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Revisiting the Evidence on Capital Openness Using a New Indicator

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Abstract

This thesis explores knowledge in the domain of capital openness by introducing new concepts of *potential capital openness* and *efficiency of capital openness* and measuring them. The new measures are applied to revisit the evidence on the macroeconomic trilemma theory and the income distribution effects of capital openness.

Chapter 2 introduces the concept of potential capital openness, which is the level of capital openness implied by de jure capital openness (DJO—rules and regulations that govern cross-border capital movement) and other economic factors such as its equity and financial market development and trade openness. I compute the levels of potential inward and outward capital openness using Stochastic Frontier Methodology (SFM) and present them as new measures of capital openness. The indices cover data from 1996 to 2013, including 81 countries for outward capital openness and 66 countries for inward openness. Using SFM, I compute the gap between potential capital openness and realised capital openness (ratio of the capital stock to Gross Domestic Product (GDP)). I introduce this gap as the (in)efficiency of capital openness and compute two separate scores measuring the efficiency of inward and outward capital openness, along with measures of potential capital openness itself. I find evidence that trade openness is an essential factor in improving potential capital openness and along with DJO. Tax burden and institutional quality affect the efficiency of both inward and outward capital openness, while human capital and labour market freedom affect the efficiency of inward capital openness.

Chapter 3 re-examines the trilemma theory introduced by Mundell (1963) in the present context of partially open capital accounts using the new indices proposed in Chapter 2. The traditional approach of assigning open or closed capital accounts in testing the trilemma hypothesis is no longer realistic when many countries practise partially open capital account policies (Aizenman, 2019). I test the hypothesis by assigning least, medium and highly open capital account status to countries based on the indices compiled in Chapter 2. I find evidence of a dilemma for both short-term policy rates and long-term bond rates. I extend the analysis to assess the role of macroprudential policies in preserving monetary policy independence. I find evidence

of macroprudential policies helping to turn the dilemma back into a trilemma for short-term policy rates. However, countries with a high level of capital openness continue to face a dilemma in long-term bond rates even with macroprudential policies.

Chapter 4 revisits the evidence on the income distribution effects of capital openness using the new indices developed in Chapter 2. The application of two separate variables representing inward and outward capital openness separately demonstrates new evidence on the effects of the *direction* of capital flows on income distribution. I find that outward capital openness exacerbates inequality in low-, middle- and high-income countries. Meanwhile, inward capital openness reduces inequality in middle- and high-income countries. Further, the intensity of the income distribution effect increases with the level of per capita income.

Declaration

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

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List of Abbreviations

ADV	Advanced income
AME	Average marginal effects
AREAER	Annual Report on Exchange Arrangements and Exchange Restrictions
BC	Battese and Coelli's (1995) model
CCER	Capital control and nominal exchange rate
DEA	Data envelopment analysis
DFO	De facto capital openness
DJO	De jure capital openness
DMU	Decision-making units
FDI	Foreign direct investment
FinMDev	Financial market development/ Credit to Private Sector to GDP
GDP	Gross domestic product
GFC	Global financial crisis
HC	Human Capital
HW	Han and Wei (2018)
ICOM	Inward capital openness model
IMF	International Monetary Fund
InsQ	Institutional Quality
KAOPEN	Chinn and Ito's (2008) index
KLH	Kumbhakar et al. (2014)
LF	Lane and Milesi-Ferretti (2001, 2007)
LFPR	Labour Force Participation Rate

LIDC	Low-income developing countries
LKA	Lien et al. (2018)
LMF	Labour market freedom
LR	Likelihood ratio
LSDV	Least squares dummy variable
MID	Middle income
OCOM	Outward capital openness model
OECD	Organisation for Economic Co-operation and Development
PTE	Persistent technical efficiency
QE	Quantitative easing
RTE	Random technical efficiency
SFA	Stochastic frontier estimation approach
SFF	Stochastic frontier framework
SFM	Stochastic frontier methodology
SMCap	Equity market development /Stock Market Capitalisation to GDP
US	United States
WEO	World Economic Outlook
WDI	World Development Indicators
WID	World Inequality Database

Chapter 1: Introduction

When analysing the macroeconomic effects of capital account openness in the literature, measuring capital openness includes de facto indicators and de jure indices. The former takes the ratio of the actual level of capital stocks or flows to the gross domestic product (GDP) and is called de facto openness (DFO). The latter, which is known as de jure openness (DJO) in the literature, considers the level of rules and regulations in place to limit or promote capital flows.

This thesis aims to advance knowledge of the macroeconomic effects of capital openness by introducing a novel set of indicators to measure it, which I apply to revisit the evidence on the macroeconomic trilemma and the income distribution effects of capital openness. This thesis contributes to the literature on capital account openness in several ways. First, the new indices provide several unexplored aspects of capital openness. Applying the Stochastic Frontier Methodology (SFM) in the capital account context, I introduce the concepts of *potential capital openness* and *efficiency of capital openness*. I measure the level of potential capital openness and the efficiency of capital openness and explore their determinants. Second, I use the new index of overall capital openness to revisit the trilemma hypothesis of Mundell (1963). In the present context of countries having partially open capital accounts, the use of the new index provides more realistic insights into the trilemma hypothesis. I extend the analysis to explore the role of macroprudential policies in trilemma. Third, I apply the capital openness and efficiency indices to explore the income distribution effects of inward and outward capital openness separately. The disaggregation of inward and outward capital openness provides useful policy insights on the effect of the direction of capital flows on income distribution.

In the remainder of this introductory chapter, I present the structure of this thesis with a brief introduction that underpins each chapter's work in this thesis.

1.1 Structure of the Thesis

Chapters 2 to 4 of this thesis contain the core work carried out during my PhD, starting from introducing a new method of measuring capital account openness and then applying the new indices to revisit the evidence on the trilemma theory and income distribution effects of capital openness.

In Chapter 2, I develop a new set of indices to measure capital openness and the efficiency of the capital openness of an economy. Capital does not flow into and out of countries solely according to the DJO level. Economies with the same level of DJO experience different levels of capital flows. I propose that there is an optimal (or potential) level of capital flow or stock implied by the level of DJO and other variables related to the capital openness of an economy. I propose to measure it using the Stochastic Frontier Framework (SFF), which is commonly used in production efficiency literature. Using SFF, the potential inward and outward capital openness of a country at a given time are computed based on its DJO and other economic factors such as its equity market development, financial market development and trade openness. Then, I measure the gap between the potential level of capital openness and realised capital openness (as measured by DFO). I suggest that this gap is the inefficiency of capital openness. I compute two separate scores, measuring the efficiency of inward and outward capital openness, along with continuous measures of capital openness itself. The datasets consist of data from 1996 to 2013 covering 81 countries for outward capital openness and 66 countries for inward openness (both unbalanced panels). The findings from this chapter indicate that, along with rules and regulations to promote or limit capital flows (DJO), trade openness is an essential factor for improving the potential capital openness of an economy. I find evidence that better institutions and a lower tax burden affect the efficiency of both inward and outward capital openness. Human capital and labour market freedom affect the efficiency of inward capital openness.

