imported motor vehicles in the total cost of intermediate inputs.

The description of industry results in Figure 6.13 for the MyAGE_LM simulations suggests that the deviation in output are explained by six factors: dependence on how exposed the industry is to trade (positive); dependence on government share in total cost (negative); dependence on the share of sales to household consumption (positive); dependence on fixed factor land (negative); imported motor vehicles as a share of total intermediate input cost (positive) and dependence on share of labour cost to total cost (negative). To see this, we re-

run the regression incorporating all six variables which we think explain the results for the deviation in domestic output:

$$x0dom_{(i)} = 0.015 + 1.11*TRADE\_EXPOSURE_{(i)}^{New} - 0.007*GOV\_SH_{(i)} + 0.09*CON\_SH_{(i)}^{NEW}$$

$$- 0.016*LAND\_SH_{(i)} + 8.28*IMP\_SH_{(i)}^{INTER-NEW} - 0.03*LAB\_SH_{(i)}$$

$$R^2 = 0.76 \qquad (6.48)$$

The regression in (6.48) shows that 76 per cent of the variation across industries in their output deviations is explained by the trade exposure variable, $TRADE\_EXPOSURE_{(i)}^{New}$, government share $GOV\_SH_{(i)}$, consumption share $CON\_SH_{(i)}^{NEW}$, share of fixed factor land $LAND\_SH_{(i)}$, share of imported motor vehicles in total intermediate input cost $IMP\_SH_{(i)}^{INTER-NEW}$, and the share of labour in total cost $LAB\_SH_{(i)}$. As discussed in the macro results, in the long run, the cut in motor vehicle tariffs benefits export-oriented industries because of the positive deviation in real devaluation. So, as anticipated, the more trade exposed an industry is, the bigger is its output deviation. This is shown where trade exposure is a positive factor in output (+1.11). We also see in (6.48) that government share is a small negative factor (-0.007). As discussed, the government does not consume any motor vehicles, and thus does not benefit from a cut in tariffs. The sales share for consumption is a positive factor (+0.09) because households consume motor vehicles and benefits from the tariff cut. The fixed factor land share has a very small negative coefficient (-0.016). This is because the only two industries that are heavily reliant on land are Agriculture (land is 27 per cent of costs) and CrdOilGas (65 per cent). We can see that the deviation in output is positively dependent on the imported share of motor vehicles as intermediate inputs (+8.28). Finally, as anticipated, the share of labour intensity is a negative factor (-0.03). Industries with a higher share of labour incur higher labour cost from the tariff cut. Because of higher pre-tax wages, employers will hire less workers, hence producing less output. The six factors explain a high percentage (76 per cent) of the variability across industries in the deviation in output.

Adopting the method by Dixon et al. (1982), we can further analyze the the regression result in (6.48) through the following question: which sources of variation across the 29 industries is most important in causing the variations in the projections for domestic output?

We can answer this question using the following econometric identity:

$$var(z) = \sum_{k=1}^{6} \hat{\delta}_k^2 \, var(V_k) + 2\sum_{k=1}^{6} \sum_{m>k} \hat{\delta}_k \, \hat{\delta}_m \, cov(V_k, V_m) + var(\bar{f}) \qquad (6.49)$$

where

- $var(z)$ is the sample variance for z (domestic output for industry i);

- $var(V_k)$ is the sample variance for variation V_k;

- $cov(V_k, V_m)$ is the covariance for variation V_k and V_m;

- $var(\bar{f})$ is the variance of the estimated residuals in the ordinary least squares regression of z on V_1 (exposure to trade), V_2 (share of government in total cost), V_3 (sales to household), V_4 (fixed factor land), V_5 (imported share of motor vehicles), and V_6 (share of labour cost); and

- $\hat{\delta}_1$, $\hat{\delta}_2$, $\hat{\delta}_3$, $\hat{\delta}_4$, $\hat{\delta}_5$ and $\hat{\delta}_6$ are the estimated regression coefficients.

If $cov(V_k, V_m)$ is close to zero for all $k \neq m$, then we can interpret the proportion of the sample variance in z that is related to the variance V_k using the following ratio:

$$contribution \; (k) \equiv \hat{\delta}_k^2 \, var(V_k) \big/ var(z) \qquad (6.50)$$

Based on equation (6.49), we carry out a decomposition to analyze the sources of variation across the 29 industry output projections in Table 6.2 below:

Table 6.2

Decomposition Based on Equation (6.49) of Variation Across the 29 Industry-Output Projections

$\hat{\delta}_1^2 \, \mathrm{var}(V_1)/\mathrm{var}(z)$ $=$ 0.382 (trade exposure)

$\hat{\delta}_2^2 \, \mathrm{var}(V_2)/\mathrm{var}(z)$ $=$ 0.029 (government share in total cost)

$\hat{\delta}_3^2 \, \mathrm{var}(V_3)/\mathrm{var}(z)$ $=$ 0.032 (sales to household for consumption)

$\hat{\delta}_4^2 \, \mathrm{var}(V_4)/\mathrm{var}(z)$ $=$ 0.015 (fixed factor land)

$\hat{\delta}_5^2 \, \mathrm{var}(V_5)/\mathrm{var}(z)$ $=$ 0.056 (import share of motor vehicles in intermediate cost)

$\hat{\delta}_6^2 \, \mathrm{var}(V_6)/\mathrm{var}(z)$ $=$ 0.068 (share of labour cost)

$2\hat{\delta}_1 \hat{\delta}_2 \, \mathrm{cov}(V_1, V_2)/\mathrm{var}(z)$ $=$ 0.048

$2\hat{\delta}_1 \hat{\delta}_3 \, \mathrm{cov}(V_1, V_3)/\mathrm{var}(z)$ $=$ -0.022

$2\hat{\delta}_1 \hat{\delta}_4 \, \mathrm{cov}(V_1, V_4)/\mathrm{var}(z)$ $=$ 0.036

$2\hat{\delta}_1 \hat{\delta}_5 \, \mathrm{cov}(V_1, V_5)/\mathrm{var}(z)$ $=$ 0.08

$2\hat{\delta}_1 \hat{\delta}_6 \, \mathrm{cov}(V_1, V_6)/\mathrm{var}(z)$ $=$ -0.027

$2\hat{\delta}_2 \hat{\delta}_3 \, \mathrm{cov}(V_2, V_3)/\mathrm{var}(z)$ $=$ 0.002

$2\hat{\delta}_2 \hat{\delta}_4 \, \mathrm{cov}(V_2, V_4)/\mathrm{var}(z)$ $=$ -0.005

$2\hat{\delta}_2 \hat{\delta}_5 \, \mathrm{cov}(V_2, V_5)/\mathrm{var}(z)$ $=$ 0.010

$2\hat{\delta}_2 \hat{\delta}_6 \, \mathrm{cov}(V_2, V_6)/\mathrm{var}(z)$ $=$ 0.053

$2\hat{\delta}_3 \hat{\delta}_4 \, \mathrm{cov}(V_3, V_4)/\mathrm{var}(z)$ $=$ 0.006

$2\hat{\delta}_3 \hat{\delta}_5 \, \mathrm{cov}(V_3, V_5)/\mathrm{var}(z)$ $=$ -0.13

$$2\hat{\delta}_3\,\hat{\delta}_6\,\mathrm{cov}(V_3, V_6)/\,\mathrm{var}(z) \quad = \quad 0.015$$

$$2\hat{\delta}_4\,\hat{\delta}_5\,\mathrm{cov}(V_4, V_5)/\,\mathrm{var}(z) \quad = \quad 0.008$$

$$2\hat{\delta}_4\,\hat{\delta}_6\,\mathrm{cov}(V_4, V_6)/\,\mathrm{var}(z) \quad = \quad 0.003$$

$$2\hat{\delta}_5\,\hat{\delta}_6\,\mathrm{cov}(V_5, V_6)/\,\mathrm{var}(z) \quad = \quad -0.015$$

$$\quad\quad\quad\quad\quad\quad\quad\quad\quad \underline{\quad\quad\quad\quad}$$

$$R^2 \quad\quad\quad\quad\quad\quad = \quad 0.762$$

$$\mathrm{var}(\bar{f})/\,\mathrm{var}(z) \quad = \quad 0.238$$

$$\quad\quad\quad\quad\quad\quad\quad\quad\quad \underline{\quad\quad\quad\quad}$$

$$\quad\quad\quad\quad\quad\quad\quad\quad\quad 1.000$$

$$\quad\quad\quad\quad\quad\quad\quad\quad\quad \underline{\quad\quad\quad\quad}$$

_____

From Table 6.2, we can see that the variation across industries for V_1 (exposure to trade) contributes significantly to the variations in industry output projections in MyAGE_LM. This supports the view that the more trade exposed an industry is (more export-oriented and import-competing), the more it is able to increase output (from real devaluation). There are also contributions of variations from V_2 (government share in total cost), V_3 (sales to household for consumption), V_4 (fixed factor land), V_5 (import share of motor vehicles used as intermediate inputs) and V_6 (share of labour cost), although not as important as the variation in V_1.

We can plot the MyAGE_LM and fitted output in Figure 6.14 below:

Figure 6.14   Effect of Cut in Motor Vehicle Tariffs on Industry Output 2021 (Percentage Deviation): MyAGE_LM Industry Output vs. Fitted Industry Output from Equation (6.48)
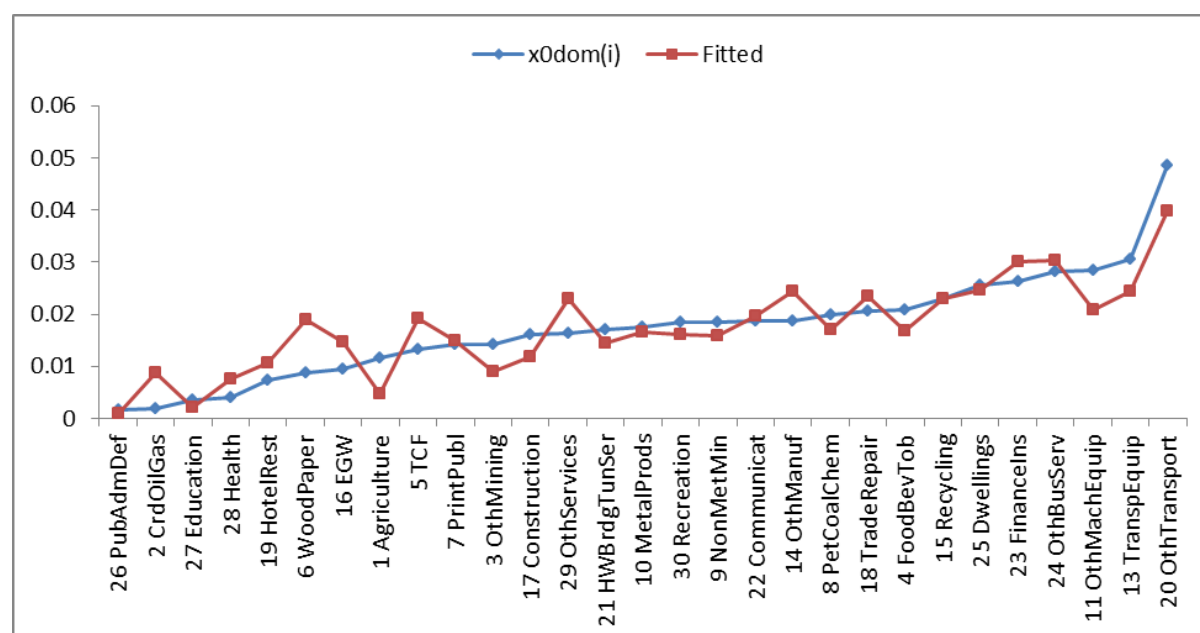
In summary, Figures 6.13 and 6.14 show MyAGE_LM model results for the effects of a motor vehicle tariff cut on domestic output together with fitted values from equations (6.42) and (6.48). Industry results showed that in general, export-oriented industries gained from the cut in tariffs in the long run. We also find industries that are labour intensive such as the Education and PubAdmDef industries did not experience much expansion in output because of higher cost of labour. The figures are used to deepen our understanding of industry results. For example, from Figure 6.13, we can ask why the MyAGE_LM model is more pessimistic about the tariff cut on deviation in output for CrdOilGas, as compared to equation (6.42). That is, does the model know more about CrdOilGas that is not included in the regression? As discussed, we think that the answer lies in the significant share of fixed factor land in that industry. With a very inelastic supply curve, the CrdOilGas industry is not able to expand as much output even though it is export-oriented. The link between the share of land in total cost and demand elasticity links are taken into account in the simulation model, but not in the regression. Using this approach, we can develop theories about all of the other industry results that are not well explained in the regression in (6.42).

6.6　Occupational Results

6.6.1　　　Labour Market Brief Overview

Having presented the macro and industry results for a cut in motor vehicle import tariffs, we now look at the effects on wages and employment in the different occupations.

The labour force specification in MyAGE_LM is a simplified version of the specification by Dixon and Rimmer (2005; 2008). In their specification, the focus was on illegal immigration. In MyAGE_LM, everyone is assumed to be a Malaysian citizen. Hence, as described in Chapter 3, categories (*cat*) and activities (*act*) are only defined over the dimension that describes the labour force function (*f*). Most of the categories reflect the activities that people undertook in year *t-1*, with the main activities being employment in occupation (*o*). As well as these occupational categories, we also allow for a new entrant category (*NEW*). These are the people who enter the labour force at the beginning of year *t* but who are not in the labour force in year *t-1*. The activities that people in a given category undertake in year *t* are determined mainly by their supply to that activity, relative to the supply from people in other categories and by the demand for the services of that activity.

Function are used to detail the characteristics of the labour force. The MyAGE_LM labour force functions include: employment in three skilled occupations (LegSenOffMan, Professional or TechAssProf); five semi-skilled occupations (Clerical and ServiceSales, SklAgriFish, CraftTraders or PlantMachOpr); and one unskilled occupation (ElementOcc); short-term unemployed (S), where workers are unemployed for a substantial amount of year *t-1*, but not unemployed in year *t-2;* and long-term unemployed (L), where workers are unemployed for a substantial amount of year *t-1* and year *t-2*,

6.6.2　　　Equations Used for Occupational Interpretation of Tariff Cut　　　　　　Simulation

To interpret the occupational results from a tariff reduction, we use the labour supply, wages adjustment and job flow equations described in Chapter 3 (Section 3.19).

The labour supply function is given by:

$$L_t(cat; act) = CAT(cat)^* \left[\frac{\left(B_t(cat; act)^* ATRW_t(act) \right)^\eta}{\sum_q \left(B_t(cat; q)^* ATRW_t(q) \right)^\eta} \right] \qquad (6.51)$$

where

- $L_t(cat; act)$ is the labour supply of people in category (*cat*) to activity (*act*) during year *t* with both (*cat*) and (*act*) defined by the dimension (*f*);

- $B_t(cat; act)$ is a variable that reflects the preference of people in category (*cat*) for earning money in activity (*act*) in year *t*;

- $CAT(cat)$ is the number of people in category (*cat*);

- and $ATRW_t(act)$ is the after tax real wage for workers in activity (*act*).

Understanding and interpreting the policy shock implemented via equation (6.51) is made easier when converted into its linearized percentage-change form:

$$l_t(cat; act) = cat_t(cat) + \eta^* \left(atrw_t(act) - atrw_t^{ave}(cat) \right) + \eta^* \left(b_t(cat) - b_t^{ave}(cat) \right) \qquad (6.51a)$$

where

- $l_t(cat; act)$, $cat_t(cat)$, $atrw_t(act)$ and $b_t(cat)$ are percentage changes in the variables denoted by the corresponding upper case symbols.

Equation (6.51a) shows that people in category (*cat*) will switch their offers towards activity (*act*) if the after-tax real-wage in activity (*act*), $atrw_t(act)$ increases relative to an average of the rates across all activities in which category (*cat*) people can participate, $atrw_t^{ave}(cat)$.

The wage adjustment mechanism in MyAGE_LM plays an important role in the functioning of the labour market. In the labour market policy runs in MyAGE_LM, the wage rate will adjust based on the following equation:

$$\frac{ATRW_t(o)}{ATRW_t^{base}(o)} - \frac{ATRW_{t\text{-}1}(o)}{ATRW_{t\text{-}1}^{base}(o)} = \beta(o)\left[\frac{D_t(o)}{D_t^{base}(o)} - \frac{L_t(o)}{L_t^{base}(o)}\right] \qquad (6.52)$$

where

- (D_t) is the labour demand and (L_t) is the labour supply based on occupations;

- β is a positive parameter that controls the adjustment or sensitivity of the after tax real wage rate to the gap between labour supply (L_t) and demand (D_t); and

- "base" is the basecase forecast .

Equation (6.52) shows that if a policy simulation causes the demand for labour to increase relative to the supply, then the labour market will not clear instantaneously. Instead, the excess of demand over supply puts upward pressure on wages. There will be an increase between years *t-1* and *t* in the deviation in occupation *o's* after tax real wages. That is, if demand for labour increases relative to the supply, after tax real wages will increase relative to their base values.

The flow from category (*cat*) to activity (*act*) is given as:

$$H_t(cat;act) = V_t(act) * \left[\frac{L_t(cat;act)}{\sum_{s \neq act} L_t(s;act)}\right] \quad \text{for all } cat \neq act \text{ and all Malaysian employment} \qquad (6.53)$$

$$\text{activities}$$

where

- $L_t(cat;act)$ is the labour supply of people in category (*cat*) to activity (*act*) during year *t*;

- $H_t(\text{cat}; \text{act})$ is the actual flow of people from start-of-year category (*cat*) to activity (*act*) during year *t;* and

- $V_t(\text{act})$ is vacancies in year *t* in activity (*act*).

In equation (6.53), the flow of people from category (*cat*) to Malaysian employment activity (*act*), where $[cat \neq act]$ is modelled as being proportional to the vacancies in activity (*act*) and the share of category (*cat*) in the supply of labour to activity (*act*) from workers outside category (*act*). Thus, if workers in category (*cat*) account for 10 per cent of the workers outside of category (*act*) who want jobs in employment-activity (*act*), then people in category (*cat*) will fill 10 per cent of the vacancies in (*act*).

It is assumed that there will always be competition for jobs, that is, the number of people from outside of category (*act*) who plan to work in employment-activity (*act*) is greater to or equal to the number of vacancies $[V_t(\text{act})]$ in act. This ensures that $H_t(\text{cat}; \text{act})$ is less than or equal to $L_t(\text{cat}; \text{act})$ for all categories cat $\neq$ act and all Malaysian activities (*act*).

6.6.3 Occupational Effects from a Cut in Motor Vehicle Tariffs

Figure 6.15   Occupational Employments (% Deviation from Basecase Forecasts)
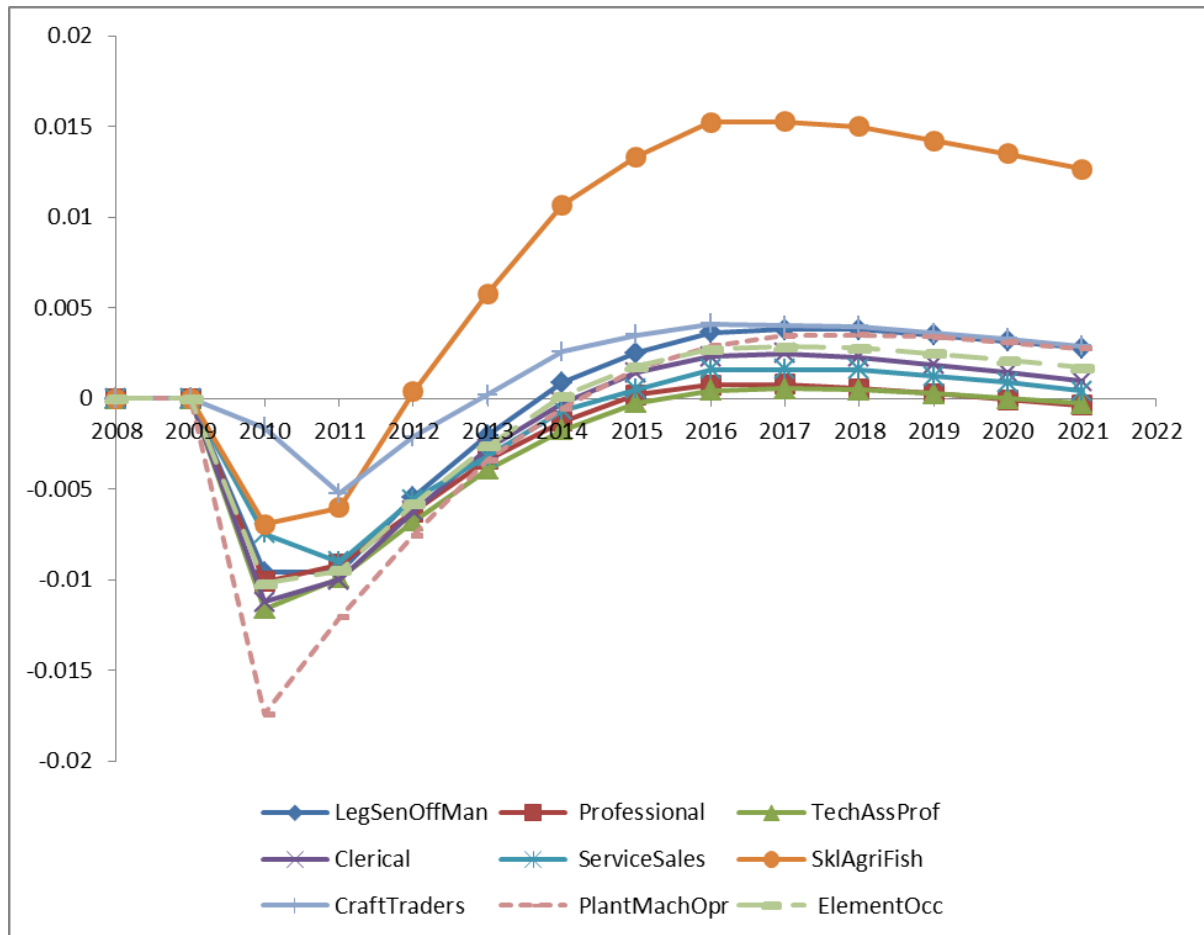
Figure 6.16   Occupational Average Post-Tax Real Wage Rate (% Deviation from Basecase Forecasts)
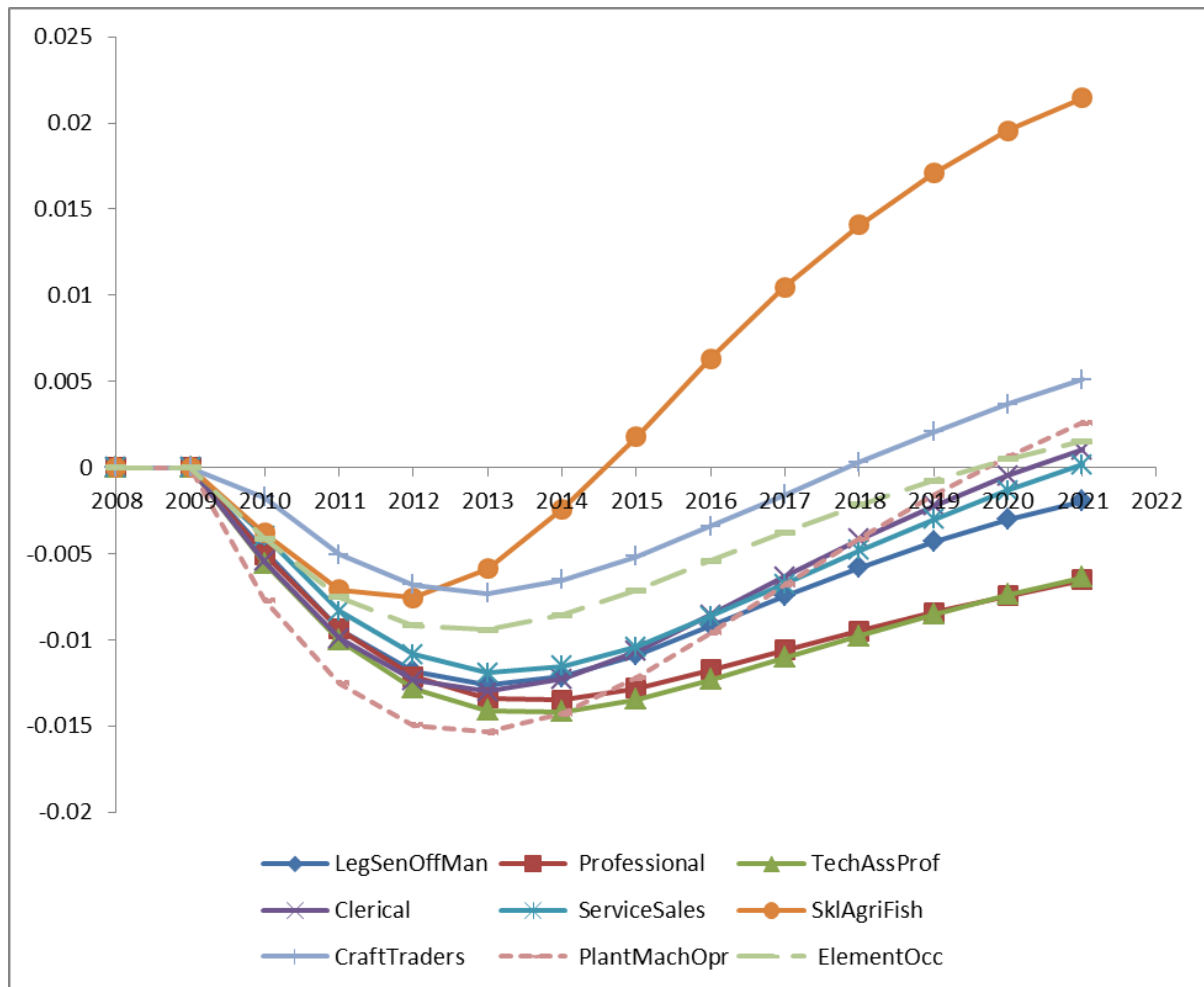
Figure 6.17   Occupational Labour Supplies (% Deviation from Basecase Forecasts)
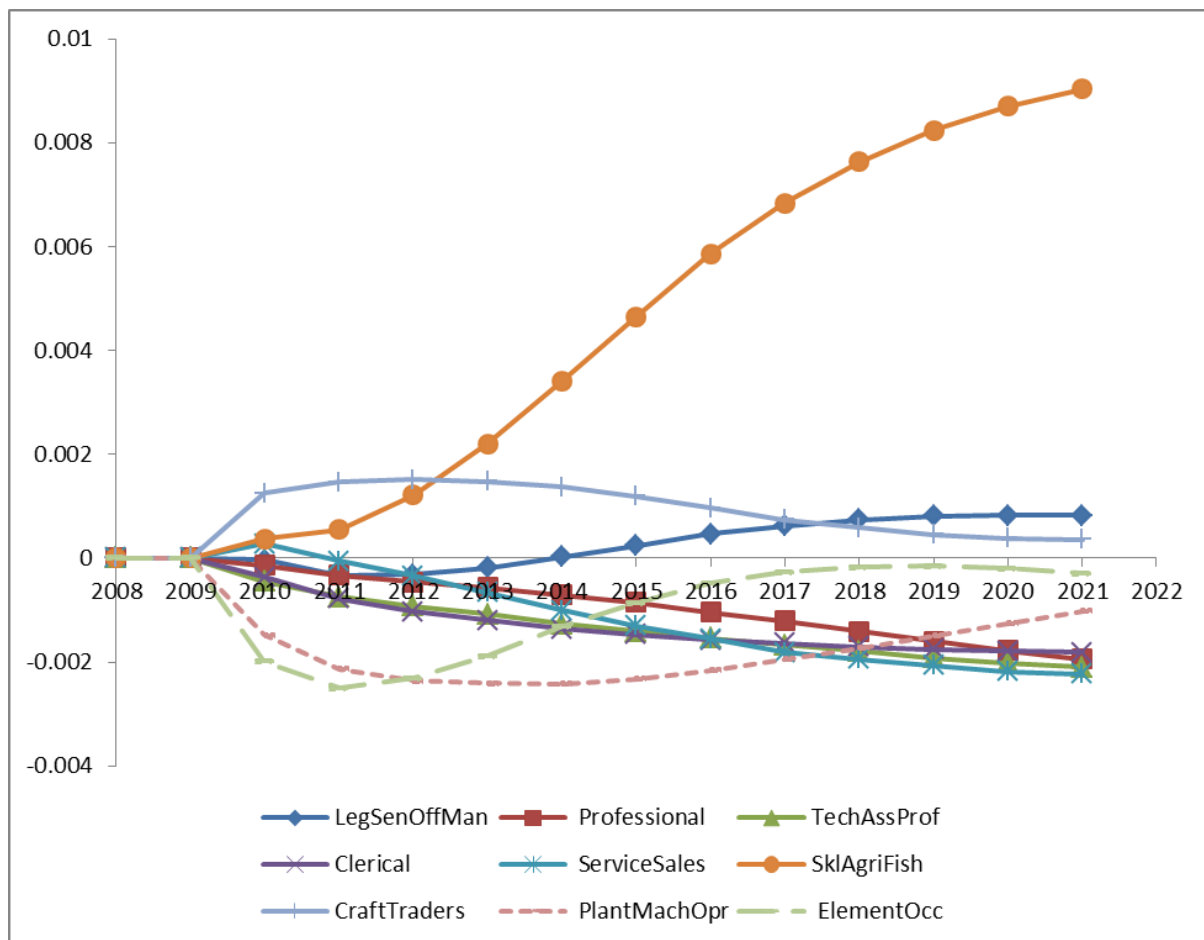
Figure 6.18   Occupational Offers to Occupation Outside (o) (% Deviation from Basecase Forecasts)
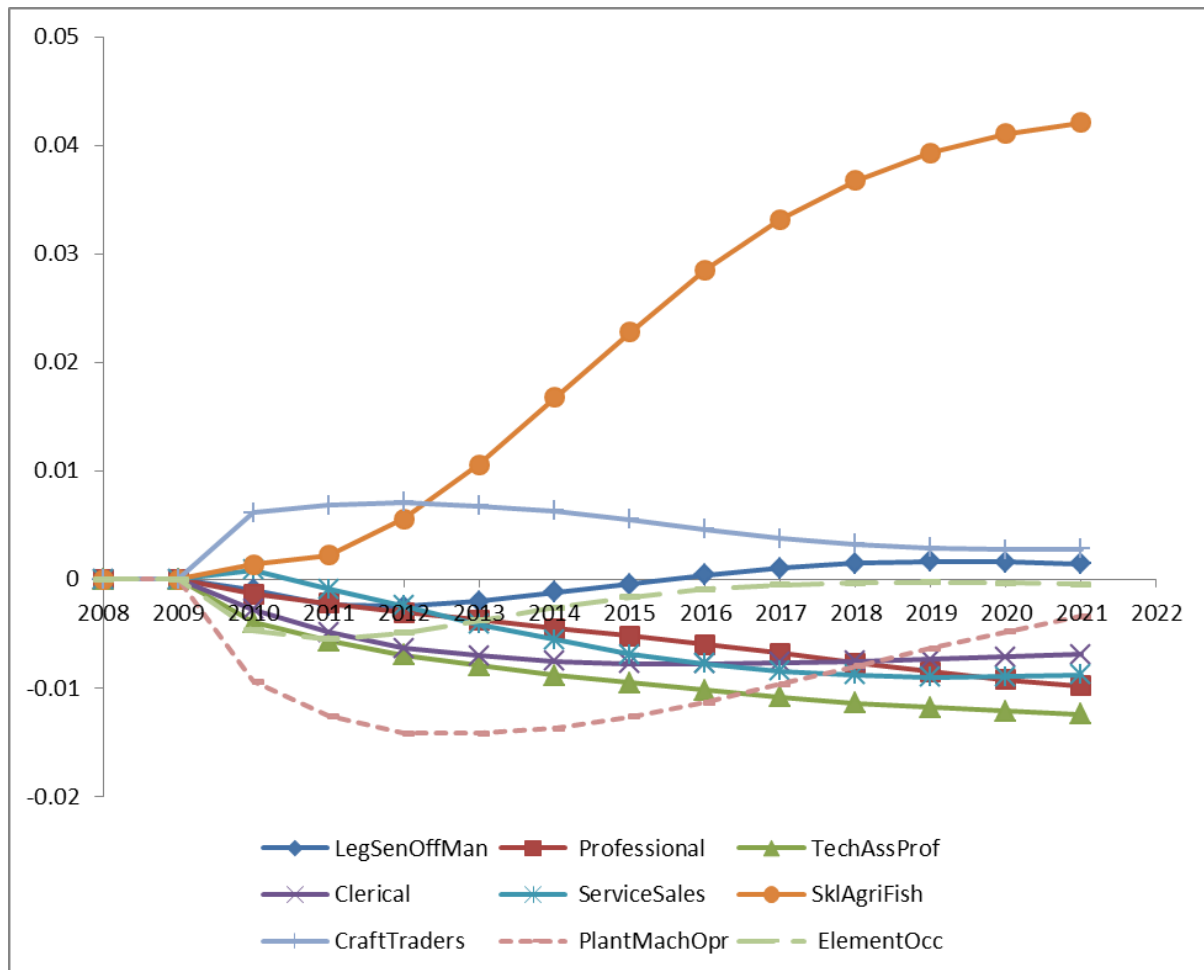
Figure 6.19   Vacancies (% Deviation from Basecase Forecasts)
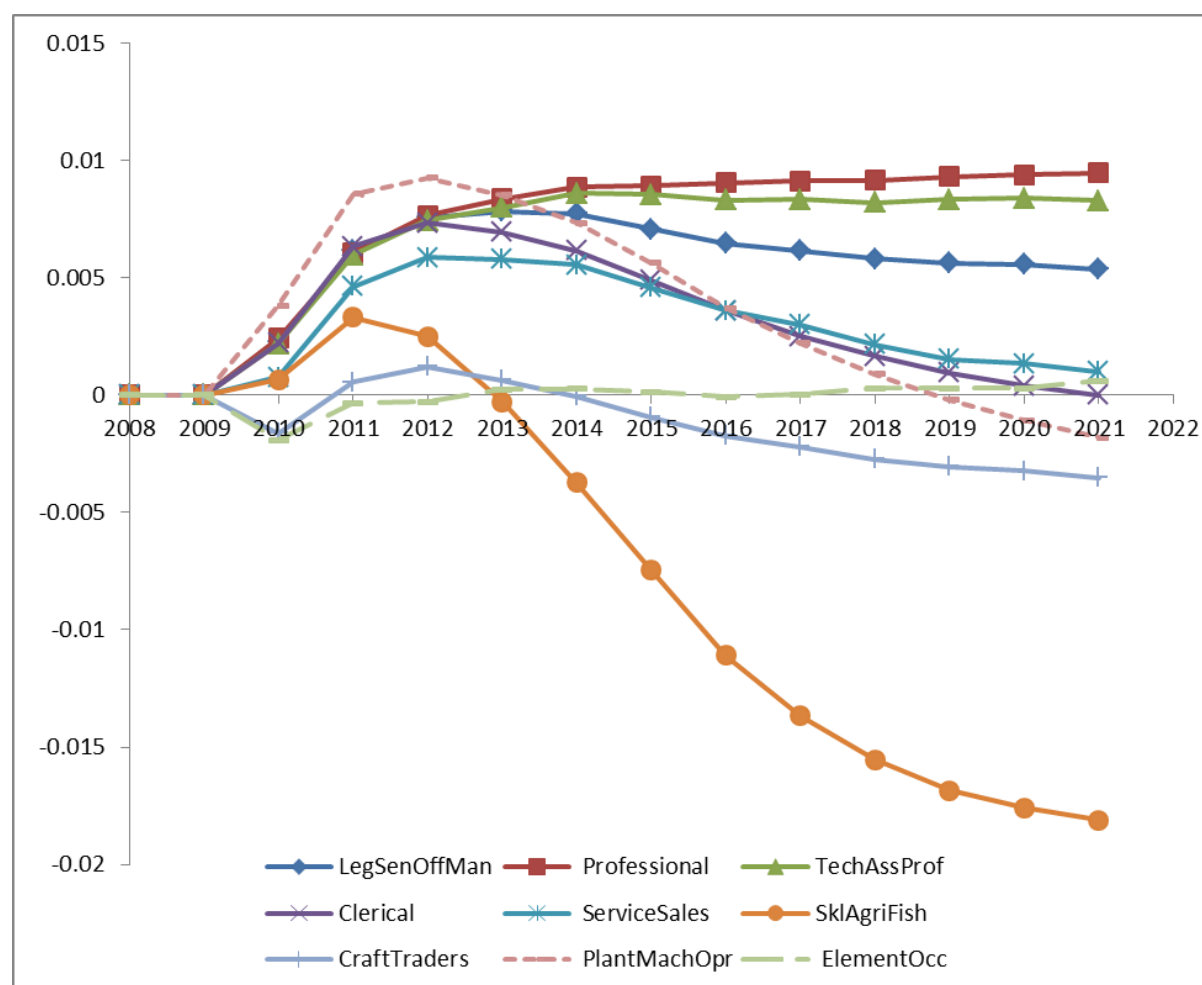
From Figure 6.15, we can see that in the short run, the policy shock decreases employment for all occupations. 3.77 per cent of plant machine operators and assemblers (PlantMachOpr) are employed in the Motor Vehicle industry. However, we note that motor vehicles are only 1.67 per cent of total employment in the economy. Thus PlantMachOpr are over-represented in the Motor Vehicle industry. With a tariff cut in the Motor Vehicle industry, we would expect the workers employed in PlantMachOpr to be the most affected. We can see this from Figure 6.15, where PlantMachOpr experienced the largest decrease in labour demand (*e_hours_o*, PlantMachOpr = -0.0174 per cent). The other affected occupation from the tariff cut is ElementOcc occupation (*e_hours_o*, ElementOcc = -0.0103 per cent). 2.56 per cent of workers in ElementOcc are employed in the Motor Vehicle industry. This means that ElementOcc is also over-represented in the Motor Vehicle industry.