In Chapter 3, I revisit the evidence on the macroeconomic trilemma, according to which an economy cannot simultaneously achieve all of the following three policy goals—monetary policy independence from a centre country, a fixed exchange rate regime and capital account openness—at a given time, but only two of them. Early studies (e.g., Aizenman, Chinn & Ito, 2016, 2017; Edwards, 2012; Klein & Shambaugh, 2015; Obstfeld, Shambaugh & Taylor, 2005, 2009, 2010) have concluded

the validity of the trilemma framework. However, recent studies (e.g., Cheng & Rajan, 2019; Han & Wei, 2018; Rey, 2015) have found that in the current global environment of highly integrated financial markets, capital controls are more effective than flexible exchange rate regimes to preserve the monetary policy independence of peripheral countries from the centre country, reducing the trilemma to a dilemma. In this study, I use the new index of overall capital openness introduced in Chapter 2, eliminating the unrealistic binary policy choice measurement of capital openness. I revisit the trilemma theory in relation to the current macroeconomic environment of partially open capital accounts. The applicability of sharp policy choices such as fully closed or open capital accounts is rarely observed in the present context, where countries tend to choose less sharp but mixed policy regimes (Aizenman, 2019). Particularly since the financial crisis of the 1990s, emerging market economies have resorted to adopting 'in-between' policy approaches (Aizenman & Pinto, 2013; De La Torre, Yeyati & Schmukler, 2002). Hence, I extend the framework introduced by Han and Wei (2018) to eliminate the binary nature of the capital account openness measurement and enrich the econometric model. Following Han and Wei (2018), I re-evaluate the trilemma framework with respect to both short-term policy rates and long-term bond rates, using an unbalanced panel of 20 countries in the former exercise and 38 in the latter, for the period from 1996 to 2013. I find evidence that flexible exchange rates do not guarantee monetary policy independence from the centre country to peripheral countries with a high level of capital openness (dilemma). Then, I extend the analysis by evaluating the role of macroprudential policies in preserving the trilemma. The implementation of macroprudential policies, which is an avenue that policymakers across the globe have increasingly embraced in the recent decade, appears to be helping to turn the dilemma back into a trilemma with respect to short-term policy rates. Nevertheless, the dilemma concerning long-term bond rates exists, with or without the implementation of macroprudential policies.

Chapter 4 analyses the income distribution effects of capital openness using the new indices of capital openness and efficiency of capital openness introduced in Chapter 2. In contrast to the existing literature, I consider the role of inward and outward capital openness separately. Using an unbalanced panel of 35 countries covering the period from 1996 to 2013, I find that inward and outward capital account openness affect the income distribution of low-, middle- and high-income economies

differently. The findings indicate that outward capital openness exacerbates the income distribution of countries in all three income categories. In contrast, inward capital openness reduces inequality in middle- and high-income countries. The degree of the effect of capital openness on income distribution increases with the per capita income level. The findings from this study provide lessons on the consequences of opening capital accounts too much too soon.

Chapter 5 provides a summary of the thesis, concluding remarks and suggestions for future research.

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Chapter 2: Measuring Potential Capital Openness and the Efficiency of Capital Openness Using the Stochastic Frontier Method*

Abstract

Capital does not flow into and out of countries according to DJO level. Economies with the same level of DJO experience different levels of capital flows. I propose that there is a potential level of capital openness allowed by the level of DJO and other market conditions of an economy, such as equity market development, financial market development and trade openness. In this study, I introduce potential capital openness as a new holistic index of measuring capital openness and compute it using the SFM, which is commonly used in the production efficiency literature. I measure the gap between potential capital openness and realised capital openness as the efficiency of capital openness. I compute separate indices measuring inward and outward capital openness and the efficiency of (inward and outward) capital openness. I find that trade openness is an essential factor in increasing inward and outward potential openness, along with DJO. A lower tax burden, better institutions, human capital and labour market freedom affect the volatility of the efficiency of capital openness.

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2.1 Introduction

Capital openness (or capital integration) is viewed through two lenses in the literature: DJO and DFO. DJO reflects the rules set by authorities that regulate capital inflows and outflows. DJO is always measured through indices, and almost all such indices are based on the data available on the International Monetary Fund's (IMF) Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) database. For example, indices of DJO from Quinn (1997), Quinn, Schindler and Toyoda (2011), Chinn and Ito (2008) and Fernandez, Klein, Rebucci, Schindler and Uribe (2016) are widely used in the literature. DFO is the realised capital flow (or stock). It is commonly measured through the ratio of capital flow (or stock) to the GDP.

The liberalisation of capital accounts through full DJO alone is insufficient to achieve a higher level of realised openness (DFO) or reap the benefits of openness, leading to mixed evidence on the benefits of capital openness. There are various domestic and international market distortions, factors and issues in domestic public governance that affect the realised extent of capital openness (Kose, Prasad & Terrones, 2009; Obstfeld, 2009; Wei, 2018). Evidence on the effect of DJO in DFO is also mixed (e.g., Lane & Milesi-Ferretti, 2003; Magud & Reinhart, 2007; Magud, Reinhart & Rogoff, 2011; Montiel & Reinhart, 1999). Hence, I propose that capital openness is a *process* that includes the regulatory controls that affect capital flows (DJO) and domestic market conditions such as equity market development, financial market development and trade openness. Applying the SFM[1] in the capital account openness context, I propose the concept of *potential capital openness*, which is the maximum achievable capital openness as per the capital openness process.[2] I measure potential capital openness using SFM and present it as a new indicator of capital openness. I find that trade openness increases potential capital openness along with DJO, which indicates the importance of establishing trade with the rest of the world before opening the capital accounts if a country wishes to promote capital flows. Further, using SFM, I measure the *in(efficiency) of capital openness*, which is the gap between potential capital openness and DFO. I find evidence of better institutions and

[1] SFM is used predominantly (but not exclusively) in production efficiency literature. The potential output is modelled through a production frontier. The radial distance between the potential and the realised output is measured as inefficiency.

[2] Capital openness process is analogues to the production process in production efficiency analysis.

a lower tax burden affecting the efficiency of both the inward and outward capital openness process. Human capital and labour market freedom also affect the volatility of the efficiency of inward capital flows. This chapter contributes to the literature on capital openness by introducing and compiling the novel holistic indices of potential capital openness and efficiency of capital openness.

The rest of the chapter is structured as follows. Section 2.2 presents a literature review, and Section 2.3 covers the methodology. Section 2.4 describes the rationale for selecting variables and data. Section 2.5 presents the results, and Section 2.6 concludes.

2.2 Literature Review

The literature review consists of two parts. Section 2.2.1 presents a review of various indices or indicators available for measuring capital openness and capital integration. A literature review on the relationship between DJO and DFO is presented in Section 2.2.2.

2.2.1 Measuring Capital Openness and Integration

The literature uses the term openness and integration interchangeably to refer to both DJO and DFO. In this chapter, I use the term openness to preserve consistency and avoid confusion.

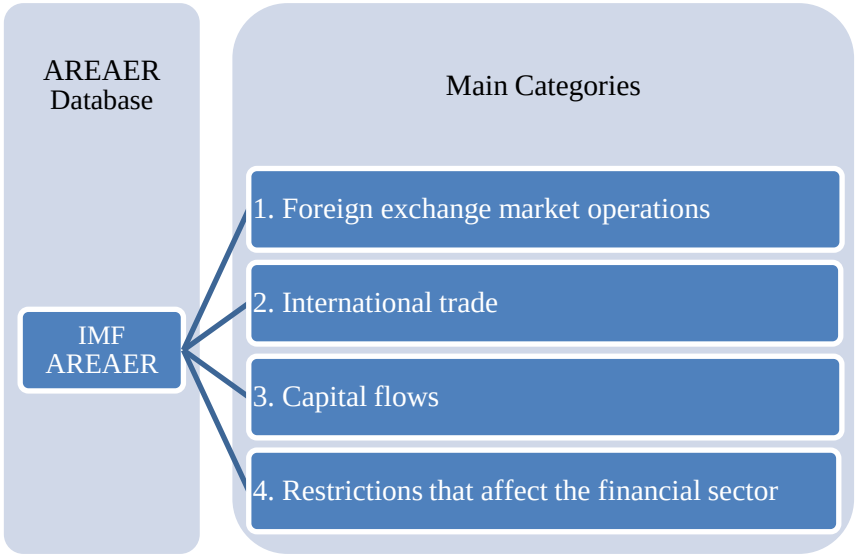
Measuring DJO: IMF AREAER Database

Many DJO indices available in the literature are based on IMF AREAER data. The IMF AREAER database provides a yearly overview of exchange arrangements and restrictions of all IMF's member countries.[3] The database broadly covers information on restrictions on the main categories of capital account operations: 1) foreign exchange market operations, 2) international trade, 3) capital flows and 4) restrictions that affect the financial sector. The database reports information summarised in three key columns. The first key column identifies the subcategories of transactions that come under the main categories listed above. The second key column states 'YES' or 'NO' or no entry, with YES indicating a restriction in place for the

[3] The OECD Code of Liberalisation of Capital Movements reports similar information, but only for OECD countries (OECD, 2011).

respective subcategory of transaction. The third key column provides a narrative on the restriction, if available. The narrative helps to understand the actual effect of the restrictions in place, particularly in the context of Low-Income Developing Countries (LIDCs), as there can be exemptions or limited restrictions that affect only a particular industry or a sector.

Figure 2.1: Main Categories of the IMF AREAER Database



This chapter focuses on the controls on capital transactions (the third category of transactions above). There are 13 subcategories of transactions listed under capital transactions, which are listed in Table 2.1. This level of disaggregation of transactions is available for the period starting from 1996, as the IMF started a new tabular format starting from the AREAER publication of 1997. AREAER publications before 1997 did not provide a disaggregated level of information.

Table 2.1: Subcategories of Transactions Listed Under Capital Transactions of IMF AREAER Data

Sub Category Number	Transaction Type
1	Shares or other securities of a participating nature
2	Bonds or other debt securities
3	Money market instruments
4	Collective investment securities
5	Controls on derivatives and other instruments
6	Commercial credits
7	Financial credits
8	Guarantees, sureties and financial backup facilities
9	Controls on direct investment
10	Controls on real estate transactions
11	Controls on liquidation of direct investment
12	Controls on personal capital transactions
13	Other

De Jure Openness Indices

Although many DJO indices available in the literature are based on IMF AREAER data, they vary in the methodology, coverage and granularity in sub-indices.

Early indices (e.g., Garrett, 1995; Grilli & Milesi-Ferretti, 1995; Klein, 2003) constructed using the tabular format available before 1997 were dummy variables indicators that took the value of 1 if the capital account is open and zero otherwise. Dummy variable indicators cannot reflect the intensity of capital openness, which results in bias in regression estimates (Quinn et al., 2011).

Quinn (1997) and Quinn et al. (2011) followed a different approach by assigning a score based on the author-defined scale to indicate the country-specific restrictions. Unlike the dummy variable approach, these indices provide a measure of the intensity of capital openness. These indices cover data from 1950 to 2009. However, they do not provide information on the direction of capital flows or transaction types.

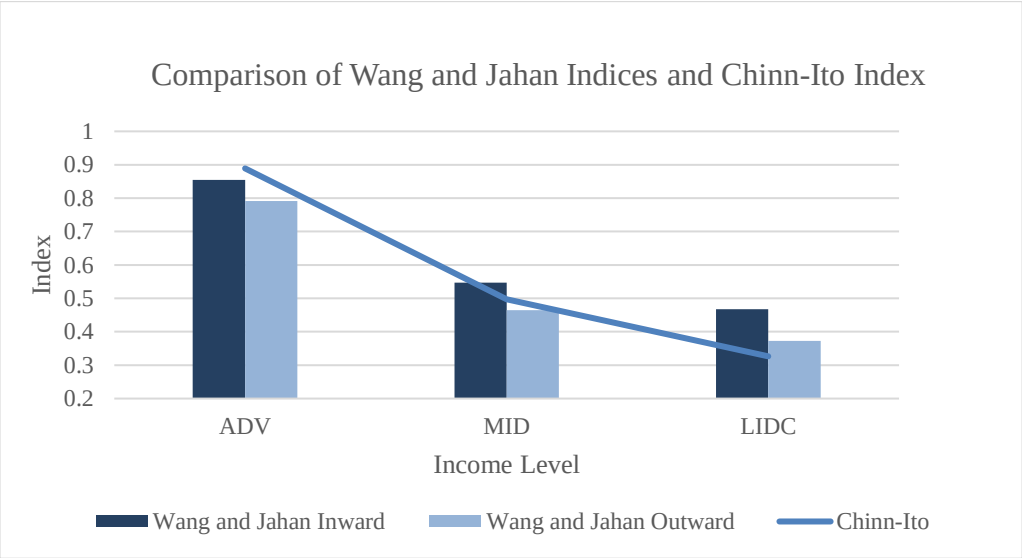
Chinn and Ito's (2008) index (also known as the KAOPEN index; Chinn & Ito [2008]) is the most widely used indicator of capital openness in the literature. The index is constructed based on four variables using principal component analysis. It uses 13 initial variables assessing the openness in AREAER data, covering four

categories of transactions (selected by the authors) specified in the IMF AREAER database. The four categories of transactions reflect the status of the foreign exchange regimes, restrictions on exports proceeds, current account transactions and capital account transactions. The index takes higher values when the economy is more open to cross-border transactions. It is the most popular index in the literature because it has a broader coverage of 182 countries starting from 1970, and it is updated yearly. However, Chinn and Ito's (2008) index provides one value indicating the level of openness. Measuring DJO in terms of the direction of capital flows (inward or outward) and the type of transactions are also crucial to the in-depth analyses of capital flows.

Several new indices are available with disaggregated sub-indices that reflect the direction of capital flows and the type of transaction. All the disaggregated indices are derived by converting the information given in key column 2 of the AREAER database to dummy variables and averaging across types of transactions for each country for each year. Schindler (2009) introduced one of the early such indices. Schindler's index covers six of the 12 types of transactions (listed in Table 2.1) for 91 countries from 1995 to 2005. Fernandez et al. (2016) expanded Schindler's (2009) index by expanding the number of transaction types covered to 10, the number of countries to 100 and the period from 1996 to 2013. Due to the expanded coverage and granularity, the Fernandez et al. (2016) index is widely used in the literature. In a recent study, Jahan and Wang (2017) further expanded the Fernandez et al. (2016) index to 164 countries from 1996 to 2013, covering 12 types of transactions. The Jahan and Wang (2017) index also considers the information given in the key column 3 of the AREAER database (narrative on the restriction) before coding the presence or absence of a restriction into the dummy variable. When aggregating the sub-indices, both the Fernandez et al. (2016) index and the Jahan and Wang (2017) index provide flexibility in aggregating the sub indices based on the three aspects: aggregation of openness based on the direction of the flow (inward/outward), based on residency (resident/non-resident) and based on transaction type (as in 12 transactions listed in Table 2.1). However, all three of these indices suffer from the inherent disadvantage of having a shorter series starting from 1996, as the IMF AREAER database only commenced publishing disaggregated level information in the 1997 report (with data pertaining to 1996).

Identifying the direction of capital flows is essential since many LIDCs are open to inward capital flows but are restricting outward capital flows due to various macroeconomic conditions such as their weaker reserve positions, weaker current account balances, higher external debt servicing costs and weaker domestic currency situations. One value indicating DJO to capital flows is not adequate to express the true DJO of economies. Figure 2.2 compares the variation between inward and outward DJO[4] as per Jahan and Wang's (2017) indices for advanced (ADV), middle-income (MID) and LIDCs. Figure 2.2 shows that the level of openness for inward and outward capital flows differ within each income level, particularly in LIDCs. Countries are more open to inward capital flows than to outward flows as per the DJO indices.

Figure 2.2: Comparison of Inward and Outward De Jure Openness



An alternative method to the indices measuring DJO measures is the DFO method. DFO indicators can be viewed as the outcome of DJO measures. Various DFO indicators have been used in the literature.

Measuring DFO

The rationale for measuring DFO is that, even though a country may be open to capital flows according to the DJO measures, it may not be experiencing large flows of capital or vice versa.

[4] Averages for the period from 1996 to 2013.

DFO is commonly measured through two methods. The first takes the ratio of observed capital flows during a specific period to the GDP. The second method takes the ratio of the stock of capital invested at a given point of time to GDP. In both methods, inward and outward capital flows (or stocks) can be aggregated or considered separately, depending on the analysis.

The most commonly used DFO indicators are the assets or liabilities to GDP ratios (which measure the cumulated flows at a given point of time or the stock variable). The most widely used DFO indicator is based on the work of Lane and Milesi-Ferretti (2001, 2007), which provides a publicly available, yearly updated database (hereafter referred to as the LF database) for different types of assets (or liabilities; e.g., Foreign Direct Investment (FDI), portfolio investment and debt and other types of assets) and total assets (or liabilities). The LF database provides data on the international investment position and its components of 212 countries from 1970 to 2015.