In addition, we can see in Figure 6.15 that the demand for SklAgriFish employment did not experience a large negative deviation (*e_hours_o*, SklAgriFish = -0.007 per cent). This is because there are no SklAgriFish workers employed in the MotorVehicle industry. We can also see that ServiceSales experiences a small negative deviation in employment (*e_hours_o*, ServiceSales = -0.0074 per cent). 0.5 per cent of ServiceSales is employed in the Motor Vehicle industry. The demand for labour this occupation does not fall as much relative to other occupations (for example TechAssProf) because this group is under-represented in the Motor Vehicle industry.

Another occupation of interest is the CraftTraders. 1.28 per cent of CraftTraders are employed in the Motor vehicle industry (as compared to 0.99 per cent of Professional), yet CraftTraders experienced the smallest negative deviation in employment (*e_hours_o*, CraftTraders = -0.002 per cent; *e_hours_o*, Professional = -0.01 per cent). So why is the negative deviation in employment for Professional bigger than CraftTraders, even though the share of Professional employment is smaller in the MotorVehicle industry? One reason is because CraftTraders are intensively employed in the Construction and TradeRepair industries. 35.46 per cent of CraftTraders are employed in the Construction industry (and the Construction industry is 6.71 per cent of total employment in the economy) and 10.1 per cent are employed in the TradeRepair industry (the TradeRepair industry is 7 per cent of total employment). These two industries are the only industries that experienced a positive deviation in output in the short run *x0dom*, "Construction" = 0.016 per cent and *x0dom*, "TradeRepair"= 0.0014 per cent). Hence, the negative deviation in the demand for CraftTraders is not as big as expected.

In the short run, post-tax real wages are sticky. We can see in Figure 6.16 that the post-tax real wages for ServiceSales, SklAgriFish and CraftTraders occupations fall less than the wages for the other occupations. As mentioned earlier, this is because the demand for labour in these three occupations experienced the lowest negative deviation in employment relative to the other occupations (Figure 6.15). Also, from Figures 6.16 and 6.17, we can also see that with real post- tax wages decreasing, workers for each occupation decrease their supply of labour, with the exception of the of ServiceSales, SklAgriFish and CraftTraders occupations. The labour supply in these three occupations increases because they are attracting workers from other occupations. Workers outside these three occupational groups (for example Professionals) are willing to supply their labour to these occupations even though post-tax

real wages in these occupations are decreasing (Figure 6.18). To see why this happens, we look at equation (6.51a). For workers in occupations outside of ServiceSales, SklAgriFish and CraftTraders (for example PlantMachOpr and Clerical), post-tax real wages for these two occupations are falling relative to those in ServiceSales, SklAgriFish and CraftTraders. Thus, they are willing to switch to occupations and supply their labour to these three occupations.

From Figure 6.19, we see positive deviations in vacancies in all occupations except ElementOcc and CraftTraders. As explained earlier, CraftTraders experiences the smallest negative deviation in employment and post-tax real wages, as well as the highest positive deviation in labour supply. The post-tax real wages of other occupational groups are falling relative to this occupation. Because of that, workers from other occupational groups (for example Professionals and Clerical) are switching towards this occupation. This increases the supply of labour to Craft Traders, which in turn decreases the vacancy for this occupation.

However, we note that for ElementOcc, the vacancy for this occupation decreases even though this occupation has the largest negative deviation in labour supply. We would expect that with the supply of workers to this occupation falling, there would be an increase in the vacancy. A reason for this fall in vacancy is because as discussed earlier, ElementOcc is over-represented in the Motor Vehicle industry (2.56 per cent of workers in ElementOcc are employed in the motor vehicle industry versus motor vehicle being 1.67 per cent of total employment in the economy). The MotorVehicle industry experienced the biggest contraction in output from the tariff cut. We also know that 15.9 per cent of workers in ElementOcc are employed in the Agriculture industry (Agriculture is only 7.9 per cent of total employment in the economy). The Agriculture industry experienced one of the largest negative deviations in output from the tariff cut in the short run. Thus, even though the negative deviation in the supply of labour for ElementOcc is relatively large, the decrease in vacancy for ElementOcc can be explained by the significant contractions in industry outputs for the Motor Vehicle and Agriculture industries.

In the long run, we can see from Figure 6.16, with a tariff cut in the Motor Vehicle industry, the post-tax real wages of PlantMachOpr and ElementOcc increase relative to those of LegSenOffMan, Professional and TechAssProf. 27.26 per cent of PlantMachOpr occupation workers are employed in the OthMachEquip industry, (as compared to OthMachEquip being 8.69 per cent of total employment). In the long run, this industry does very well from the

motor vehicle tariff cut. As discussed in the sections on macro and industry results, the OthMachEquip industry is export intensive and is around 50 per cent of the total value of exports in the Malaysian economy. This industry gains in the long run from real devaluation. Its long run output deviation is larger than that for any other industry (Figure 6.14). As the demand for workers in PlantMachOpr occupation increases relative to the supply, post-tax real wages will adjust and increase relative to basecase forecast, based on the wage adjustment mechanism in equation (6.52). We can also see that the post-tax real wages for Professional and TechAssProf occupations experienced the slowest growth in wages.

For the SklAgriFish occupational group, the dominant employer, accounting for 90.68 per cent of jobs, is Agriculture. ElementOcc also has a heavy dependence on Agriculture which accounts for 16.06 per cent of its jobs. In the long run, Agriculture experiences an increase in its output and exports, reflecting the continued increase in real devaluation (as the economy recovers and moves towards balance of trade surplus). This explains why both SklAgriFish and ElementOcc appear with relatively large long run positive employment and wage deviations in Figures 6.15 and 6.16. By contrast, workers in TechAssProf occupations are predominantly hired in non-export-oriented industries (e.g. the Education industry which accounts for 13.44 per cent of their employment). Consequently, TechAssProf shows negative long run deviations for employment and wages in Figures 6.15 and 6.16.

We can also that with the exception of CraftTraders and SklAgriFish, there is a positive deviation in the vacancies for the other occupational groups. We would expect that because of the increase in vacancies in these occupations relative to CraftTraders and SklAgriFish, workers are more likely to offer their labour supply to these occupations. However, the increase post-tax real wages are not enough to absorb an increased proportion of new entrants and unemployed workers into the workforce, as most workers from other occupations and new entrants as well as unemployed workers are now more likely to offer their services to CraftTraders and especially SklAgriFish. This is because the post-tax real wages of these occupations (CraftTraders and SklAgriFish) are increasing relative to that of the other occupations.

From Figures 6.15 to 6.19, one occupational group that stands out among the rest is the SklAgriFish occupation. With a cut in motor vehicle tariffs, post-tax real wages for workers in this occupational group grew faster than the wages of the other skill, semi-skilled and

unskilled occupations. There are no SklAgriFish workers employed in the motor vehicle industry. With the post-tax real wages of SklAgriFish increasing relative to the wages for the other occupations (for example Professionals and Clerical), workers from these occupations are switching and increasing their offers to SklAgriFish. That is why SklAgriFish has the lowest number of vacancies, as most workers from other occupations and new entrants, as well as unemployed workers are now more likely to offer their labour to this semi-skilled occupation (Figure 6.19). In terms of equation (6.51a), the decrease in tariff rates in the motor vehicle industry causes an occupational shift of employment towards semi-skilled occupations, particularly the SklAgriFish occupation (Figure 6.18) as post-tax real wages of this occupation increases relative to the other occupations. So why is SklAgriFish doing well? We can explain this in more detailed below:

Why Does the SklAgriFish Occupational Group Do Well?

Around 90 per cent of SklAgriFish workers are employed in the Agriculture industry. In the long run, the Agriculture industry does well with a positive deviation in output (*x0ind*, "*Agriculture*" = 0.012 per cent). The main customer for the Agriculture industry is the FoodBevTob industry, where this industry uses around 50 per cent of Agriculture (V1BAS, "*Agriculture*", "*dom*", i = 50 per cent). We know that the FoodBevTob industry does well because around 52.5 per cent of its sale (after excluding intra-industry sales) goes towards exports. As shown in Figure 6.14, the FoodBevTob industry has a relatively high positive deviation in output.

More generally, occupational results are determined mainly by industry results. If an occupation is heavily employed in an industry that does well from the tariff cut, then that occupation also does well. To demonstrate this, we use the following regression equation:

$$e\_hours\_o_{(o)} = 0.0004 + 0.70 * \text{Emp\_Index}_{(o)} \qquad R^2 = 0.98 \qquad (6.54)$$

where

- $e\_hours\_o_{(o)}$ is the percentage deviation in employment based on occupation, *occ* (e_*hours_o*) in the long run, i.e., 2021; and

- Emp_Index$_{(o)}$ is an employment index in the long run (year 2021) for each occupation o, calculated as:

$$\text{Emp\_Index}_{(o)} = \sum_i \text{SH}_{(o,i)} * emp_{(i)} \qquad (6.55)$$

where

- SH$_{(o,i)}$ is the share of occupation o employed in industry i; and

- $emp_{(i)}$ is the percentage deviation in employment for industry i for the year 2021.

Emp_Index$_{(o)}$ shows what would happen to employment in occupation o if the occupational composition of employment were fixed.