Several reasons are given in the literature for using the stock variables (assets or liabilities) instead of the flow variables (actual capital flows). The first is that the key question addressed in the literature is an assessment of the benefits of international capital integration. These benefits are mostly tied to the values of the holdings of international assets and liabilities but not to the capital flows (Lane & Milesi-Ferretti, 2001). Second, particularly in economic growth regressions, what matters for the economic growth is not the capital flow experienced in a specific period but the stock of capital available (Bussiere & Fratzscher, 2008). Third, annual flow values are volatile and prone to measurement error (Kose, Prasad, Rogoff & Wei, 2009; Lane & Milesi-Ferretti, 2001; Quinn et al., 2011), and the stock variable provides a refined version of the flow variable, which is also free from valuation errors and omissions (Kose, Prasad, Rogoff et al., 2009). Finally, if the research interest is about the risk appetite of countries, the stock variable captures the effect of exchange rate fluctuations, but the flow variable does not (Kose, Prasad, Rogoff et al., 2009).

Capital flow to GDP ratio has also been used in the literature as a yardstick of DFO. For example, Mandilaras and Popper (2009) use the sum of capital inflows and outflows to GDP as a DFO measurement. Iyer, Rambaldi and Tang (2008) and Bussiere and Fratzscher (2008) use the main components of capital inflows and

outflows such as FDI, foreign debt, foreign portfolio investment and other foreign investment separately.

The rationale for using the flow variable in measuring DFO is that it measures the actual flow of capital into or out of a country during a particular period. Measuring capital openness as the capital flow to GDP is equivalent to measuring trade openness as the ratio of total trade (imports plus exports) to GDP.

Other Methods of Measuring Openness

In addition to the DJO and DFO measurement, many other indicators have been used in the literature to measure capital openness. These include measurements based on prices (rates of return), savings and investment ratios, and the portion of the country's stocks available for foreigners. Yu (2014), Edison, Klein, Ricci and Sløk (2004) and Quinn et al. (2011) provide detailed reviews of such methods.

Price-based openness measures are discussed in the early literature (e.g., Levine & Zervos, 1999; Quinn & Jacobson, 1989; Yeyati, Schmukler & Van Horen, 2009). These types of indicators consider the price (rate of return) differential of various instruments (e.g., debt and securities) to measure DFO. Kose, Prasad, Rogoff et al. (2009) explain the rationale for using price-based indicators to measure DFO is the notion of true capital integration being reflected through prices of similar instruments traded across borders, as they are comparable. However, this notion is mainly theoretical, as prices of such instruments carry various disturbance effects, for example, investor appetite towards particular types of assets or markets, the competitiveness of the economy and the global investment environment. Price-based measures fail to distinguish between the direction of capital flows. Kose, Prasad, Rogoff et al. (2009) explain the practical issues of obtaining such data for a large sample of economies (particularly for LIDCs) with respect to a common instrument and some markets not being efficient enough to compare price differentials with other markets. Nevertheless, if data are available and markets are efficient for a particular set of countries, price-based measures of openness can be used in studies that require alternative indices to DFO and DJO indices.

2.2.2 Relationship between DJO and DFO

Several studies (e.g., Ariyoshi et al., 2000; Binici, Hutchison & Schindler, 2010; Bush, 2015; Korinek, 2018; Lane & Milesi-Ferretti, 2003; Magud & Reinhart, 2007;

Magud et al., 2011; Montiel & Reinhart, 1999) explore the relationship between the DJO and DFO using multi-country datasets.

Montiel and Reinhart (1999) find no statistically significant effect of capital controls on capital flows. However, they find that capital controls significantly alter the composition (seen as long term or short term) of capital flows, using a least squares dummy variable (LSDV) regression model and a regression model with instrumental variables.

Ariyoshi et al. (2000) study the effect of capital controls on capital flows using a case study approach for 14 countries. They study both capital inflows and outflows. They find capital inflow controls reducing capital inflows in only two cases (Thailand and Malaysia during 1993 to 1997). They also study the effect of capital outflow controls during financial crises and find that the success of such controls is short-lived.

Using a panel data set of 18 Organisation for Economic Co-operation and Development (OECD) economies from 1978 to 2001, Lane and Milesi-Ferretti (2003) study the effect of capital openness, as measured by an index ranging from 0 to 4 (with the value of 4 representing the highest level of openness), computed using IMF's AREAER data. Their LSDV regression model also concludes that capital openness does not have explanatory power on capital flows. This study also does not distinguish between capital inflows and outflows.

Magud and Reinhart (2007) and Magud et al. (2011) provide surveys of the literature on the effectiveness of capital controls in reducing capital flows and other objectives associated with capital controls: monetary policy independence, relieving exchange rate pressure and altering the composition of capital flows. The surveys include several single and multi-country studies. Overall, the evidence of the surveys is mixed or unclear.

Using the DJO index compiled by Schindler (2009), Binici et al. (2010) assess the effect of legal capital restrictions on realised capital flows (as measured by cumulative flows in the LF database) using a panel dataset of 74 economies from 1995 to 2005. Their results indicate that capital controls affect both the volume and the composition of actual flows. However, the degree of effectiveness of controls varies depending on the type and the direction of capital flows. The level of income,

institutional quality, trade openness, private credit and level of financial development also matter.

In a similar study conducted on a panel of 119 countries from 1980 to 2008, Bush (2015) explores the effect of DJO compiled by Chinn and Ito (2008) on DFO as measured in the LF database. The results imply that legal openness affects different types of capital to different degrees, and the effect depends on the economy's level of development. DJO alone does not result in capital flows. Country-specific characteristics such as financial development, level of corruption and trade openness also matter.

Forbes, Fratzscher and Straub (2015) find that capital controls and macroprudential measures have a little significant effect on capital flows and other macroeconomic variables, based on capital flow management events that took place between 2009 and 2011 in 60 countries to lessen the harmful effects of the global financial crisis.

In summary, the studies exploring the effect of capital openness/controls on capital flows mostly find effects conditional on factors that reflect financial development, trade openness, institutional quality and governance. Prasad, Rogoff, Wei and Kose (2005) state the importance of countries having the absorptive capacity regarding human capital, governance and financial market development, and financial globalisation to benefit.

In the literature, the link between DJO and DFO is analysed predominantly to assess how movements of DJO explain DFO. Inconclusive and mixed evidence indicates a gap between the DJO and DFO due to various factors. This study proposes that this gap is due to inefficiency in the process of promoting capital flow. I develop a measurement of the (in)efficiency of capital openness using SFF (which is a methodology used in measuring the efficiency of a production process). In frontier studies, (in)efficiency is measured as the gap between the potential and the realised output. The potential output is modelled through a production frontier, and the radial distance between the potential and the realised output is measured. I estimate a *capital openness frontier* and measure *potential capital openness* and the *efficiency of capital openness* of economies, which provides a novel perspective on capital openness.

2.3 Methodology

2.3.1 Stochastic Frontier Models

There are two main approaches to measuring the performance of decision-making units (DMUs) in the literature. The first is the parametric approach (e.g., the stochastic frontier estimation approach [SFA]), and the second is the non-parametric approach (e.g., Data Envelopment Analysis [DEA]). Both methods involve measuring the radial distance between the observed point of the DMU and the best practice frontier. The main difference between SFA and DEA is the treatment of the stochastic error. SFA accounts for the stochastic error, while DEA is sensitive to outliers.[5] SFA is the most suitable approach in this study because the DMUs' (countries') performance on capital openness is sensitive to random shocks.

SFMs were first introduced by Aigner, Lovell and Schmidt (1977) and Meeusen and van Den Broeck (1977) in two independent studies. The early literature was focused on cross-sectional data models, whereas the specification of SFMs was later modified to be applied in a panel data set-up. SFMs are applied in any situation where the realised outcome is less than or greater than the potential (or the ideal) outcome due to technical inefficiency (Kumbhakar, Wang & Horncastle, 2015). For example, in a production function context, the potential output is the maximum output attainable as per the technology and inputs available, and the actual or realised output falls below the potential output due to technical inefficiency. Conversely, in a context of a cost function, the ideal cost is the minimum attainable cost, but the actual cost lies above the ideal cost due to technical inefficiency. Although the application of SFMs is mostly seen in the production and cost efficiency context, SFMs are also applied in other areas of research (Kumbhakar, Parmeter & Zelenyuk, 2017; Kumbhakar et al., 2015; Wang, 2016).[6]

[5] For a detailed comparison between SFA and DEA, see Coelli, Rao, O'Donnell and Battese (2005) and Kumbhakar, Wang and Horncastle (2015).