From the regression in (6.54), we can see that the percentage deviation in employment for each occupation, $e\_hours\_o_{(o)}$, is around 98 per cent explained by Emp_Index$_{(o)}$. The employment index, Emp_Index$_{(o)}$, is a positive factor (+0.7) in employment. Why doesn't Emp_Index$_{(o)}$ explain $e\_hours\_o_{(o)}$ completely (why only 98 per cent)? Why is the factor only 0.7 (why not 1)? To answer these questions, we draw a scatter diagram (Figure 6.20) for Emp_Index$_{(o)}$ versus $e\_hours\_o_{(o)}$:

Figure 6.20   Effect of Cut in Motor Vehicle Tariffs on Occupational Employment in 2021 (Percentage Deviations): MyAGE_LM Occupational Employment vs. Employment Index from Equation (6.54)
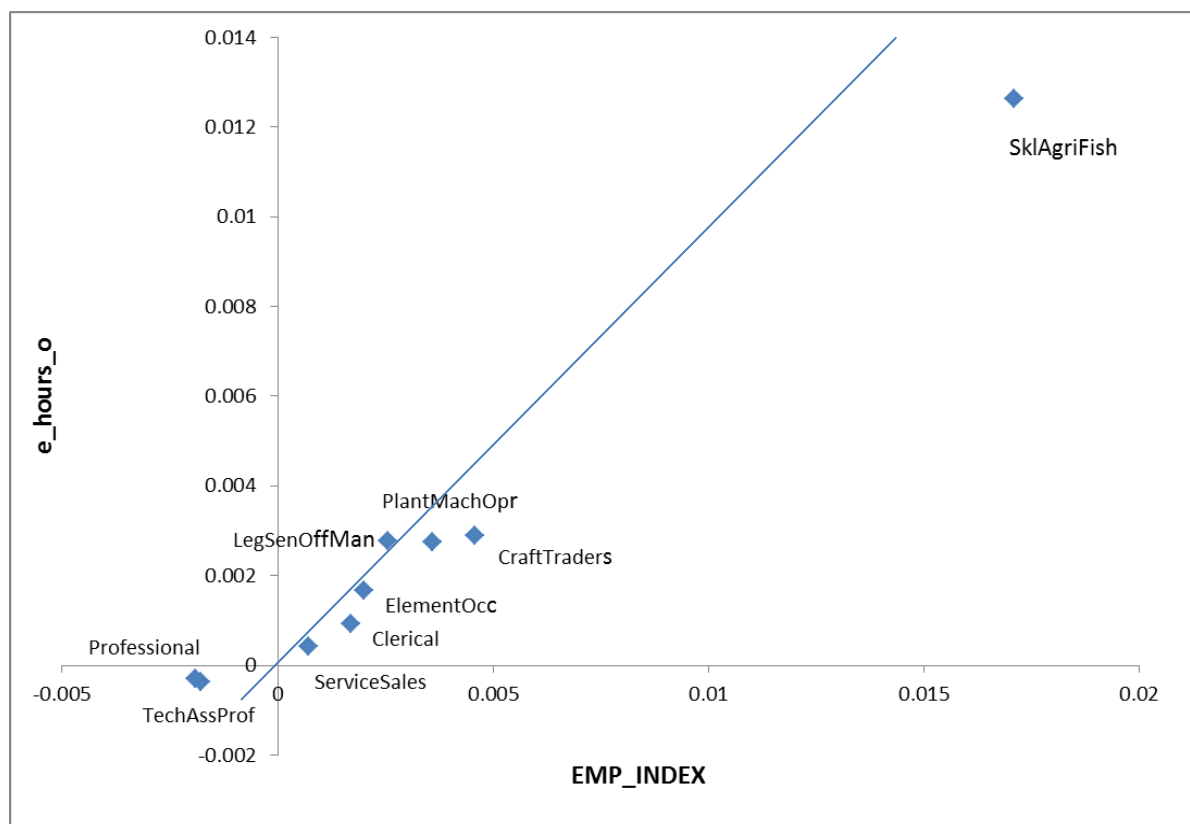
Figure 6.20 can be used to extend our understanding of employment results for the nine different occupational groups. We see, with one exception, that all of the points in Figure 6.20 on the right side of the vertical axis are below the 45 degree line and both the points on the left side are above the 45 degree line. We can ask why the MyAGE_LM model is more pessimistic about the deviation in employment for occupation o, as compared to the regression in 6.53. Figure 6.20 shows the employment index, $Emp\_Index_{(o)}$ for each occupation o on the horizontal axis and the MyAGE_LM percentage change in occupational employment on the vertical axis.

As mentioned earlier, $Emp\_Index_{(o)}$ shows occupational employment with the occupational composition held fixed. In contrast, for MyAGE_LM, the composition of occupational employment adjusts because of the changes in post-tax real wages. For example, for SklAgriFish occupation, $Emp\_Index_{SklAgriFish} = 0.017$ per cent, but $e\_hours\_o_{SklAgriFish} =$

0.012 per cent. The positive deviation in employment for SklAgriFish in the employment index is bigger than those predicted in MyAGE_LM because SklAgriFish experienced the biggest positive deviation in post-tax real wages relative to the other occupational groups ($rwptd\_cat_{SklAgriFish}$ = 0.022 per cent). Because of the large positive deviation in post-tax real wages, employers are not hiring as many SklAgriFish as predicted by the employment index. Similarly, for PlantMachOpr, CraftTraders, Clerical, ServiceSales and ElementOcc, the positive deviations in the employment index are bigger than those in MyAGE_LM. With post-tax real wages of these occupations increasing relative to the other occupations (for example LegSenOffMan), firms are hiring less workers from PlantMachOpr, CraftTraders, Clerical, ServiceSales and ElementOcc, as compared to employment predicted by the index.

For Professional and TechAssProf, the deviations in employment for these occupations are larger in MyAGE_LM as compared to those predicted by the employment index. This is because post-tax real wages for these occupational groups are falling relative to the other occupations. Hence employers are hiring more workers from these occupations.

The exception metioned above is LegSenOffMan. For this occupation, Figure 6.20 shows a point above the 45 degree line and to the right of the vertical. The wage deviation for this occupation is negative, causing employers to substitute towards it. This explains why the LegSenOffMan point is above the 45 degree line. But why do wages fall for LegSenOffMan even though employment rises? The answer is that the wage deviation depends on not just on demand. It also depends on supply. For LegSenOffMan, the wage deviation (-0.00194 per cent) is less negative than those for the other two skilled occupations (-0.0654 per cent for Professionals and -0.00636 per cent for TechAssProf). This stimulates supply for LegSenOffMan which attracts workers that would otherwise would have been in the other two skilled occupations.

From Figure 6.20, we also note that the point SklAgriFish is an extreme observation. This has the potential to unduly influence the regression result in equation (6.54). To check the robustness of (6.54), I repeat the regression without the SklAgriFish observation. This gives:

$$e\_hours\_o_{(o)} = 0.0005 + 0.56 * Emp\_Index_{(o)} \qquad R^2 = 0.90 \qquad (6.54a)$$

From the regression in (6.54a), with the exclusion of SklAgriFish, I still obtain a relatively high R-square. We can see that the percentage deviation in employment for each occupation, $e\_hours\_o_{(o)}$, is around 90 per cent explained by $\text{Emp\_Index}_{(o)}$.

6.7 Conclusion

In this chapter, we have provided an analysis of the results for the MyAGE_LM policy simulation from a 5 per cent cut in Malaysia's motor vehicle tariff rate in 2010. It might be argued that the 5 per cent tariff cut is too small and hence the results obtained only showed a small impact on the economy and the labour market. To adress this issue, I repeated the simulation experiment by scaling up the tariff rate cut to 50 per cent. We can see that scaling up the tariff cut by ten times gives percentage deviation results that are approximately ten times larger. Consequently the results presented in this chapter can be used to represent tariff cuts over a broad range: if we want to know that effect of an *x* per cent tariff cut, then this can be deduced quite accurately by multiplying the results for a 5 per cent tariff cut by *x/5*.

Table 6.3 shows a summary of the long run macro results comparing the 5 per cent and 50 per cent cut in motor vehicle tariffs.

Table 6.3   Summary of Long-Run Macro Effects of Removing Motor Vehicle Tariffs in 2010: 5% Tariff Reduction versus 50% Tariff Reduction MyAGE_LM Simulation Results

	Variable	MyAGE_LM Symbol	Percentage Changes	
			Long Run 5%	Long Run 50%
1.	Employment	emp_hours	0.002649	0.02738
2.	Total labour supply	ls_tot	0.00005	0.001523
3.	Real pre-tax wage rate	real_wage_c	0.0484	0.4876
4.	Average post tax real wage	realw_pt	0.00211	0.01747
5.	Real GDP	x0gdpexp	0.01437	0.14229
6.	Real GNE	x0gne	0.01478	0.14896
7.	Capital stock, rental weights	x1cap_i	0.026	0. 26
8.	Real investment	x2tot_i	0.033	0. 33
9.	Household consumption	x3tot	0.0111	0. 113
10.	Export volumes	x4tot	0.0295	0.295
11.	Import volumes	x0cif_c	0.0296	0. 30
12.	Capital rental	p1cap_i	-0.0043	-0.040
13.	Investment price index	p2tot_i	-0.0088	-0.088
14.	Export price index	p4tot	0.0171	0. 173
15.	Import price index	p0cif_c	0.022	0. 22
16.	GDP price deflator	p0gdpexp	-0.00044	-0.0044
17.	Government price index	p5tot	0.0127	0. 128
18.	Consumer price index	p3tot	0	0
19.	Real exchange rate	p0realdev	0.0225	0.227
20.	Trems of trade	p0toft	-0.0049	-0.0496

From Table 6.3, even though increasing the tariff cut by ten times increases the percentage deviations by around the same magnitude (that is, cutting the tariff rate by 50 per cent), the effect of this tariff cut is still not very significant.

Economists used to thinking in terms of the standard welfare diagram might be surprised that the MyAGE_LM model shows that the response of endogenous variables to a ten-fold increase in the tariff cut should be linear. We re-calculate the efficiency gain from the tariff cut in Figure 6.7a:

Figure 6.7a   Efficiency Gain from Removal of Motor Vehicle Tariff Cut by 50%:

Partial Equilibrium Approach

Tariff Inclusive Price
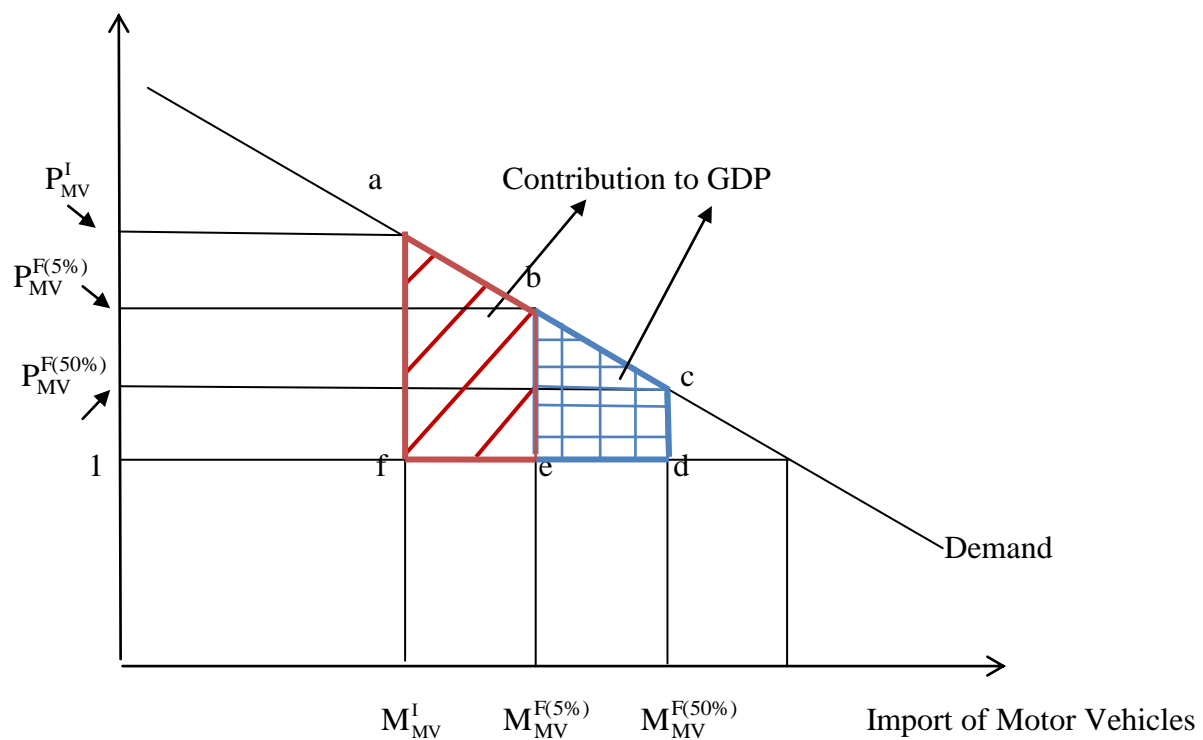
(1)   Efficiency Gain

In Figure 6.7a, the area *abef* is the efficiency gain from a 5 per cent tariff cut. With a 50 per cent cut in tariffs, we do not get an efficiency gain (area *acdf*) that is ten times that of the 5 per cent in tariffs. To see this, we re-calculate the gain in the long run from the 50 per cent cut in motor vehicle tariff using equation (6.33):

$$\text{Efficiency area} = \frac{1}{2}\left[\left(P_{MV}^{I} - 1\right) + \left(P_{MV}^{F} - 1\right)\right] * \left[M_{MV}^{F} - M_{MV}^{I}\right] \qquad (6.33)$$

where

- P_{MV}^{I} is the initial power of tariff for motor vehicle in the basecase forecast period;

- P_{MV}^{F} is the final power of tax;

- M_{MV}^{I} is the quantity of imports of motor vehicles in the base year, 2021, measured by the c.i.f value [$V0CIF^{I}$ (*MotorVehicle*) = RM33323.17 million]; and

- M_{MV}^{F} is the final quantity of imports of motor vehicles in 2021 in the policy calculated as:

  $M_{MV}^{F} = V0CIF^{I}$ (*MotorVehicle*) *(1+percentage change in motor vehicle imports in policy ($x0imp_{mv}$)/100)

  $= 33323.2*(1+3.59/100) = RM34519.5 \text{million}$

From Figure 6.7a, with $P_{MV}^{I} = 1.114$; $P_{MV}^{F} = 1.057$; $M_{MV}^{I} = 33323.17$ and $M_{MV}^{F} = 34519.5$, we can calculate the area *acdf* using equation (6.33):

$$\text{Efficiency area } (acdf) = \frac{1}{2}\left[0.114 + 0.057\right]*\left[34519.5 - 33323.17\right] = 102.3 \qquad (6.33e)$$

The percentage contribution of the efficiency gain from a cut in tariff in the motor vehicle industry to GDP is calculated as:

$$\frac{abcde}{\text{GDP}} = \frac{102.3}{1236972.14}*100 \qquad (6.33f)$$

$$= 0.00827 \text{ per cent} \qquad (6.33g)$$

With consumption being 53.2 per cent of GDP, in the long run, this efficiency gain translates into a consumption increase of around 0.0155per cent (0.0083/0.532). The additional efficiency area from cutting tariffs by 50 per cent is given by the area *bcde*. As calculated earlier, with a 5 per cent cut in motor vehicle tariffs, we obtain an efficiency gain of 0.002 per cent. When we scale up the tariff rate by ten times, we obtain a welfare gain of a magnitude that is less than ten times; 0.0155 per cent instead of 0.02 per cent. Thus, as expected on the basis of the standard welfare diagram, the efficiency gain does not scale up proportionately with the size of the tariff cut. However, the efficiency gain is a small part of the overall welfare picture worked out in Section 6.3. That this small part of the welfare gain does not scale up proportionately does not prevent the total effect from scaling up approximately proportionately.

We re-calculate the other factors contributing to the long run positive deviation in consumption. Results of these re-calculations are given in Table 6.4.

(2)   Terms of Trade Loss

With the 50 per cent tariff cut, the terms of trade (*p0toft*) decreases by 0.0496 per cent, almost precisely ten times the decrease in the 5 per cent tariff cut simulation (see Table 6.3). Consequently, the terms of trade contribution to welfare is almost precisely ten times larger than in the 5 per cent tariff cut simulation, 0.078 per cent rather than 0.0077 per cent.

(3)   Budget effect

After the initial increase in labour taxes in the policy year; 2010, the deviation of the labour tax rate from its basecase forecast is kept at 8.656 per cent for the rest of the simulation period. In only the policy year, the increase in labour taxes balances the loss in tariff revenue from the tariff cut. With the labour tax rate kept constant throughout the simulation period, total government revenue collected from personal income tax is not enough to balance the budget deficit from the tariff revenue loss. This benefits the household and gives a little bit of a tax break from having to pay higher taxes, enabling them to increase consumption. The change in the ratio of government deficit to GDP (*d_def_gdp_r*) is 0.00045. This is translated into an increase of 0.0846 per cent in consumption [(0.00045/0.532)*100].

(4)   *Devaluation effect*

Malaysian household owns assets in foreign currency. In 2021, the baseline assets in foreign currency (FDATT) is (F$)1859562.88 million and households earn 7 per cent (ROIFOREIGN_P = 0.07) on those assets. Also, in the long run, the cut in motor vehicle tariffs caused the exchange rate (*phi*; $Foreign/$RM) to be 0.22 per cent lower than it otherwise would have been. On the baseline assets, this increases interest in Malaysian currency by 0.22 per cent. This is worth (F$) 286.37 million (0.0022*1859562.88 *0.07), and is available for consumption. With consumption being 53.2 per cent of GDP (V0GDPEXP = RM1236972.14 million); this translates into a 0.0435 per cent increase in consumption $\left[\dfrac{286.37}{(0.532*1236972.14)} *100 \right]$.

(5)   *Extra Savings*

The MyAGE_LM results show that Malaysia saves an extra RM5659.1 million throughout the simulation period up to the long run. This is shown as the sum of the change in household saving (*d_Saving_P*) from 2010 to 2021. In 2021, this earns around RM396.14 million (5659.1*0.07). Translating this into a percentage change in consumption gives $\dfrac{\left[\dfrac{396.14}{1236972.14} \right]}{0.53} *100 = 0.06 \, \text{per cent}$

Table 6.4   Contributing Factors to Consumption with 5% versus 50% Tariff Cut

Contributing Factors	5 % Tariff Cut	50 % Tariff Cut
Efficiency Gain	+0.0020	+0.0155
Terms of Trade Loss	-0.0077	- 0.0780
Budget effect	+0.0077	+ 0.0846
Devaluation effect	+0.0037	+ 0.0435
Extra Savings	+0.0060	+ 0.060
Total effect	**+0.00117**	**+0.1256**

From Table 6.4, the five factors give a total contribution to consumption of 0.1256 per cent. This value is close to the long run value of household consumption in the MyAGE_LM simulation results ($x3tot = 0.113$ per cent). Also, from the factors contributing to aggregate consumption calculated above, we can see that when we cut motor vehicle tariffs by 50 per cent (ten times the original 5 per cent cut), the factors contributing to consumption also increases by approximately ten times, with the exception of the efficiency gain. The efficiency gain is 0.0155 per cent, which is less than ten times the efficiency gain from a 5 per cent tariff cut (efficiency gain of 0.0020 per cent). As mentioned earlier, the efficiency gain is a small part of the overall welfare.

An important part of the analyis in this chapter is the use of a BOTE model. The BOTE model in Section 6.3.2 is a powerful tool used to analyze and justify the MyAGE_LM simulations results, especially at the macro level. It provides additional theoretical insights into the policy simulation. For example, we use the BOTE model to show that the percentage reduction in the power of the tax on consumption, T_c is smaller than the percentage increase in the power of the tax on labour TL, that is, we can show that $TL * T_c$ increases. This is used to explain the increase in the marginal product of labour, hence the decrease in aggregate employment in MyAGE_LM. We found that aggregate employment in MyAGE_LM decreases by less than we would expect on the basis of the BOTE model. This led to further investigation which showed that in MyAGE_LM, the decrease in tariffs caused a decrease in the cost of intermediate inputs used in production, whereas in the BOTE model, there are no intermediate inputs used in production. After taking into account the cost of intermediate inputs, we found that the agggregate employment result from MyAGE_LM was accurately explained by the BOTE model.

With a cut in motor vehicle tariffs, there is a decrease in the cost of imported cars, but as discussed in the maro section (Section 6.3), labour costs increase because of higher average pre-tax real wages. The cut in tariff also decreases the price of domestic cars. However, the price of imported motor vehicle decreases relative to the price of domestic motor vehicles, and households substitute away from domestic towards more imported cars. Output of domestic motor vehicles has a negative deviation in the short run which is sustained right up to the long run. The output for industries other than motor vehicles contracts in the short run because of a decrease in employment (and capital is assumed fixed).

Despite real devaluation in the short run, export-oriented industries do not benefit. The effects of real devaluation are offset by higher labour costs. Also, in the short run, the extent of real devaluation is limited by an increase in investment which strengthens the real exchange rate. In the long run, the investment effect on the exchange rate fades away and allows the export industries to gain (with the exception of CrdOilGas because of fixed factor land) from real devaluation. For the interpretation of industry results, we carried out a regression to demonstrate what factors contribute to deviation in domestic output (other than motor vehicle). We found that the deviation in output depended on: trade exposure variable, $TRADE\_EXPOSURE_{(i)}^{New}$, government share $GOV\_SH_{(i)}$, consumption share $CON\_SH_{(i)}^{NEW}$, share of fixed factor land $LAND\_SH_{(i)}$, share of imported motor vehicles in total intermediate cost $IMP\_SH_{(i)}^{MV,INTER}$, and the share of labour in total cost $LAB\_SH_{(i)}$.

In terms of the labour market, a motor vehicle tariff cut had a minor effect on labour supply, as demonstrated in both macro and occupational results. The only occupational group that stands out is the semi-skilled occupational group; SklAgriFish occupation, where average real wages grew the fastest. This occupational group also experiences the biggest decrease in vacancies as workers from other occupational groups were willing to switch occupations and supply labour to this occupation. SklAgriFish occupations do well because there are no workers from this occupational group employed in the motor vehicle industry. Also, a significant proportion of workers in this occupation are hired in the export-oriented industry; Agriculture, and the Agriculture industry sells to FoodBevTob (which does very well in the long run because of real devaluation). The PlantMachOpr occupation also does relatively well because a large share of PlantMachOpr workers are employed in the OthMachEquip industry (very export-oriented and a big winner from tariff cut in the long run).

Skilled occupational groups (LegSenOffMan, Professional and TechAssProf) do not do very well. Workers in these occupations are mostly hired in Education and PubAdmDef sectors in which there is little changes in emplyoment. In general, workers in the semi-skilled and unskilled occupations experience a faster growth in real wages and employment as compared to the workers in the skilled occupations.

We carried out a regression to show that if occupation o is heavily employed in an industry that does well from the tariff cut, then that occupation also does well. We find that the percentage deviation in employment for each occupation, $e\_hours\_o_{(o)}$, is around 98 per cent explained by an employment index, $Emp\_Index_{(o)}$: the employment index shows what would have happened in occupation o if there were no changes in the occupational composition of employment in each industry. To understand why $Emp\_Index_{(o)}$ does not completely explain $e\_hours\_o_{(o)}$ (why is it only 98 per cent), we drew a scatter diagram to extend our understanding of employment results for the nine different occupational groups. As discussed in detail above, the scatter diagram is used to explain why the MyAGE_LM model is more pessimistic about the deviation in employment for occupation o if o is an occupation that gains from the tariff cut and less optimistic about the deviation in employment for occupation o if o is an occupation that loses from the tariff cut.

CHAPTER 7

CONCLUSION

7.1 Overview

This study investigates the effects of a policy-induced reduction in tariffs on Malaysia's labour market, in terms of occupational wages and employment. The policy is simulated as a 5 per cent cut in the tariff rate in the motor vehicle industry.

In order to carry out the analysis on how a cut in motor vehicle tariff affects occupational wages and employment in Malaysia, we used the MyAGE_LM model (adopted from the MyAGE model) for Malaysia. MyAGE_LM is a MONASH-style dynamic computable general equilibrium (CGE) model, used to describe the Malaysian economy. To facilitate the analysis of the tariff cut on the labour market, MyAGE_LM incorporates labour market mechanisms similar to those in Dixon and Rimmer (2003; 2008). In Dixon and Rimmer (2003; 2008), the labour market is modelled to investigate the effects of reducing illegal immigrants. In MyAGE_LM, it is assumed that there are no illegal immigrants. The labour force specification in MyAGE_LM is a simplified version of the specification by Dixon and Rimmer (2003; 2008), where in MyAGE_LM, everyone is assumed to be a Malaysian citizen.

The objectives of the thesis and motivations are presented in the introductory chapter. In Chapter 2, we provided an overview of the Malaysian economy and the evolution of its tariff policy since independence. We note that in the economy-wide approach, there is the lack of occupational wage and employment data for the Malaysian economy to carry out econometric analysis to generate reliable results for analysis. As an attempt to fill this gap, we use a dynamic CGE model of the Malaysian economy. A brief review of the literature on tariffs, wages and employment, along with an introduction to CGE models is also given in the chapter. Chapter 3 describes the theoretical structure of MyAGE_LM in detail, with the introduction of the labour market mechanism. The key features of the model's database and different closure settings are described in Chapters 4 and 5 respectively. Chapter 6 contains a

detailed analysis of the tariff cut simulation, in terms of macro and industry results, along with the nine different occupational results.

In conducting our policy analysis, we considered the model's validity and reliability. In test simulations, MyAGE_LM was found to generate results that were consistent with economic theory. Model validation tests were carried out to ensure the reliability of the model. Among the tests carried are: (i) Homogeneity tests (nominal and real); (ii) GDP identities to ensure equality between the expenditure and income sides of GDP in both nominal and real terms and (iii) The back-of-the-envelope (BOTE) model to explain relevant aspects of the MyAGE_LM model and justify results at the macro level (as demonstrated in the macro results in Chapter 6). The model's performance in these validation tests gives us confidence that the MyAGE_LM model provides reasonable qualitative and quantitative analysis of the policy simulation carried out.

7.2   Policy Implications

The macroeconomic results of the tariff cut in Malaysia's motor vehicle industry indicate that with the government balancing the loss in tariff revenue through increased labour taxes, there would be a small welfare gain measured by the increase in aggregate consumption. In the short run, export-oriented industries do not gain despite real devaluation, but in the long run, these sectors gain.

We find that with the 5 per cent tariff cut on motor vehicle imports, there will be some industry winners and some losers. For all industries including the motor vehicle industry, the cut in tariffs had only minor effects on output, employment and average post-tax real wages. The sectoral results revealed that in general, export-oriented industries would experience a long run increase in output, while labour-intensive industries such as Education and PubAdmDef industries do not expand as much because of higher labour costs. In the short run however, we find that the export sectors do not benefit from the cut in tariffs.

The results of the MyAGE_LM simulations showed some noticeable effects on occupational wages and employment. The occupational group that stands out is the semi-skilled occupational group; SklAgriFish occupation, where post-tax real wages grew the fastest. This

occupational group also experiences the largest decrease in vacancies as workers from other occupational groups are willing to switch occupations and supply labour to this occupation. SklAgriFish occupations do well because no workers in this occupational group are employed in the motor vehicle industry. Also, a significant proportion of workers in this occupation are hired in the export-oriented Agriculture industry, which gains in the long run from a devaluation in the exchange rate. The PlantMachOpr occupation also does relatively well because workers are employed in the OthMachEquip industry (very export-oriented and is a big winner from tariff cut in the long run). As most skilled occupational groups (LegSenOffMan, Professional and TechAssProf) are hired in labour intensive sectors that experienced small changes in real wages and employment, workers in these occupations do not do very well.

From the MyAGE_LM policy simulation, we find that tariff cut has little impact on the labour market. There are only minor changes in average real wages and employment which are not very significant. We also find very a damped labour supply in both the short and the long run. In general, semi-skilled occupations gain relative to skilled and unskilled workers.

7.3 Directions for Future Research

The MyAGE_LM model framework developed in this study opens up a number of possibilities for future research regarding a cut in motor vehicle tariffs and the labour market in Malaysia. There are also numerous avenues as to how the current model can be improved. One of the future research topics from the development of MyAGE_LM is to add the "*cold shower effect*" (Dixon & Rimmer, 2010). According to this hypothesis, if the tariff rates are low in the import-competing industries, then these industries are more productive, as opposed to when tariffs are high. We can measure this effect as a tariff-related wastage of resources in an import competing industry, expressed as a proportion of the resources used[35].

Another future research direction is modelling the labour market with households classified into different categories, e.g., based on income. This can be incorporated into MyAGE_LM to investigate the welfare effects from a cut in tariffs. We can also extend this model by taking into account not only Malaysian citizens, but also foreign labour.

---

[35] A detailed discussion can be found in Dixon and Rimmer (2010).

Finally, incorporating the effects of foreign direct investment (FDI) is another avenue for future research using the MyAGE_LM model. While FDI may bring benefits to the economy in which it is located, it is by no means clear whether everyone will benefit to the same extent or indeed whether some will be better off while others will be worse off. The technologies being introduced through FDI include new management practices and new forms of work organization. The inflowing technology is assumed to be skill-biased because it is mainly adopted in industrialized countries which tend to be skill intensive. The incorporation of new technologies will therefore be accompanied by a change in labour demand in favour of skilled workers. If changes are large enough, this shift can outweigh the reduction in the demand for skilled labour that is predicted by traditional trade theory.

REFERENCES

Acemoglu, D., (1998), 'Why do New Technologies Complement Skills? Directed Technical Change and Wage Inequality', *Quarterly Journal of Economics*, no.113, pp. 1055-1089.

Acemoglu, D., (2002), 'Technical Change, Inequality and the Labour Market', *Journal of Economic Literature*, vol, 40(1), pp. 7-72.

Adams, P. and Dixon, P. (1995), 'Prospects for Australian Industries, States and Regions: 1993-94 to 2001-02', *Australian Bulletin of Labour*, vol. 21, no. 2, pp. 87–108.

Adams, P. D., Horridge, M. J., & Parmenter, B. R., (2002), 'Forecasts for Australian Regions Using the MMRF-Green model', *Australian Journal of Regional Studies*', Vol. 6, Issue 3, pp. 293-322.

Anderson, K., Martin, W., & van der Mensbrugghe, D., (2012), 'Estimating effects of price-distorting policies using alternative distortions databases', in Dixon, P. B & Jorgenson, D. W (eds.), *Handbook of Computable General Equilibrium Modelling,* Elsevier, forthcoming.

Armington, P. A., (1969), 'Theory of Demand for Products Distinguished by Place of Production', IMF Staff Papers no. 27, pp. 488-526.

Athukorala, P. C., (2005),'Trade Policy in Malaysia: Liberalization Process, Structure of Protection, and Reform Agenda', *ASEAN Economic Bulletin*, vol.22, no. 1, pp. 19-34.

Athukorala, P.C., & Menon, J., (1999), 'Outward Orientation and Economic Development in Malaysia', *The World Economy*, vol. 22, no.8, 1119-1139.

Bayar, A., Diao, X., & Yeldan, A. E., (2000), 'An Intertemporal, Multi-region General Equilibrium Model of Agricultural Trade Liberalization in the South Mediterranean NIC's, Turkey and the European Union', Trade and Macroeconomics Division (TMD) Discussion Paper No. 56.

Berman, E., J., Bound, J., & Griliches, Z., (1994), 'Change in the Demand for Skilled Labour within U.S Manufacturing: Evidence from the Annual Survey of Manufacturers', *Quarterly Journal of Economics*, vol.109, pp. 367-398.

Bhagwati, J., & Dehejia, V., (1994), 'Freerer Trade and Wages of the Unskilled: Is Marx Striking Again?', Trade and wage Workshop Conference Paper, American Enterprise Institute Discussion Paper No. 672.

Bovenberg, A. L., (1988), 'The Corporate Income Tax in An Intertemporal Equilibrium Model with Imperfect Mobile Capital', *International Economic Review*, vol. 29, no.2, pp. 321-340.

Burtless, G., (1995), 'International Trade and the Rise in Earnings Inequality', *Journal of Economic Literature*, vol. 33,no. 2, pp. 800 – 816.

Centre of Policy Studies (CoPS), (2010), Malaysian Applied General Equilibrium Model Documentation.

Ching, P.W., (2008), 'Malaysian Economy', Prentice Hall, Malaysia.

Chumacero, R., & Hebbel, K, S., (2004), 'General Equilibrium Models: An Overview', Central Bank of Chile Working Papers No. 37.

Deardorff, A. V., & Hakura, D. S., (1994), 'Trade and Wages-What Are the Questions?', Research Seminar in International Economics Paper No. 8 ,University of Michigan.

Devarajan, S., & Go, D.S., (1996), 'The Simplest Dynamic General- Equilibrium Model of an Open Economy', *Journal of Policy Modeling*, vol. 20, no. 6, pp.677-714.

Diao, X., Rattso, J., & Stokke, H. E., (2002), 'Learning by Exporting and Productivity-Investment Interaction: An Intertemporal General Equilibrium Analysis of the Growth Process in Thailand', European University Institute (EUI) Working Paper No. 2002.25.

Dixon, P. B., (2008), 'Trade Policy Decision Making in Australia and the Development of Computable General Equilibrium Modelling', *Journal of Economic Integration*, vol.23, no.3, pp. 605-630.

Dixon, P. B., & Rimmer, M. T., (2002), Dynamic General Equilibrium Modelling for Forecasting and Policy: A Practical Guide and Documentation of MONASH. North-Holland, Amsterdam.

Dixon, P.B., and Rimmer, M. T., (2003), 'A New Specification of Labour Supply in the MONASH model with an Illustrative Application', *The Australian Economic Review*, vol. 36, no.1, pp. 22-40.

Dixon, P.B., and Rimmer, M. T., (2008), 'Reducing Illegal Migrants in the United States: A Dynamic CGE Analysis, CoPS/IMPACT General Paper G-183, Centre of Policy Studies, Monash University.

Dixon, P.B., and Rimmer, M. T., (2010), 'Optimal Tariffs: Should Australia Cut Automotive Tariffs Unilaterally?', *Economic Record*, vol. 86, no. 273, pp. 143-161.

Dixon, P.B., Johnson, M., and Rimmer, M. T., (2010), 'Economy-wide Effects of Reducing Illegal Immigrants in US Employment ', *Contemporary Economic Policy*, vol. 29, no.1, pp. 14-30.

Dixon, P. D., and Rimmer, M. T., (2012), 'Validation ain CGE Modelling', Handbook of Computable General Equilibrium Modelling (forthcoming), Elsevier.

Dixon, P.B., Parmenter, B. R., Powell, A. A., & Wilcoxen, P.J., (1992), 'Notes and Problems in Applied Equilibrium Economics', Amsterdam: North-Holland.