[6] For example, Drake and Simper (2003) uses SFM in assessing English and Welsh police force efficiency. Garg, Goyal and Pal (2017) estimate the efficiency of tax collection in 14 Indian states using SFMs. SFMs have been used assessing the efficiency in sports, in terms of producing wins by Kahane, Shmanske and Lee (2012). In a similar type of study, the efficiency of funded research projects has been analysed by Mutz, Bornmann and Daniel (2017). Hofler and Murphy (1992) use SFMs in labour market search models determine the gap between potential wage and actual wages due to cost of job searching. Hunt-McCool, Koh and Francis (1996) apply SFM in finance with regard to the determination of the level of deliberate under-pricing at Initial Public Offerings from the firm's side.

Panel Data SFMs Used in the Analysis

I use three models to measure potential capital openness and the efficiency of capital openness. All three models enable measuring potential capital openness and the efficiency of capital openness. However, there are some key differences between these three models. The first, Battese and Coelli's (1995) model, accounts for determinants of efficiency. The next model, Kumbhakar, Lien and Hardaker's (2014) model, accounts for country heterogeneity. However, it does not account for determinants of efficiency. The third model, Lien, Kumbhakar and Alem's (2018) model, accounts for country heterogeneity and endogeneity while accounting for the determinants of efficiency. To preserve the originality of the methodology and avoid confusion, equations in the methodology section are presented in a production frontier context (not in a capital openness context). The equations in the results section are presented in a capital openness context.

2.3.2 Battese and Coelli's (1995) Model

The SFM specification used in Battese and Coelli's (1995) model (hereafter referred to as the BC model) is one of the commonly used specifications among the panel data models. The most sought-after property of the BC model is that it accounts for determinants of inefficiency[7] and the estimation of time-varying inefficiency.[8]

The BC model in a production function context is:

$$lny_{it} = \beta_0 + \beta X_{it} + V_{it} - U_{it} \tag{2.1}$$

Where y_{it} denotes the output of the DMU i at time t, X_{it} Represents a $(1 \times K)$ vector of the logarithm of inputs and the time indicator (time trend or time dummy variables), β is a $(K \times 1)$ vector of unknown parameters and U_{it} and V_{it} represent the technical inefficiency and the random noise, respectively, and jointly represent the error term. Here, $V_{it} \sim N(0, \sigma_V^2)$ and $U_{it} \sim N^+(m_{it}, \sigma_U^2)$, where $m_{it} = \delta z_{it}$, with z_{it} is a $(1 \times M)$ vector comprising exogenous variables, and δ is a $(M \times 1)$ vector with unknown parameters. The variables in vector X_{it} are the inputs and other explanatory variables associated with DMU i. The variables in vector z_{it} are explanatory variables associated with the technical inefficiency of production of country i over time.

[7] There is a stream of literature (e.g., Battese & Coelli, 1992, 1995; Kumbhakar, 1987; Pitt & Lee, 1981; Reifschneider & Stevenson, 1991) that incorporate variables outside the production process, but affect the output through the inefficiency in the production process to SFMs.
[8] Some of the early panel data models assumed that the inefficiency is time invariant.

Hence, the noise part of the random error can take either negative or positive values, while the technical inefficiency part of the error term is assumed to be drawn from a truncated Normal random variable.

Given the above specification, the Technical Efficiency of DMU *i* at time *t* is defined as:

$$TE_{it} = \frac{\exp(\beta_0+\beta X_{it}+V_{it}-U_{it})}{\exp(\beta_0+\beta X_{it}+V_{it})} = \exp(-U_{it}) \quad (2.2)$$

TE_{it} is the ratio of the actual output to the best practice production frontier of country *i* at a given time *t* and takes values between zero and one (Coelli, Rao, O'Donnell & Battese, 2005). As TE_{it} measures a percentage deviation, efficiency scores ($TE_{it}\ s$) are comparable across countries and time.

The specification of $U_{it} \sim N^{+}(m_{it}, \sigma_U^2)$, along with $m_{it} = \delta z_{it}$, allows the exploration of the effect of inefficiency determinants. The *'sfpanel'* command in Stata 15 was used to estimate the model parameters.

The production frontier (potential output) is measured as:

$$\widehat{lny_{it}} = \beta_0 + \beta X_{it} \quad (2.3)$$

Nevertheless, the BC specification does not allow to identify the individual DMU specific heterogeneity and efficiency separately. In a recent stream of literature (Badunenko & Kumbhakar, 2017; Colombi, Kumbhakar, Martini & Vittadini, 2014; Kumbhakar et al., 2014; Lien et al., 2018; Tsionas & Kumbhakar, 2014), the authors introduced *'four-component models'*, which allows the separability of the four components: DMU heterogeneity, time-varying efficiency, persistent efficiency and the random noise.[9] Specifications of the early four-component models (e.g., Colombi et al., 2014; Kumbhakar et al., 2014) did not accommodate determinants of inefficiency. Recent models (e.g., Badunenko & Kumbhakar, 2017; Lien et al., 2018) accommodate inefficiency determinants.

2.3.3 Kumbhakar, Lien and Hardeker (2014) Model

The general four-component SFM is written as:

$$lny_{it} = \beta_0 + \beta X_{it} + b_i - \eta_i + V_{it} - U_{it} \quad (2.4)$$

[9] These models are also called generalised true random effects (GTRE) models, as they capture persistent inefficiency in addition to the unobserved heterogeneity of DMUs.

As in the BC model, y_{it} denotes the output of the DMU i at time t, X_{it} represents a $(1 \times K)$ vector of the logarithm of inputs and the time indicator (time trend or time dummy variables), β is a $(K \times 1)$ vector of unknown parameters, η_i captures the persistent inefficiency, U_{it} represents the random inefficiency, b_i captures the unobserved heterogeneity of DMUs, and V_{it} represents the random noise.

Kumbhakar et al.'s (2014) model (hereafter referred to as the KLH model) defines the four components as per the following assumptions:

V_{it} is i.i.d. and $N(0, \sigma_V^2)$,

U_{it} is i.i.d. and $N^+(0, \sigma_U^2)$, which means $E(U_{it}) = \sqrt{2\sigma_U^2/\pi}$

b_i is i.i.d and $N(0, \sigma_b^2)$ and

η_i is i.i.d. and $N^+(0, \sigma_\eta^2)$, (which means $E(\eta_i) = \sqrt{2\sigma_\eta^2/\pi}$).

The estimation of the KLH Model involves a multi-step procedure.

Step 1: Rewrite equation (2.4) as

$$lny_{it} = \alpha_0^* + \beta X_{it} + \alpha_i + \epsilon_{it} \tag{2.5}$$

Where

$$\alpha_0^* = \beta_0 - E(\eta_i) - E(U_{it}) \tag{2.6}$$

$$\alpha_i = b_i - \eta_i + E(\eta_i) \quad \text{and} \tag{2.7}$$

$$\epsilon_{it} = V_{it} - U_{it} + E(U_{it}) \tag{2.8}$$

Step 2: Estimate the equation (2.5) using the standard random effect panel regression and obtain predicted values for α_i and ϵ_{it}.

Step 3: Using the estimates of ϵ_{it} obtained in Step 2, estimate the equation (2.8) using standard SFM techniques based on the assumptions V_{it} is i.i.d. $N(0, \sigma_V^2)$ and U_{it} is i.i.d. and $N^+(0, \sigma_U^2)$, (which means $E(U_{it}) = \sqrt{2\sigma_U^2/\pi}$). The standard practice in multi-step procedures is to ignore the differences between the actual and predicted values of ϵ_{it}. This procedure gives estimates of U_{it}, which is the random

part of technical inefficiency.[10] Random Technical Efficiency (RTE) can be obtained using equation (2.2) defined in the BC model, $RTE_{it} = \exp(-U_{it})$.

Step 4: Estimate the equation (2.7) using the estimates of α_i obtained in Step 2 based on the assumptions that b_i is i.i.d and $N(0, \sigma_b^2)$, and η_i is i.i.d. and $N^+(0, \sigma_\eta^2)$, (which means $E(\eta_i) = \sqrt{2\sigma_\eta^2/\pi}$). This makes it possible to obtain the estimates of the persistent component of technical inefficiency, η_i. Persistent Technical Efficiency (PTE) can be obtained using $PTE_{it} = \exp(-\eta_i)$, as in the BC model.

Step 5: Overall Technical Efficiency can be estimated by:

$$OTE_{it} = PTE_{it} \times RTE_{it} \tag{2.9}$$

The KLH model does not accommodate the determinants of inefficiency.

2.3.4 Lien, Kumbhakar and Alem's (2018) Model

The KLH model assumes that all four components (η_i, b_i, U_{it} and V_{it}) are homoscedastic. As per the distributional assumptions of the four components, the inclusion of determinants of inefficiency (as in the BC model) is not possible in the KLH model. Lien et al.'s (2018) model (hereafter referred to as the LKA model) relaxes the assumption of homoscedasticity of U_{it} assuming that $U_{it}(z_{it}) \sim N^+\left(0, \sigma^2_{U(z_{it})}\right) = N^+(0, \exp(\delta_{U0} + \delta_{Uit} z_{it}))$. While the KLH model accounts for country heterogeneity, the LKA model addresses both endogeneity in the frontier specification and country heterogeneity. The heterogeneity is dealt with in the same way as in the KLH model, whereas the endogeneity is solved by assuming that the production function is linearly homogeneous in inputs.[11]

Assume a production function of the form:

$$Y_{it} = f(X_{it}) A_{it} \tag{2.10}$$

Where Y_{it} is the output, X_{it} is a vector of inputs and $A_{it} = e^{v_{it} - u_{it}}$, where v_{it} is the stochastic noise and u_{it} is inefficiency. Assuming the production function is Cobb–Douglas and is homogeneous in degree 1 in inputs, the production function can be rewritten as:

[10] Kumbhakar et al. (2015) provide Stata commands for the estimation of KLH Model using the multi-step procedure.
[11] The particular model specification used in Lien et al. (2018) is linearly homogeneous in inputs.

$$ln\frac{y_{it}}{x_{1t}} = \beta_0 + \sum_{j=2}\beta_j ln\left(\frac{x_j}{x_1}\right)_{it} + lnA_{it} \quad (2.11)$$

Lien et al. (2018) show that, irrespective of how lnA_{it} is specified, the equation (2.11) solves the endogeneity problem because input ratios are independent of the error term with $\frac{dlny}{dlnx_j} = \beta_j$. In other words, regressors in the equation (2.11) are independent of the error term.[12]

Building on the equation (2.11), by adding the time trend and decomposing lnA_{it} into $lnA_{it} = b_i - \eta_i + V_{it} - U_{it}(z_{it})$, the model can be rewritten as:

$$ln\tilde{y}_{it} = \beta_0 + \sum_{j=2}\beta_j ln\tilde{x}_{it} + \beta_t t + b_i - \eta_i + V_{it} - U_{it}(z_{it}) \quad (2.12)$$

Where $\tilde{y}_{it} = \frac{y_{it}}{x_{1t}}$, $\tilde{x}_{it} = \frac{x_{it}}{x_{1t}}$ with $i \neq 1$, t denotes the time trend and

$b_i - \eta_i + V_{it} - U_{it}(z_{it})$ is jointly represented through lnA_{it} in the equation (2.11). Here, $b_i, \eta_i \; and \; V_{it}$ are unobserved heterogeneity, persistent efficiency and error term, as specified in the equation (2.4). U_{it} is now specified as a function of z_{it}, where z_{it} is a vector of determinants of inefficiency.

The unobserved heterogeneity, b_i can be fixed or random and assumed to be i.i.d with zero mean. The random error, V_{it}, is assumed to be i. i. d. and $N(0, \sigma_V^2)$, where σ_V^2 is a constant. The persistent component of inefficiency, η_i, is assumed to be i. i. d. and $\mathrm{E}(\eta_i) = a$, where a is a constant. The mean of the random inefficiency, $E(U_{it}(z_{it})) = g(z_{it}) \geq 0$.

The equation (2.12) can be rewritten as:

$$ln\tilde{y}_{it} = h(z_{it}) + \beta' ln\tilde{x}_{it} + a_i + \epsilon_{it} \quad (2.13)$$

Where

$\beta' ln\tilde{x}_{it} = \sum_{j=2}\beta_j ln\tilde{x}_{it} + \beta_t t$ with β' is a vector of coefficients, and $\tilde{x}_{it}$ is a vector of inputs and time trend t,

$$h(z_{it}) = \beta_0 - a - g(z_{it}), \quad (2.14)$$

$$a_i = b_i - (\eta_i - a) \text{ and} \quad (2.15)$$

$$\epsilon_{it} = V_{it} - (U_{it}(z_{it}) - g(z_{it})) \quad (2.16)$$

[12] For the proof, see Lien et al. (2018).

Note that $E(a_i) = 0$ and $E(\epsilon_{it}) = 0$.

The equation (2.13) is a partial linear model for random effects panel data. The equation can be estimated in a two-step procedure.

First, by taking the conditional expectation of each side of the equation (2.13) with respect to z_{it}:

$$E(ln\tilde{y}_{it}/z_{it}) = E((h(z_{it}) + \beta' ln\tilde{x}_{it} + a_i + \epsilon_{it})/z_{it})$$

$$= E(h(z_{it})/z_{it}) + \beta' E(ln\tilde{x}_{it}/z_{it}) + E(a_i/z_{it}) + E(\epsilon_{it}/z_{it})$$

$$= h(z_{it}) + \beta' E(ln\tilde{x}_{it}/z_{it}) \quad (2.17)$$

Second, by subtracting (2.17) from (2.13), the following equation is obtained:

$$ln\tilde{y}_{it} - E(ln\tilde{y}_{it}/z_{it}) = h(z_{it}) + \beta' ln\tilde{x}_{it} + a_i + \epsilon_{it} - (h(z_{it}) + \beta' E(ln\tilde{x}_{it}/z_{it}))$$

$$= \beta'[ln\tilde{x}_{it} - E(ln\tilde{x}_{it}/z_{it})] + a_i + \epsilon_{it} \quad (2.18)$$

The conditional means $E(ln\tilde{y}_{it}/z_{it})$ and $E(ln\tilde{x}_{it}/z_{it})$ can be estimated non-parametrically using the '*npregress*' command in the Stata package. Using the estimates of conditional means, the equation (2.15) can be rewritten as the following linear random effects panel data model:

$$y_{it}^* = \beta' x_{it}^* + a_i + \epsilon_{it} \quad (2.19)$$

Where $y_{it}^* = ln\tilde{y}_{it} - E(ln\tilde{y}_{it}/z_{it})$ and $x_{it}^* = ln\tilde{x}_{it} - E(ln\tilde{x}_{it}/z_{it})$.

For a detailed theoretical explanation, see Lien et al. (2018).

The estimation procedure of the LKA model is a stepwise process.

Step 1: Once y_{it}^* and x_{it}^* are obtained, equation (2.16) can be estimated using the standard panel data random effects model, and the consistent parameter estimates of β' and the values of a_i and ϵ_{it} can be obtained.