Dixon, P.B., Parmenter B.R., Sutton, J., & D.P. Vincent (1982), ORANI: A Multisectoral Model of the Australian Economy, North-Holland, Amsterdam.

Dollar, D., & Kraay, A., (2004), 'Trade, Growth and Poverty', *The Economic Journal*, vol. 114, no. 493, pp.22-49.

Freeman R. B., (1995), 'Are Your Wages Set In Beijing?', *Journal of Economic Perspectives*, vol.9, pp. 15-32.

Giesecke, J. A, (2000), 'FEDERAL-F: A Multi-Regional Multi-Sectoral Dynamic Model of the Australian Economy', PhD Thesis, University of Adelaide, Department of Economics.

Giesecke, J. A., & Madden, J. R., (2003), 'A Large-Scale Dynamic Multi-Regional CGE model with an Illustrative Application', RORDS, nol. 15, no.1, pp. 2-25.

Goulder, L. H., & Summers, L. H., (1989), 'Tax Policy, Asset Prices and Growth: A General Equilibrium Analysis', *Journal of Public Economics*, vol. 38, no.3, pp. 265-269.

Haskel, J., & Slaughter, M., (2001), 'Trade, Technology and U.K Wage Inequality', *The Economic Journal*, 111, pp. 163-187.

Horridge, J. M., (2008), ''ORANI-G: A General Equilibrium Model of the Australian Economy', CoPS/IMPACT Working Paper OP-93, Centre of Policy Studies, Monash University.

Johansen, L., (1960), 'A Multi-Sectoral Study of Economic Growth', North-Holland, Amsterdam.

Join Committee of Taxation, (2006), 'Background Information about the Dynamic Stochastic General Equilibrium Model used by the Staff if the Joint Committee on Taxation in the Macroeconomic Analysis of Tax Policy', 52.

Jorgensen, D.W., & Wilcoxen, P.J., (1990), 'Intertemporal General Equilibrium Modelling of US Environmental Regulation', *Journal of Policy Modelling*, vol.12, no. 4, pp.715-744.

Jorgensen, D. W., & Yun, K.Y., (1986), 'Tax Policy and Capital Allocation', *The Scandinavian Journal of Economics*, vol. 88, no.2, pp. 355-377.

Katz, L. F., & Murphy, K., M., (1992), 'Change in Relative Wages, 1963-1987: Supply and Demand Factors', *The Quarterly Journal of Economics*, vol.107, no.1, pp. 35-78.

Khonder, B., Mujeri, M., Raihan, S., (2008), 'Welfare and poverty Impacts of tariff Reforms in Bangladesh: A General Equilibrium Approach', in Cockburn, J., Dealuwe, B., & Robichaud, V., (eds.), Trade Liberalization and Poverty: A CGE Analysis of the 1990s: Experience in Africa and Asia, Poverty and Economic Policy (PEP) Research Network.

Khor, H. E., (1982), 'Income Distribution and Unemployment in Malaysia: A Dual Economy (CGE) Model', PhD thesis, Princeton University.

Leamer, E.E., (1994), 'Trade, Wages and Revolving-Door Ideas', NBER Working Paper No. 4716.

Leamer, E.E., (1996), 'In Search of Stolper-Samuelson Effects on U.S. Wages; National Bureau of Economic Research (NBER) Working Paper, No. 5427.

Liew, L.H., (1984), '"Tops-Down" Versus "Bottom-Up" Approach to Regional Modelling', *Journal of Policy Modelling*, A Social Science Forum of World Issues, Vol. 6, No.3 August. Institute of Applied Economic and Social Research, University of Melbourne.

Madden, J. R., (1990), 'FEDERAL: A Two-Region Multisectoral Fiscal Model of the Australian Economy', PhD thesis, University of Tasmania.

Malakellis, M., (2000), 'Integrated Macro-Micro-Modelling Under Rational Expectations with an Application to Tariff Reform in Australia', Physica-Verlag, Heidelberg, New York.

Malaysia Department of Statistics (2011), Vital Statistics, Malaysia, viewed 24th August 2012,www.statistics.gov.my/portal/download_Buletin_Bulanan/files/BPBM/2012/JUN/05_Population.pdf.

Ministry of Finance Malaysia (2007), 'Estimates of Federal Government's Revenue for the year 2007', MOF.

Malaysia Standard Classification of Occupations (MASCO) (2008), Malaysia Department of Statistics (DOS).

Malaysia Standard Industrial Classification (2008), Malaysia Department of Statistics.

McKibbin, W. J., & Wilcoxen, P.J., (1999), 'The Theoretical and Empirical Structure of the G-Cubbed Model', *Economic Modelling*, vol.16, pp. 123-148.

Parmenter, B.R., & Welsh, A., (2001), 'Historical Simulations with the Monash Regional Equation System', CoPS/IMPACT Working Paper No. OP-95.

Pereira, A. M., & Shoven, J.B., (1988), 'Survey of Dynamic Computable General Equilibrium Models for Tax Policy Evaluation', *Journal of Policy Modelling*, vol. 10, no. 3, pp. 401-426.

Partridge, M., & Rickman, D. S., (1998), 'Regional Computational General Equilibrium Modelling: A Survey and Critical Appraisal', *International Regional Science Review*, vol. 21, no. 3, pp.205-248.

Piazolo, D., (2000), 'Poland's Membership in the European Union: An Analysis with a Dynamic Computable General Equilibrium (CGE) Model', LICOS Centre for Transition Economics Discussion Paper No. 89/2000.

Press, W., Flannery, B., Teukolsky, S., & Vetterling, W., (1986), 'Numerical Recipes', New York, Cambridge University Press.

Powell, A., (1991), 'A Brief Account of Activities 1988 to 1990', IMPACT Project Report No. R-08, February, pp. 50.

Powell, A., & Lawson, A., (1989), A Decade of Applied General Equilibrium Modelling for Policy Work, pp. 241-290 in Bergman, L., Jorgensen David Zalawi E (ed.), General equilibrium Modelling and Economic Policy Analysis, New York: Blackwell.

Sachs, J.D. & Shaz, H., (1994), 'Trade and Jobs in U.S. Manufacturing', *Brookings Papers on Economic Activity,* pp. 1-84.

Schmidt, G., (2003), 'Dynamic of Endogenous Economic Growth', A Case Study of the Romer Model , North Holland.

Summers, L. H., (1981), 'Capital Taxation and Accumulation in a Life Cycle Growth Model', *American Economic Review*, no. 71, pp. 533-544.

Toan, N, M., (2005), 'The Effect of Trade Liberalization on Income Distribution in Vietnam-Dynamic CGE Approach', Ongoing PhD thesis, Economic Development and Policies Department, Kobe University.

United Nations Development Program (UNDP), (2006), 'Malaysia International Trade, Growth, Poverty Reduction and Human Development', UNDP Report.

Wood, A., (1997), 'Openness and Wage Inequality in Developing Countries: the Latin American Challenge to East Asian Conventional Wisdom', *World Bank Economic Review*, vol.11, pp. 33-57.

Yusoff, M. B., Hasan, F. A., & Jalil, S. A., (2000), 'Poverty, Economic Policy and Equity: the Case of Malaysia', Paper presented at an OECD workshop on 'Poverty and income Inequality in Developing Countries: A Policy Dialogue on the Effects of Globalisation', Paris, 30 November – 1 December.

APPENDIX A.1

Derivation of Input Demand and Composite Price Functions from the CES Production Function

Producers' in industry i, ($i \in IND$) choose intermediate input type c ($c \in COM$) from domestic or imported sources $\left(X^{(1)}_{c,s,i}\right)$ to minimise the cost:

$$\sum_{s \in SRC} X^{(1)}_{c,s,i} P^{(1)}_{c,s,i} \qquad\qquad s = dom, imp \qquad\qquad (A1.1)$$

subject to
$$X^{(1)}_{c,i} = CES\left(\frac{X^{(1)}_{c,s,i}}{A^{(1)}_{c,s,i}}\right) \qquad\qquad (A1.2)$$

where

- $X^{(1)}_{c,i}$ is the quantity of composite commodity c used in industry i;

- $X^{(1)}_{c,s,i}$ and $P^{(1)}_{c,s,i}$ are the quantity and purchaser's price of commodity c from source s used in industry i for current production; and

- $A^{(1)}_{c,s,i}$ is a variable that can be used in simulating input-(c,s)-augmenting technological change in i.

For simplicity, the subscript i, c and (1) (which represents industry, commodity and current production respectively) are omitted since the problem is to choose between alternate source s for the same commodity c in industry i. Denote the following:

$$X = X^{(1)}_{c,s} \quad X_s = \frac{X^{(1)}_{c,s,i}}{A^{(1)}_{c,s,i}} \quad P_s = P^{(1)}_{c,s,i} A^{(1)}_{c,s,i} \qquad\qquad (A1.3)$$

Rewrite (A1.1) as:

$$\text{Min } \sum_{s \in SRC}^{2} P_s X_s \tag{A1.4}$$

subject to $X = CES(X_1, X_2)$ \hspace{1cm} (A1.5)

where $CES(X_1, X_2)$ is the CES production function

The Lagrangian function is given as:

$$L = P_s X_s - \Lambda[X - CES(X_1, X_2)] \tag{A1.6}$$

Differentiating the Lagrangian with respect to X_1

$$\frac{\partial L}{\partial X_1} = P_1 - \Lambda\left[-\frac{\partial CES}{\partial X_1}\right] = 0 \tag{A1.7}$$

Differentiating the Lagrangian with respect to X_2

$$\frac{\partial L}{\partial X_2} = P_2 - \Lambda\left[-\frac{\partial CES}{\partial X_2}\right] = 0 \tag{A1.8}$$

Differentiating the Lagrangian with respect to Λ

$$\frac{\partial L}{\partial \Lambda} = X - CES(X_1, X_2) = 0 \tag{A1.9}$$

The CES production function is defined as:

$$X = CES(X_1, X_2) = \left(\sum_{s \in SRC}^{2} \delta_s X_s^{-\rho} \right)^{-\rho-1} \tag{A1.10}$$

where

- $\delta_{c,s,i}^{(1)}$ is a positive parameter; and

- $\rho_c^{(1)}$ has a value $-1 < \rho_c^{(1)} \neq 0$

From (A1.7) and (A1.8),

$$P_s = \Lambda \left(\sum_{s \in SRC}^{2} \delta_s X_s^{-\rho} \right)^{-\rho-1} \tag{A1.11}$$

$$P_s = \Lambda X^{-\rho\left(-1/\rho-1\right)} \delta_s X_s^{-\rho-1} \qquad s = 1,2; \tag{A1.12}$$

Define the following:

$$(1+\rho) = \frac{1}{\sigma} \tag{A1.13}$$

where

- σ is the elasticity of substitution between domestic and imported sources.

Equation (A1.13) becomes:

$$P_s = \Lambda X^{1+\rho} \delta_s X_s^{-\rho-1} \tag{A1.14}$$

Taking percentage form and using (A1.13) gives the following:

$$p_1 = \lambda + \frac{1}{\sigma}(x - x_1) \tag{A1.15}$$

$$p_2 = \lambda + \frac{1}{\sigma}(x - x_2) \tag{A1.16}$$

Multiply equations (A1.14) and (A1.14) by S_s (cost share of commodity c from source s in total cost of the composite commodity c) to give equations (A1.17) and (A1.18):

$$S_1 p_1 = S_1 \lambda + \frac{1}{\sigma}(x - x_1)S_1 \tag{A1.17}$$

$$S_2 p_2 = S_2 \lambda + \frac{1}{\sigma}(x - x_2)S_2 \tag{A1.18}$$

$$\text{where} \quad S_s = \frac{\delta_s^{\frac{1}{1+\rho}} P_s^{\frac{\rho}{1+\rho}}}{\sum_{t \in SRC} \delta_t^{\frac{1}{1+\rho}} P_t^{\frac{\rho}{1+\rho}}} \tag{A1.19}$$

Taking the sum of equations (A1.17) and (A1.18), along with some manipulation by getting rid of λ where $\lambda = \sum_{s \in SRC} p_s$ gives:

$$p_s = \sum_{s \in SRC} S_s p_s + \frac{1}{\sigma}(x - x_s) \tag{A1.20}$$

The rearranging of (A1.20) gives equation (A1.21):

$$x_s = x - \sigma\left(p_s - \sum_{s \in SRC} S_s p_s\right) \tag{A1.21}$$

Taking the percentage change for (A1.3):

$$x = x_{c,i}^{(1)}; \quad x_s = x_{c,s,i}^{(1)} - a_{c,s,i}^{(1)}; \quad p_s = p_{c,s,i}^{(1)} - a_{c,s,i}^{(1)} \tag{A1.22}$$

Substituting (A1.22) into (A1.21):

$$x_{c,s,i}^{(1)} = x_{c,i}^{(1)} - \sigma\left(p_{c,s,i}^{(1)} - \sum_{s \in SRC} S_s p_{c,s,i}^{(1)}\right) + a_{c,s,i}^{(1)} - \sigma\left(a_{c,s,i}^{(1)} - \sum_{s \in SRC} S_s a_{c,s,i}^{(1)}\right)$$

<div align="right">(A1.23)</div>

Equation (A1.23) is equation E_x1 of the TABLO code in excerpt 4.2.

The cost of a unit of composite good c $P_{c,i}^{(1)}$ is

$$\frac{\sum_{S \in SRC} X_{c,s,i}^{(1)} P_{c,s,i}^{(1)}}{X_{c,i}^{(1)}} = P_{c,i}^{(1)}$$

<div align="right">(A1.24)</div>

Taking the percentage change for equation (A1.24)

$$p_{c,i}^{(1)} = \sum_{s \in SRC} S_s \left(p_{c,s,i}^{(1)} + x_{c,s,i}^{(1)}\right) - x_{c,i}^{(1)}$$

<div align="right">(A1.25)</div>

Substituting $x_{c,s,i}^{(1)}$ from (A1.23) gives the following equation:

$$p_{c,i}^{(1)} = \sum_{s \in SRC} S_s p_{c,s,i}^{(1)} + \sum_{s \in SRC} S_s \left[x_{c,s,i}^{(1)} = x_{c,i}^{(1)} - \sigma\left(p_{c,s,i}^{(1)} - \sum_{s \in SRC} S_s p_{c,s,i}^{(1)}\right) + a_{c,s,i}^{(1)} - \sigma\left(a_{c,s,i}^{(1)} - \sum_{s \in SRC} S_s a_{c,s,i}^{(1)}\right)\right] - x_{c,i}^{(1)}$$

<div align="right">(A1.26)</div>

With $\sigma\left(p_{c,s,i}^{(1)} - \sum_{s \in SRC} S_s p_{c,s,i}^{(1)}\right) = 0$ and $\sigma\left(a_{c,s,i}^{(1)} - \sum_{s \in SRC} S_s a_{c,s,i}^{(1)}\right) = 0$ equation (A1.26) is simplified to:

$$p_{c,i}^{(1)} = \sum_{s \in SRC} S_s \left(p_{c,s,i}^{(1)} + a_{c,s,i}^{(1)}\right)$$

<div align="right">(A1.27)</div>

Equation (A1.27) is equation E_p1_s in the TABLO code in excerpt 4.2.

APPENDIX A.2

Household Utility Function

The representative household chooses $X_c^{(3)}$ to maximise a Klein-Rubin utility function of the form:

$$U = \prod_{c \in COM} \left(\frac{X_1^{(3)}}{A_1^{(3)}Q} - \frac{X_{sub,c}^{(3)}}{A_{sub,c}^{(3)}Q} \right)^{\Delta_c} \tag{A2.1}$$

subject to

$$\sum_{c \in COM} \frac{X_c^{(3)}}{Q} P_c^{(3)} = \frac{V_{tot}^{(3)}}{Q} \tag{A2.2}$$

where

- $X_c^{(3)}$ and $P_c^{(3)}$ are quantities consumed and prices paid by the average household of composite good c;

- Q is the number of households in the economy;

- $A_c^{(3)}$ are positive coefficients introduced to allow for changes in tastes;

- $V_{tot}^{(3)}$ is the aggregate household budget, $X_{sub,c}^{(3)}$ is the subsistence quantities of commodity *c* below which consumption cannot fall;

- $A_{sub,c}^{(3)}$ are positive coefficients introduced to allow for changes in tastes towards subsistence part of commodity *c;* and

- Δ_c is a positive parameter with is less than one and $\sum_{c=1}^{k} \Delta_c = 1$.