Step 2: Using the predicted values of ϵ_{it} of equation (2.18), and ignoring the difference between the actual and predicted values of ϵ_{it}, as the estimates from Step 1 are consistent, estimate equation (2.16) (which is $\epsilon_{it} = V_{it} - (U_{it}(z_{it}) - g(z_{it}))$), using standard SFM techniques. It is assumed that V_{it} is i.i.d. $N(0, \sigma_V^2)$ and U_{it} is i.i.d. and $N^+(0, \sigma_U^2(z_{it}))$, (which means $E(U_{it}(z_{it})) = \sqrt{2\sigma_U^2(z_{it})/\pi} \equiv g(z_{it})$). Here, the dependent variable is ϵ_{it} and the regression part is $g(z_{it})$. As $g(z_{it})$ is related to the variance of $U_{it}(z_{it})$, to ensure the non-negativity of the variance, it is

parameterised as $\sigma_U^2(z_{it}) = \exp(\delta_0 + \delta' z_{it})$. This procedure gives estimates of $U_{it}(z_{it})$, which is random technical inefficiency, and the parameter estimates of δ'. RTE can be obtained using equation (2.2) defined in the BC model, $RTE_{it} = \exp(-U_{it}(z_{it}))$.

Step 3: Using the predicted values of a_i from Step 1 and ignoring the difference between actual and predicted values of a_i, as they are consistent estimates, estimate equation (2.15) ($a_i = b_i - (\eta_i - a)$) using standard SFM techniques. It is assumed that b_i is i.i.d and $N(0, \sigma_b^2)$ and η_i is i.i.d. and $N^+(0, \sigma_\eta^2)$, (which means $E(\eta_i) = \sqrt{2\sigma_\eta^2/\pi}$). Hence, the persistent component of technical inefficiency, η_i is obtained. PTE can be obtained using $PTE_{it} = \exp(-\eta_i)$.

Step 4: As in the KLH model, the Overall Technical Efficiency can be estimated by:

$$OTE_{it} = PTE_{it} \times RTE_{it} \tag{2.9}$$

Table 2.2: Summary of the Specifications of the Stochastic Frontiers Used

	BC Model	KLH Model	LKA Model
Error term (ε_{it})	$\varepsilon_{it} = V_{it} - U_{it}$ V_{it} i.i.d. $N(0, \sigma_V^2)$ and $U_{it} \sim N^+(\delta z_{it}, \sigma_U^2)$	$\varepsilon_{it} = b_i - \eta_i + V_{it} - U_{it}$ b_i i.i.d and $N(0, \sigma_b^2)$, η_i i.i.d. and $N^+(0, \sigma_\eta^2)$, V_{it} i.i.d. and $N(0, \sigma_V^2)$ and U_{it} i.i.d. and $N^+(0, \sigma_U^2)$	$\varepsilon_{it} = b_i - \eta_i + V_{it} - U_{it}(z_{it})$ b_i i.i.d and $N(0, \sigma_b^2)$, η_i i.i.d. and $N^+(0, \sigma_\eta^2)$, V_{it} i.i.d. and $N(0, \sigma_V^2)$ and U_{it} i.i.d. and $N^+(0, \sigma_U^2(z_{it}))$ $\equiv N^+(0, \exp(\delta_0 + \delta' z_{it}))$
Determinants of Inefficiency (δz_{it})	Yes. Mean of $U_{it} = \delta z_{it}$	No	Yes. Variance of $U_{it} = \exp(\delta_0 + \delta' z_{it})$

Source: Lien et al. (2018) for KHL and LKA model columns.

2.4 Variables Used and Data

To match the production function aspects to the capital openness aspects, variables were selected, matching the output to the outcome variable in the capital

openness context. Input variables and inefficiency determinants are also determined and selected, matching the context of the study.

Dependent Variable (Output): The output (or the outcome) variable in the context of this study is the realised capital openness. Stock measures of capital openness are used for the analysis. Outward capital openness is measured by the ratio of total external assets to GDP in the outward capital openness model. The ratio of total external liabilities to GDP (which is the stock measure of DFO) is used as the outcome variable in the inward capital openness model.

Inputs: The main input variables used in both inward and outward openness models are the inward and outward DJO indices, developed by Wang and Jahan (2017). In addition to the DJO, economies must have other financial and investment infrastructure to mobilise cross-border capital flows, such as domestic financial market development (Brafu-Insaidoo & Biekpe, 2014; Eryigit & Dulgeroglu, 2015; Kaminsky & Schmukler, 2008; Prasad et al., 2005) and equity market development or the depth of the equity markets (Campion & Neumann, 2004; Kaminsky & Schmukler, 2008; Montiel & Reinhart, 1999; Prasad et al., 2005). Domestic financial and equity markets act as vehicles for investments to flow effectively to suitable destinations within the country. Hence the development of such markets provides an ease for both investors and borrowers. The size of external trade or the trade openness of the economy is also linked with capital openness (Aizenman, 2004, 2008). Forbes (2002) finds that trade directly links stock market returns in countries. This indicates a link between trade and investment (both domestic and foreign) in an economy. International trade between two countries provides means of establishing familiarity and trust before embarking on investment ventures. Input variables selected directly affect DFO, which is the outcome variable.

Determinants of inefficiency: Determinants of efficiency are the factors outside the process that we consider but affect the outcome of the process (Coelli et al., 2005). Based on a survey of the literature on the effectiveness of capital openness measures adopted by economies. Du, Nie and Wei (2017) argue that domestic labour market rigidities deter investment, as it becomes expensive to hire and fire workers. According to their findings, a flexible labour market will ensure a higher level of employment when the capital account is open to inward investment. Conversely, labour market rigidities will lead to capital outflows when the capital account is open, as investing in

domestic markets is expensive for local investors. Institutional quality and governance are also important factors to reap the benefits of financial globalisation (Binici et al., 2010; Mishkin, 2006; Prasad et al., 2005; Wei, 2018). Wei (2018) summarises the recent literature on how weak domestic institutions lead to the misallocation of resources and lower productivity, which result in capital flight and deterrence of foreign capital. Many studies (e.g., Bovenberg, Anderson, Aramaki & Chand, 1990; Edgerton, 2010; Feldstein, 1994; Razin & Sadka, 1991) discuss the effect of corporate income tax on international capital flows. The findings of these studies reveal that a higher tax burden on corporate income deters investors because it narrows their profit margins. Finally, for inward foreign investments to grow, the economy must have the absorptive capacity in the labour force and human capital (Prasad et al., 2005). Human capital and labour availability are vital factors that foreign investors consider when deciding on their investment destinations.

Table 2.3 lays out the variables used in the analysis for inward and outward models. All variables selected, except for Tax Burden, Human Capital and Labour Force Participation have statistically significant correlation coefficients at 5% significance level. This further establishes the choice of variables with significant correlation coefficients. However, according to literature, the level of tax burden, the level and the quality of labour availability also affect capital flows. The insignificant correlation coefficients could be due to the fact that these variables influence capital openness through its efficiency. Hence it is prudent to include these three variables in the efficiency component of the model. All variables used are log-transformed. The variables to be included in the openness frontier and inefficacy effects were decided considering the literature and the correlation coefficients with the dependent variable (see Table 2.4).

Table 2.3: Variables Used in Openness Models

	Variable	Indicator Used *(Abbreviation used is in parentheses)*
Dependent Variable	Observed openness*	Total External Assets Stock to GDP
Frontier variables	DJO	DJO index *(KOIndex)*
	Equity market development	Stock Market Capitalisation to GDP *(SMCap)*
	Financial market development	Credit to Private Sector to GDP *(FinMDev)*
	Trade Openness	Total Trade to GDP *(Trade)*
	time trend	time trend *(time)*
Inefficiency Effects	Tax Burden	Tax on Corporate Sector to GDP *(TaxBurden)*
	Institutional Quality	Institutional Quality Index *(InsQ)*
	Labour Market Freedom	Labour Market Freedom Index *(LMF)*
	Human Capital **	Human Capital Index *(HC)*
	Labour Force Participation **	Labour Force Participation Rate *(LFPR)*

*- Total external assets for the outward openness model and total external liabilities for the inward openness model
** - only in the inward openness model

Total external assets and liabilities data are sourced from the IMF database. DJO inward and outward indices are from Jahan and Wang (2017). Stock market capitalisation, credit to the private sector, total trade and labour force data are extracted from the World Bank's World Development Indicators (WDI) database. Institutional quality index data are extracted from Worldwide Governance Indicator (WGI) dataset which is made available by the World Bank.The labour market freedom index[13] is extracted from the economic freedom index data. The tax burden on the corporate sector to GDP is extracted from the United Nations Government Revenue Dataset. Human Capital Index is extracted from Penn World Tables. A constant was added to DJO Indices and Institutional Quality Index before log transformation to avoid

[13] The labour market freedom index represents the degree of freedom enjoyed by employers with respect to minimum wages, rigidity in working hours, ability to hire additional workers, firing redundant workers, legally mandated notice period and mandatory severance pay.

negative values and zeros in log transformation, following Osborne (2002) and Kline (2015).[14]

The data used in the sample for the outward openness models consist of 1,441 observations from 81 countries observed from 1996 to 2013. The sample for inward openness models consists of 1,171 observations from 66 countries for the same period. Both datasets are unbalanced panels.