For simplicity, the following notations are used:

$$X_c = \frac{X_c^{(3)}}{A_1^{(3)}Q} \; ; \; P_c = P_c^{(3)}A_1^{(3)} \; ; \; Y = \frac{V_{tot}^{(3)}}{Q} \; ; \; \gamma_c = \frac{X_{sub,c}^{(3)}}{A_{sub,c}^{(3)}Q}$$ (A2.3)

Rewriting (A2.1) gives the following maximization, where the representative household chooses X_c to maximize:

$$U = \sum_{c \in COM} \Delta_c In(X_c - \gamma_c)$$ (A2.4)

subject to $$\sum_{c \in COM} X_c P_c = Y$$ (A2.5)

The Lagrangian function is written as:

$$L = \sum_{c \in COM} \Delta_c In(X_c - \gamma_c) - \Lambda \left[Y - \sum_{c \in COM} X_c P_c \right]$$ (A2.6)

Taking first order conditions:

$$\frac{\partial U}{\partial X_c} = \frac{\Delta_c}{X_c - \gamma_c} - \Lambda P_c = 0$$ (A2.7)

$$\Rightarrow \frac{\Delta_c}{X_c - \gamma_c} = \Lambda P_c$$ (A2.8)

Thus, $\Delta_c = \Lambda [P_c X_c - P_c \gamma_c]$ (A2.10)

$$\frac{\partial U}{\partial \Lambda} = Y - \sum_{c \in COM} X_c P_c = 0$$ (A2.11)

$$\Rightarrow Y = \sum_{c \in COM} X_c P_c$$ (A2.12)

Summing (A2.11) over c gives the following equation:

$$\sum_{c \in COM} \Delta_c = \Lambda \sum_{c \in COM} [P_c X_c - P_c \gamma_c] = 1$$ (A2.13)

$$\therefore \Lambda = \frac{1}{\sum_{c \in COM} [P_c X_c - P_c \gamma_c]} \tag{A2.14}$$

Substituting (A2.12) and (A2.14) into (A2.10) gives:

$$\Delta_c = \frac{P_c X_c - P_c \gamma_c}{Y - \sum_{c \in COM} P_c \gamma_c} \tag{A2.15}$$

$$P_c X_c = P_c \gamma_c + \Delta_c \left[Y - \sum_{k \in COM} P_k \gamma_k \right] \tag{A2.16}$$

Equation (A2.16) is a Linear Expenditure System, where household expenditure $P_c X_c$ is a linear function of subsistence expenditure $P_c \gamma_c$ and supernumerary expenditure $\Delta_c \left[Y - \sum_{k \in COM} P_k \gamma_k \right]$ on good k. The expression $\left[Y - \sum_{k \in COM} P_k \gamma_k \right]$ is total uncommitted purchasing power remaining after purchasing the minimum, subsistence bundle of goods and Δ_c is the share of good c in total supernumerary expenditure.

From (A2.16),

$$X_c = \gamma_c + \frac{\Delta_c}{P_c} \left[Y - \sum_{K \in Com} P_k \gamma_k \right] \tag{A2.17}$$

$$\Rightarrow \frac{\partial X_c}{\partial Y} = \frac{\Delta_c}{P_c} \tag{A2.18}$$

The household expenditure elasticity is derived as:

$$E_c = \frac{\partial X_c}{\partial Y} \frac{Y}{X_c} \tag{A2.19}$$

$$\Rightarrow \frac{\Delta_c}{P_c} \frac{Y}{X_c} \tag{A2.20}$$

With the average share of expenditure on good i in total household expenditure expressed as:

$$\frac{P_c X_c}{Y} = S_c \tag{A2.21}$$

The household expenditure elasticity can be defined as:

$$E_c = \frac{\Delta_c}{S_c} \qquad (A2.22)$$

From (A2.22),

$$\Delta_c = E_c S_c \qquad (A2.23)$$

$$\Rightarrow \frac{\partial X_c}{\partial Y} \cdot \frac{Y}{X_c} \cdot \frac{P_c X_c}{Y} \qquad (A2.24)$$

$$\therefore \Delta_c = \frac{\partial X_c P_c}{\partial Y} \qquad (A2.25)$$

Δ_c's are marginal budget shares of commodity c in household total expenditure.

Taking the derivative of X_c from (A2.17) relative to price P_k where k can either be the own price of c or the price of other goods $k \in COM$ gives the following:

$$\frac{\partial X_c}{\partial P_k} = -KD_{c,k} \frac{\Delta_c}{P_c} \left(Y - \sum_{K \in Com} P_k \gamma_k \right) - \frac{\Delta_c}{P_c} \gamma_k \qquad (A2.26)$$

where $- KD_{c,k}$ $\qquad (A2.27)$

$\{ KD_{c,k} = 1 \text{ if } c = k \}$ $\qquad (A2.28)$

$\{ KD_{c,k} = 0 \text{ if } c \neq k \}$ $\qquad (A2.29)$

The equation for own and cross price elasticity of demand is given as:

$$\eta_{c,k} = \frac{\partial X_c}{\partial P_k} \frac{P_k}{X_c} \qquad (A2.30)$$

$$= -KD_{c,k} \frac{\Delta_c}{P_c} \frac{Y}{X_c} \frac{\left(Y - \sum_t P_t \gamma_t \right)}{Y} - \frac{\Delta_c}{P_c} \frac{P_k}{X_c} \frac{\gamma_k Y}{Y} \qquad (A2.31)$$

Using the following equations defined as:

$$P_k X_k = P_k \gamma_k + \Delta_k \left[Y - \sum_t P_t \gamma_t \right]$$ (A2.32)

$$E_c = \frac{\Delta_c}{S_c} \quad \text{(from above)}$$ (A2.21)

$$S_c = \frac{P_c X_c}{Y} \quad \text{(from above)}$$ (A2.22)

$$F = \frac{Y}{\left(Y - \sum_t P_t \gamma_t \right)}$$ (A2.33)

and substituting into (A2.31) gives the following:

$$\eta_{c,k} = KD_{c,k} \frac{\Delta_c}{S_c} \frac{1}{F} - \frac{\Delta_c}{S_c} \left(S_c + \Delta_k \frac{1}{F} \right)$$ (A2.34)

$$\therefore \eta_{c,k} = KD_{c,k} \frac{E_c}{F} - E_c \left(S_c + \frac{\Delta_k}{F} \right)$$ (A2.35)

The parameter F is the Frisch parameter, which is the negative inverse of the share of supernumerary expenditure in total household expenditure.

APPENDIX A.3

_____

Example of Eliminating the Quantity Variable Using the Input Demand Equation for Zero Pure Profits in Production

Choose $\left(\dfrac{X_1}{A_1}\right)$ and $\left(\dfrac{X_2}{A_2}\right)$ (A3.1)

to minimize

$$\left(A_1 P_1\right)\left(\frac{X_1}{A_1}\right) + \left(A_2 P_2\right)\left(\frac{X_2}{A_2}\right) \tag{A3.2}$$

subject to a CES function given by:

$$Z = CES\left(\frac{X_1}{A_1}, \frac{X_2}{A_2}\right) \tag{A3.3}$$

where

- X_c and P_c are the quantity and purchaser's price of composite commodity c for current production;

- Z is industry output; and

- A_c is a variable that can be used in simulating input augmenting technological change.

Solving for x_i using the same method as in appendix A1 gives the following input demand equation:

$$x_i - a_i = z - \sigma\left(p_i - \sum_{c \in COM} S_c p_c\right) - \sigma\left(a_i - \sum_{c \in COM} S_c a_c\right) \qquad i = 1,2 \tag{A3.4}$$

Multiplying both sides of equation (A3.4) by the cost share of composite i in total cost S_i gives:

$$S_i x_i - S_i a_i = S_i z - \sigma \left(S_i p_i - S_i \sum_{c \in COM} S_c p_c \right) - \sigma \left(S_i a_i - S_i \sum_{c \in COM} S_c a_c \right) \qquad (A3.5)$$

Summing up over industry i and simplifying:

$$\sum_i S_i x_i - \sum_i S_i a_i = \sum_i S_i z - \sigma \left(\sum_i S_i p_i - \sum_i S_i \left(\sum_{c \in COM} S_c p_c \right) \right) - \sigma \left(\sum_i S_i a_i - \sum_i S_i \left(\sum_{c \in COM} S_c a_c \right) \right)$$

$$(A3.6)$$

$$\therefore z = \sum_i S_i x_i - \sum_i S_i a_i$$

$$(A3.7)$$

where $\sigma \left(\sum_i S_i p_i - \sum_i S_i \left(\sum_{c \in COM} S_c p_c \right) \right) = 0$ and $\sigma \left(\sum_i S_i a_i - \sum_i S_i \left(\sum_{c \in COM} S_c a_c \right) \right) = 0$ \qquad (A3.8)

APPENDIX A.4

_____

Derivation of Government Revenue from indirect Taxes

The equation for the level of tax revenue on commodity flow or production tax on basic value of an industry's output is given as follows:

$$R = B(T-1) \tag{A4.1}$$

where

- R is the tax revenue;

- B is the value of the tax base with B=P*X;

- P is the basic price of the relevant commodity;

- X is the quantity flow; and

- T is the power (one plus the tax rate) of the tax applicable to the basic value of the flow or outputs.

After some rearranging, equation (A4.1) can be redefined as:

$$BT = R + B \tag{A4.2}$$

Taking the ordinary change for (A4.4.1) gives the following:

$$dR = d(T-1).B + d(B).(T-1) \tag{A4.3}$$

$$= B.d(T-1) + (T-1).d(PX) \quad \text{where } B = P.X \tag{A4.4}$$

$$= B.d(T-1) + (T-1)(dP.X + dX.P) \tag{A4.5}$$

$$= B.d(T-1) + (T-1)dP.X + (T-1)dX.P \tag{A4.6}$$

$$100*dR = 100.BT.\frac{dT}{T} + 100.(T-1).PX\frac{dP}{P} + 100.(T-1).PX\frac{dX}{X} \tag{A4.7}$$

where

- $100.\dfrac{dT}{T} = t$; $100.\dfrac{dP}{P} = p$; $100.\dfrac{dX}{X} = x$ (A4.8)

with t, p and x are the percentage change for T, P and X respectively.

Using (A4.8), equation (A4.7) can be re-written as:

$$100*dR = BT.t + (T-1)PX.p + (T-1)PX.x \qquad (A4.9)$$

Using equations (A4.4.1) and (A4.4.2), equation (A4.4.9) is simplified to:

$$100*dR = t(R+B) + T(p+x) \qquad (A4.10)$$

The format used in equation (A4.10) is similar to equations *E_w1tax_csi* to *E_w5tax_cs* of the TABLO code in Excerpt 4.22.

APPENDIX A.5

Relationship between the Price Deflator for GDP, Terms of Trade and Price Deflators for Expenditure Aggregates (Investment and Consumption)

The percentage change in the price of GDP can be written in the form of shares for private consumption, investment, government expenditure, exports and imports of GDP:

$$p_{gdp} = S_c p_c + S_i p_i + S_g p_g + S_x p_x - S_m p_m \qquad \text{(A5.1)}$$

where

- $p_{gdp}, p_c, p_i, p_g, p_x$ and p_m are the percentage changes in the price of GDP, private consumption, investment, government expenditure, exports and imports respectively; and

- S_c, S_i, S_g, S_x and S_m are the shares of private consumption, investment, government expenditure, exports and imports in GDP respectively.

With the assumption that trade is approximately balanced, then

$$S_x = S_m \qquad \text{(A5.2)}$$

Thus, equation (5.1) is simplified to;

$$p_{gdp} = p_{gne} + S_x (p_x - p_m) \qquad \text{(A5.3)}$$

where

$$S_c + S_i + S_g = 1 \quad \text{and} \quad p_c + p_i + p_g = p_{gne} \qquad \text{(A5.4)}$$

Consumption is a dominant component of GNE, hence

$$p_c \approx p_{gne} \tag{A5.5}$$

Equation (A5.5) implies that the percentage changes in investment and government expenditure (p_i and p_g) are not too different to that of the consumer price index (p_c) where $p_c \approx p_i \approx p_g$. Hence equation (A5.3) can be written as:

$$p_{gdp} \approx p_c + S_x(p_x - p_m) \tag{A5.6}$$

Re-arranging equation (A5.6) gives:

$$p_{gdp} - p_c \approx S_x(p_x - p_m) \tag{A5.7}$$

It can be seen from equation (A5.7) that the difference in the percentage changes in p_{gdp} and p_c is a function of the percentage change in the terms of trade $(p_x - p_m)$. Thus, in the BOTE model, (P_{GDP}/P_C) can be interpreted as a function of the terms of trade (TOT), and written as $Y * f(TOT)$. Similarly, it can be shown that P_{GDP}/P_I is a function of the TOT (P_{GDP} includes exports but not imports and P_I includes imports and not exports).

APPENDIX A.6

_____

Calculation of Initial Tariff Rate for Motor Vehicles in 2010

Revenue from motor vehicle tariffs (V0TAR, "MotorVehicle") = 2174.4

C.i.f. value of motor vehicle imports (V0CIF) = 19057.5

Hence tariff rate = 2174.4/19057.5 = 0.114

Calculation of Power of Tariff for Policy Simulation

Initial tariff rate = 0.114 (11.4 per cent)

With a 5% reduction of the final tariff rate is given by 0.114*0.95 = 0.1083. Thus,

Initial power of tariff = 1.114

Final power of tariff = 1.1083

Therefore, to ensure that the tariff rate is decreased by 5% from the basecase in the policy simulation, the percentage change in the power of tariff in the motor vehicle industry, *t0imp* ("*MotorVehicle*") is calculated as:

$$\left[\frac{1.1083}{1.114} - 1\right] * 100 = -0.5117$$

APPENDIX A.7

_____

Derivation of Equation (6.8)

We start with the pre-tax wage equation given in equation (A7a.1):

$$W^{Pre} = P_r.MPL \tag{A7a.1}$$

Rearranging (A7a.1) to find an expression for MPL:

$$MPL = \frac{W^{Pre}}{P_r} \tag{A7a.2}$$

We also know that post-tax wages is given as:

$$W^{Post} = \frac{W^{Pre}}{TL} \tag{A7a.3}$$

Rearranging (A7a.3) to find an expression for W^{Pre}:

$$W^{Pre} = W^{Post}.TL \tag{A7.4}$$

Real wages is defined as:

$$W^{Real} = \frac{W^{Post}}{P_c} \tag{A7a.5}$$

Using (A7a.5), we can write the post-tax wage equation as:

$$W^{Post} = W^{Real}.P_c \tag{A7a.6}$$

Substituting (A7a.6) into (A7a.4) gives the expression for W^{Pre}:

$$W^{Pre} = W^{Real}.P_c.TL \tag{A7a.7}$$

Purchaser's price for a unit of consumption is defined as:

$$P_c = \left(P_r T_{rc}\right)^{\alpha_{rc}} \left(P_v T_{vc}\right)^{\alpha_{vc}} \tag{A7a.8}$$

Equation (A7a.8) can be simplified to:

$$P_c = P_r^{\alpha_{rc}}.P_v^{\alpha_{vc}}.T_c \tag{A7a.9}$$

where

$$T_c = T_{rc}^{\alpha_{rc}}.T_{vc}^{\alpha_{vc}} \tag{A7a.10}$$

Using equations (A7a.7) and (A7a.9), equation (A7a.2) can be written as:

$$MPL = W^{Real}.TL.\frac{P_c}{P_r} \tag{A7a.11}$$

With $P_c = P_r^{\alpha_{rc}}.P_v^{\alpha_{vc}}.T_c$ (A7a.12), equation (A7a.2) becomes:

$$MPL = W^{Real}.TL.T_c.\frac{P_r^{\alpha_{rc}}.P_v^{\alpha_{vc}}}{P_r} \tag{A7a.12}$$

We can define:

$$\alpha_{rc} + \alpha_{vc} = 1 \tag{A7a.13}$$

Thus, the expression for the marginal product of labour (given as function of K/L ratio) is given as:

$$MPL\left(\frac{K}{L}\right) = W^{Real}.TL.\left(\frac{P_v}{P_r}\right)^{\alpha_{vc}}.T_c \tag{A7a.14}$$

which is equation (6.8)

Derivation of Equation (6.9)

Capital rental is given in the following equation:

$$Q = P_r.MPK \tag{A7b.1}$$

Rearranging (A7b.1) to obtain an expression for MPK:

$$MPK = \frac{Q}{P_r} \tag{A7b.2}$$

We define the rate of return on capital as:

$$R = \frac{Q}{P_i} \tag{A7b.3}$$

We can write (A7b.3) as:

$$Q = R.P_i \tag{A7b.4}$$

Substituting (A7b.4) into (A7b.2) gives:

$$MPK = R.\frac{P_i}{P_r} \tag{A7b.5}$$

The purchaser's price for a unit of investment is given as:

$$P_i = \left(P_r T_{ri}\right)^{\alpha_{ri}} \left(P_v T_{vi}\right)^{\alpha_{vi}} \tag{A7b.6}$$

We can simplify equation (A7b.6) to:

$$P_i = P_r^{\alpha_{ri}}.P_v^{\alpha_{vi}}.T_i \tag{A7b.7}$$

Substituting (A7b.6) into (A7b.5):

$$MPK = R.T_i.\frac{P_r^{\alpha_{ri}}.P_v^{\alpha_{vi}}}{P_r} \tag{A7b.8}$$

The average power of tax on a unit of investment is defined as:

$$T_i = T_{ri}^{\alpha_{ri}}.T_{vi}^{\alpha_{vi}} \tag{A7b.9}$$

with

$\alpha_{ri} + \alpha_{vi} = 1$ (A7b.10), the expression for the marginal product of capital (given as function of K/L ratio) is given as:

$$MPK\left(\frac{K}{L}\right) = R.\left(\frac{P_v}{P_r}\right)^{\alpha_{vi}}.T_i \tag{A7b.11}$$

which is equation (6.9).

APPENDIX A.8

Calculation of Capital Share in Returns to Capital and Labour S_K

A CES production function is given by the following equation:

$$Y = A\left[\delta K^{-\rho} + (1-\delta)\rho^{-\rho}\right]^{-\frac{1}{\rho}} \qquad \text{(A8.1)}$$

where

- Y is real GDP;

- A is a technical coefficient allowing for Hicks-neutral technical change;

- K is the capital stock;

- L is labour demand;

- ρ has a value $-1 < \rho \neq 0$; and

- δ is a positive parameter.

We differentiate equation (A8.1) with respect to labour and capital to obtain equations (A8.2) and (A8.3) respectively:

$$\frac{\partial Y}{\partial L} = A\left[\delta K^{-\rho} + (1-\delta)L^{-\rho}\right]^{\left(-\frac{1}{\rho}\right)-1}(1-\delta)L^{-\rho-1} \qquad \text{(A8.2)}$$

$$\frac{\partial Y}{\partial K} = A\left[\delta K^{-\rho} + (1-\delta)L^{-\rho}\right]^{\left(-\frac{1}{\rho}\right)-1}\delta K^{-\rho-1} \qquad \text{(A8.3)}$$

These marginal products are equated to the wage rate and the capital rental rate:

$$A\left[\delta K^{-\rho} + (1-\delta)L^{-\rho}\right]^{\left(-\frac{1}{\rho}\right)-1}(1-\delta)L^{-\rho-1} = W \qquad \text{(A8.4)}$$

$$A\left[\delta K^{-\rho} + (1-\delta)L^{-\rho}\right]^{\left(-\frac{1}{\rho}\right)-1} \delta K^{-\rho-1} = R \tag{A8.5}$$

By multiplying both sides of (A8.4) by L, we find that the returns to labour are given by:

$$WL = A\left[\delta K^{-\rho} + (1-\delta)L^{-\rho}\right]^{\left(-\frac{1}{\rho}\right)-1} (1-\delta)L^{-\rho} \tag{A8.6}$$

Similarly, the returns to capital, R*K, are given by:

$$KR = A\left[\delta K^{-\rho} + (1-\delta)L^{-\rho}\right]^{\left(-\frac{1}{\rho}\right)-1} \delta K^{-\rho} \tag{A8.7}$$

The share of capital in the returns to capital and labour is calculated as:

$$\frac{KR}{LW + KR} = \frac{A\left[\delta K^{-\rho} + (1-\delta)L^{-\rho}\right]^{\left(-\frac{1}{\rho}\right)-1} \delta K^{-\rho}}{\left\{ A\left[\delta K^{-\rho} + (1-\delta)L^{-\rho}\right]^{\left(-\frac{1}{\rho}\right)-1} (1-\delta)L^{-\rho} + A\left[\delta K^{-\rho} + (1-\delta)L^{-\rho}\right]^{\left(-\frac{1}{\rho}\right)-1} \delta K^{-\rho} \right\}} \tag{A8.8}$$

Simplifying equation (A8.8), we obtain:

$$\frac{KR}{LW + KR} = \frac{\delta K^{-\rho}}{\left[(1-\delta)L^{-\rho} + \delta K^{-\rho}\right]} = s_K \tag{A8.9}$$

APPENDIX B.1

_____

Exogenous Variables in the MyAGE_LM Short Run Closure

TECHNOLOGY, IMPORT/DOMESTIC PREFERENCES AND CONSUMER TASTES

Variable	Size/Dimension	Description
f_a1prim	IND	Vector shift prim-fac augmenting tech.change
a1lab	OCC*IND	Labour-saving technical change by type of labour
a1lnd	IND	Land-saving technical change
a1	IND	All-input augmenting technical change, production
a2	IND	All-input augmenting technical change, investment
a3com	COM	Combined change in household tastes
ac	COM	Commodity-c-using technical change
ftwistlk	IND	Labour/capital twist shift
ftwist_src	COM	Import/domestic twist shift
twist_i 1	1	Scalar shift for labour/capital twist
ff_a1prim 1	1	Scalar shift prim-fac. augmenting tech. change
f_a1cap	IND	Shift for capital-saving technical change
f_a1lab_o	IND	Shift for labour-saving technical change

EMPLOYMENT AND WAGES

Variable	Size/Dimension	Description
f1lab	OCC*IND	Wage shift variable, by OCC and IND
real_wage_c	1	Real wage for consumers
real_wage_pt	1	Real post-tax wage to consumers
f1lab_occ	OCC	Occupation specific wage shifter
f1lab_o	IND	Wage shift variable
f_emp_o	1	Shift in eqn that sets the value of emp_hours_o
f_emp_oo	OCC	Shift in eqn that sets the value of e_hours_o_o
f_rwage_o	1	Shift in eqn that sets the value of real_wage_c_o
f_r_wage_oo	OCC	Shift in eqn that sets the value of r_wag_o_o
f_rw_pt_o_o	OCC	Shift in equation that sets value of rwag_pt_o_o
f_rwage_pt_o	1	Shift in equation that sets the value of real_wage_pt_o

d_empadj	1	Determines the speed of direct adjustment of employment
d_empj	OCC	Determines the speed of direct adjustment of employment based on occ
d_emp_sh	1	Set at one to zero out shift variable in E_d_f_empadj
d_emp_sh_o	OCC	Set at one to zero out shift variable in E_d_f_empj

LABOUR SUPPLY

b_pref	OCCP*NONNEW	Preference for working in o
f_hrslrd	OCC	Shift, forecast/policy transfer for supply to work o
d_f_rw_ptd_A	UNEMP	Shift, real returns to unemployment
f_x1labose	1	Used to shock numbers of new entrants
f_x1lab_obs	OCC	Shifter, used in transferring employment o ;

CAPITAL,INVESTMENT AND RATES OF RETURN

x1cap	IND	Start-of-year capital stock
del_r_tot	1	Allows for equal changes in rates of return
d_f_eeqror	1	Scalar shift variable in K-growth/ROR equation
r_inv_cap	IND	Invest/capital ratio shifters
r_inv_cap_u	1	Uniform shifter in I/K ratio
d_rint	1	Real interest rate
fgv2tot_i	1	Uniform shift on govt share of investment in industry
gv2tot	IND	% change in govt share of investment in industry (i)

PUBLIC AND PRIVATE CONSUMPTION,STOCKS

apc_gnp	1	Ratio of total consumption to GNP
f5	COM*SRC	Shift terms for government demands domestic
f5gen	1	Overall shift term for government demands
fx6	COM*SRC	Allows inventory demands to move with demand
f_for_GrantG	1	Shifter on foreign transfers to government
f_for_GrantP	1	Shifter on foreign transfers to households
d_GAssetSale	1	Govt asset sales to private sector (RM m.)
d_DDebtIss	1	Issue of domestic government debt (RM m.)
f_non_tax_rev	1	shifter for government non-tax revenue
f_oth_expend	1	Shifter for other govt expenditure items

fx6	COM*SRC	Allows inventory demands to move with demand

IMPORTS AND EXPORTS

f4pgen	1	Uniform vertical shifter on export demand curves
f4qgen	1	Uniform horizontal shifter for export demand curves
f4ptour	1	Vertical shift in foreign tourism demand
f4pntrad	1	Vertical shift in non-traditional export demands
f4p	COM	Export demand shift, price or vertical
f4q	COM	Export demand shift, quantity or horizontal
f4tax	COM	Export tax shifter
twist_c	1	Scalar shift for import/domestic twist
pf0cif	COM	CIF import prices, \$F
phi	1	Exchange rate, mid year, \$Foreign/\$RM

TAX AND TARIFF RATES

fbens	1	Shifter on government net benefit payments
ft1_i	COM*SRC*CTAX	Tax power shifter, intermediate
ft2_i	COM*SRC*CTAX	Tax power shifter, investment
ft3	COM*SRC*CTAX	Tax power shifter, household
ft4	COM*CTAX	Tax power shifter, export
ft5	COM*SRC*CTAX	Tax power shifter, government
f0tax_csu	1	General sales tax shifter
f0tax_s	COM	General sales tax shifter, by commodity
f1tax_csi	1	Tax shift, intermediate usage
f2tax_csi	1	Tax shift, investment
f3tax_cs	1	Tax shift, household usage
f4tax_c	1	Tax shift, exports
ff_t0imp	1	Scalar shifter on power of tariff
f_tax_k	IND	Shifter on capital tax rate
tax_l_r	1	Rate of tax on labour income
tax_l_r_o	1	Rate of tax on wages in the forecast run
f_tax_inc	1	General income tax shifter
f_t0imp	COM	Vector shifter on power of tariff
t1ptx	PTAX*IND	Tax power, production tax
f_d_tax_k_r	1	Uniform shifter for change in capital income tax
tax_n_r	IND	Rate of tax on land income

FOREIGN LIABILITIES AND PUBLIC SECTOR DEBT

d_NFLG_t	1	Change in net foreign liabilities at start of year, govt
d_NFLP_t	1	Change in net foreign liabilities at start of year, private
d_psd_t	1	Change in domestic govt debt, start of year
flab_shr	1	% change in lab share for foreigners
p_psd_t	1	Domestic govt debt, start of year

NUMERAIRE,LAND,HOMOTOPY AND POPULATION

p3tot_l	1	Lagged CPI, usually CPI in year t-1
q	1	Number of Households
pop	1	Population
del_unity	1	Normally shocked from zero to one
x1lnd	IND	Land

APPENDIX B.2

Swap Statements to Generate Historical Closure

Previously Exogenous   *Exogenous After Swap*

Part 1: Swaps to Implement Assumptions about Inventories and Consumption

delx6... fx6
apc_gnp..apc_gndi

Part 2: Swaps to Activate Year-on-Year Accumulation

x1cap.. d_f_cap_t
r_inv_cap.. d_f_eeqror_j
d_NFLP_t.. d_f_fdP_t
d_NFLG_t..d_f_fdG_t
d_psd_t .... d_f_psd_t
phi... p3tot

Part 3: Exogenize Variables for Which There are Historical Data

ff_a1prim…………………………………. .x0gdpinc
real_wage_c …………………………………..emp_hours
apc_gnp………………………………………..x3tot
f5gen……………………………………….. x5tot
d_f_eeqror……………………………………..x2tot_i
f4pgen………………………………………….x4tot
twist_c…………………………………………...p0toft

Description of Newly Exogenized Variables

Exogenous Variables   *Description*

fx6...allows inventory demand to move with demand
apc_gndi...national propensity to consume out of GNDI
d_f_cap_t... shifter in year-to-year capital growth equation
d_f_eeqror_j.....................................vector shifter in K-growth/ROR equation
d_f_fdP_t..shifter in start-of-year foreign debt equation-private
d_f_fdG_t…………………………shifter in start-of-year foreign debt equation, government
d_f_psd_t..shifter in start-of-year pub-sector
p3tot..consumer price index (CPI)
x0gdpinc……………………………real GDP, income side
emp_hours…………………………aggregate employment, hours
x3tot……………………………..real household consumption
x5tot……………………………..aggregate real government demands
x2tot_i……………………………...aggregate real investment
x4tot………………………………...export volume index
p0toft……………………………..terms of trade

APPENDIX B.3

_____

Swap Statements to Generate Forecast Closure

Previously Exogenous   _Exogenous After Swap_

Part 1: Swaps to Implement Assumptions about Inventories and Consumption

delx6……………………………………….. fx6
apc_gnp…………………………………… apc_gndi

Part 2: Swaps to Activate Year-on-Year Accumulation

x1cap………………………………………..d_f_cap_t
r_inv_cap…………………………………...d_f_eeqror_j
d_NFLP_t…………………………………...d_f_fdP_t
d_NFLG_t…………………………………...d_f_fdG_t
d_psd_t…………………………………...d_f_psd_t
phi…………………………………………. p3tot

Part 3: Exogenize Variables for Which There are Forecast Data

ff_a1prim …………………………………..x0gdpinc
real_wage_c………………………………... emp_hours
f4pgen……………………………………….p0toft

Description of Newly Exogenized Variables

Exogenous Variables   _Description_

fx6..allows inventory demand to move with demand
apc_gndi...national propensity to consume out of GNDI
d_f_cap_t..shifter in year-to-year capital growth equation
d_f_eeqror_j......................................vector shifter in K-growth/ROR equation

d_f_fdP_t..shifter in start-of-year foreign debt equation-private

d_f_fdG_t………………………….shifter in start-of-year foreign debt equation, government

d_f_psd_t...shifter in start-of-year pub-sector

p3tot...consumer price index (CPI)

x0gdpinc…………………………real GDP, income side

emp_hours…………………………aggregate employment, hours

p0toft……………………………..terms of trade

APPENDIX B.4

_____

Swap Statements to Generate Policy Closure

Previously Exogenous   *Exogenous After Swap*

Part 1: Swaps to Implement Assumptions about Inventories and Consumption

delx6...fx6
apc_gnp ....apc

Part 2: Swaps to Activate Year-on-Year Accumulation

x1cap...d_f_cap_t
r_inv_cap ....d_f_eeqror_j
d_NFLP_t ....d_f_fdP_t
d_NFLG_t ....d_f_fdG_t
d_psd_t ....d_f_psd_t
phi..p3tot

Part 3: Activate short-run wage adjustment

real_wage_c..f1lab_i
real_wage_pt...real_wage_pt_o
f_rwage_pt_o..del_f_wage_pt
f1lab_occ ....d_f_w_pt_o
f_rw_pt_o_o ....rwag_pt_o_o
f_emp_o ....emp_hours_o
f_emp_oo ....e_hours_o_o

Part 3a: Labour Supply

f_hrslrd...emp_hourslrdo
f_x1lab_obs ....x1lab_obso

f_a1cap.. a1cap
f_a1lab_o ....a1lab_o

Part 3b: Tariff Simulation

tax_l_r ....ftax_l_imp
f_t0imp t0imp
a1cap ....f_a1cap
a1lab_o ....f_a1lab_o

Description of Newly Exogenized Variables

Exogenous Variables   *Description*

fx6...............................allows inventory demand to move with demand
apc...............................average propensity to consume
d_f_cap_t.....................shifter in year-to-year capital growth equation
d_f_eeqror_j................vector shifter in K-growth/ROR equation
d_f_fdP_t.....................shifter in start-of-year foreign debt equation-private
d_f_fdG_t…………..shifter in start-of-year foreign debt equation, government
d_f_psd_t.....................shifter in start-of-year pub-sector
p3tot............................consumer price index (CPI)
f1lab_i.........................overall wage shifter
real_wage_pt_o...........real post-tax wage to consumers, forecast simulation
del_f_wage_pt............ shifter in post-tax stick-wage equation
d_f_w_pt_o.................relates deviation in CPI-deflated post-tax wages based on occ.in emp.
rwag_pt_o_o ....forecast post-tax CPI delflated wage based on occ in policy simulation
emp_hours_o ....aggregate employment in hours, forecast
e_hours_o_o................employment based on occ, hours, forecast
emp_hourslrdo............transfers labor supply o from forecast to policy
x1lab_obso..................transferring forecast values of employment
a1cap...........................capital-saving technical change
a1lab_o........................labour-saving technical change
ftax_l_imp...................activates equation E_ftax_l_imp
t0imp...........................vector shifter on power of tariff
f_a1cap........................shift for capital-saving technical change
f_a1lab_o....................shift for labour-saving technical change