[14] Adding the constant shifts the values of indices above zero.

Table 2.4: Correlation Coefficients Between the Dependant Variable and Other Variables in the Model

Variables	Inward DJO Index	Outward DJO Index	Financial market development	Equity market development	Trade Openness	Institutional Quality	Tax Burden	Labour Market Freedom	Human Capital	Labour Force Participation
Inward DJO Index	1.000									
Outward DJO Index	0.779*	1.000								
Financial market development	0.102*	0.100*	1.000							
Equity market development	0.191*	0.154*	0.150*	1.000						
Trade Openness	0.114*	0.138*	0.120*	0.109*	1.000					
Institutional Quality	0.181*	0.123*	0.049	0.231*	0.187*	1.000				
Tax Burden	-0.005	-0.019	-0.050*	-0.014	0.015	-0.033	1.000			
Labour Market Freedom	0.104*	0.147*	0.059*	0.063*	0.401*	0.139*	0.022	1.000		
Human Capital	0.040	0.021	0.142*	0.090*	0.041*	0.010	0.034	0.071*	1.000	
Labour Force Participation	-0.018	0.002	-0.030	0.060*	-0.368*	-0.094*	-0.039*	-0.229*	-0.024	1.000

* $p<0.05$.

2.5 Results

In this study, I estimate inward and outward capital openness frontiers using the three SFM specifications discussed in the methodology section (see Section 2.3; six models in total). Section 2.5.1 presents the SFM specifications in the context of capital openness, accommodating the variables used in the analysis. Section 2.5.2 presents an interpretation of results based on the model estimates.

2.5.1 Model Specifications in Openness Context

BC Model

I assume that the openness frontier is of Cobb–Douglas type, and hence the BC model specification of the openness frontier is as follows:

$$Openness_{it} = \alpha_0 + \alpha_1 KOIndex_{it} + \alpha_2 SMCap_{it} + \alpha_3 FinMDev_{it} + \alpha_4 Trade_{it} + \alpha_t time + V_{it} - U_{it} \quad (2.20)$$

and

$$U_{it} = \delta_0 + \delta_1 InsQ_{it} + \delta_2 LMF_{it} + \delta_3 TaxBurden_{it} + \delta_4 HC_{it} + \delta_4 LF_{it} \quad (2.21)$$

for the inward capital openness model (ICOM)

$$U_{it} = \delta_0 + \delta_1 InsQ_{it} + \delta_2 LMF_{it} + \delta_3 CTaxBurden_{it} \quad (2.22)$$

for the outward capital openness model (OCOM).

The estimated potential openness is:

$$\widehat{Openness}_{it} = \alpha_0 + \alpha_1 KOIndex_{it} + \alpha_2 SMCap_{it} + \alpha_3 FinMDev_{it} + \alpha_4 Trade_{it} + \alpha_t time \quad (2,23)$$

To verify the robustness of the model specification, I test several hypotheses, which are presented in Appendix 2.1.

Model estimates of the OCOM and ICOM are given in Table 2.6, along with KLH and LKA model estimates.

KLH Model

The BC model does not account for the country heterogeneity. Country heterogeneity is considered a part of inefficiency in the BC model. Magud et al. (2011) point out that there is country heterogeneity in capital controls with respect to the subtlety

and market friendliness. The KLH model accounts for the country heterogeneity, while it decomposes the inefficiency into persistent and random components.

A Cobb–Douglas type of openness frontier as per the KLH model specification can be written as:

$$Openness_{it} = \alpha_0 + \alpha_1 KOIndex_{it} + \alpha_2 SMCap_{it} + \alpha_3 FinMDev_{it} + \alpha_4 Trade_{it} + \alpha_t time + b_i - \eta_i + V_{it} - U_{it} \quad (2.24)$$

KLH model estimates of the OCOM and ICOM are given in Table 2.6.

LKA Model

A Cobb–Douglas type of openness frontier as per the four-component model specification can be written as:

$$Openness_{it} = \alpha_0 + \alpha_1 KOIndex_{it} + \alpha_2 SMCap_{it} + \alpha_3 FinMDev_{it} + \alpha_4 Trade_{it} + \alpha_t time + b_i - \eta_i + V_{it} - U_{it}(z_{it}) \quad (2.25)$$

The LKA model deals with the endogeneity problem when the openness frontier is linearly homogeneous. The openness frontier model could have the endogeneity problem, mainly caused by simultaneity between the dependent variable (openness) and the independent variable SMCap. The level of stock market capitalisation encourages capital flows (Montiel & Reinhart, 1999), while capital flows cause changes in stock market capitalisation (Levine & Zervos, 1999; Wu, Huang & Ni, 2017).

I test the hypothesis of linear homogeneity ($\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 = 1$) for both inward and outward capital openness frontiers. The results are shown in Table 2.5, and the hypothesis of liner homogeneity in inputs cannot be rejected in both frontiers.

Table 2.5: Hypothesis Tests for Linear Homogeneity in Inputs of Openness Frontiers

Null Hypothesis: $\boldsymbol{\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 = 1}$	**Test Statistic**	**P-value**	**Decision**
ICOM	0.146	0.126	Do not reject H_0
OCOM	–0.207	0.409	Do not reject H_0

When the openness frontier is linearly homogeneous in inputs, the LKA model with a Cobb–Douglas type openness frontier specification can be written as follows:

$$\widetilde{Openness}_{it} = \alpha_0 + \alpha_2 \widetilde{KOIndex}_{it} + \alpha_3 \widetilde{FinMDev}_{it} + \alpha_4 \widetilde{Trade}_{it} + \beta_t t + b_i - \eta_i + V_{it} - U_{it}(z_{it}) \quad (2.26)$$

Where $$\widetilde{Variable}_{it} = \frac{Variable_{it}}{SMCap_{it}} \quad (2.27)$$

The equation (2.26) does not have the endogeneity problem, as the ratios represented in equation (2.27) are independent of the error term $(b_i - \eta_i + V_{it} - U_{it}(z_{it}))$.

2.5.2 Interpretation of Results

Determinants of the Potential Capital Openness

In the Cobb–Douglas production function specification, output elasticities do not vary with the input levels, and the values of output elasticities are the coefficients of input variables (Coelli, Rahman & Thirtle, 2003; Coelli et al., 2005).

Based on the results of all three model specifications (see Table 2.6), trade openness has elasticity estimates greater than the elasticity estimates of DJO in all OCOMs and almost as large as in ICOMs. These results indicate that it is essential to establish greater trade openness along with greater DJO if a country wishes to achieve a higher capital openness position, confirming the findings of Aizenman (2004, 2008). The BC model provides statistically significant estimates for all independent variables in the frontier. However, the BC specification does not account for country heterogeneity and endogeneity. The KLH model, which accounts for country heterogeneity, indicates that equity market development (SMCap) is also important to increasing potential outward capital openness, which confirms the claims of Campion and Neumann (2004), Kaminsky and Schmukler (2008), Montiel and Reinhart (1999) and Prasad et al. (2005). The LKA model accounts for both country heterogeneity and endogeneity. However, the LKA estimation methodology hinders the estimation of one independent variable in the frontier in addressing endogeneity, and in this case, it is SMCap. The value presented in Table 6 is calculated based on the linear homogeneity of inputs assumption. On average, the inward capital openness frontier moves forward by 2.6% to 3.5% every year and the outward capital openness frontier by 5.0% to 5.9%, according to the coefficient of the time trend.

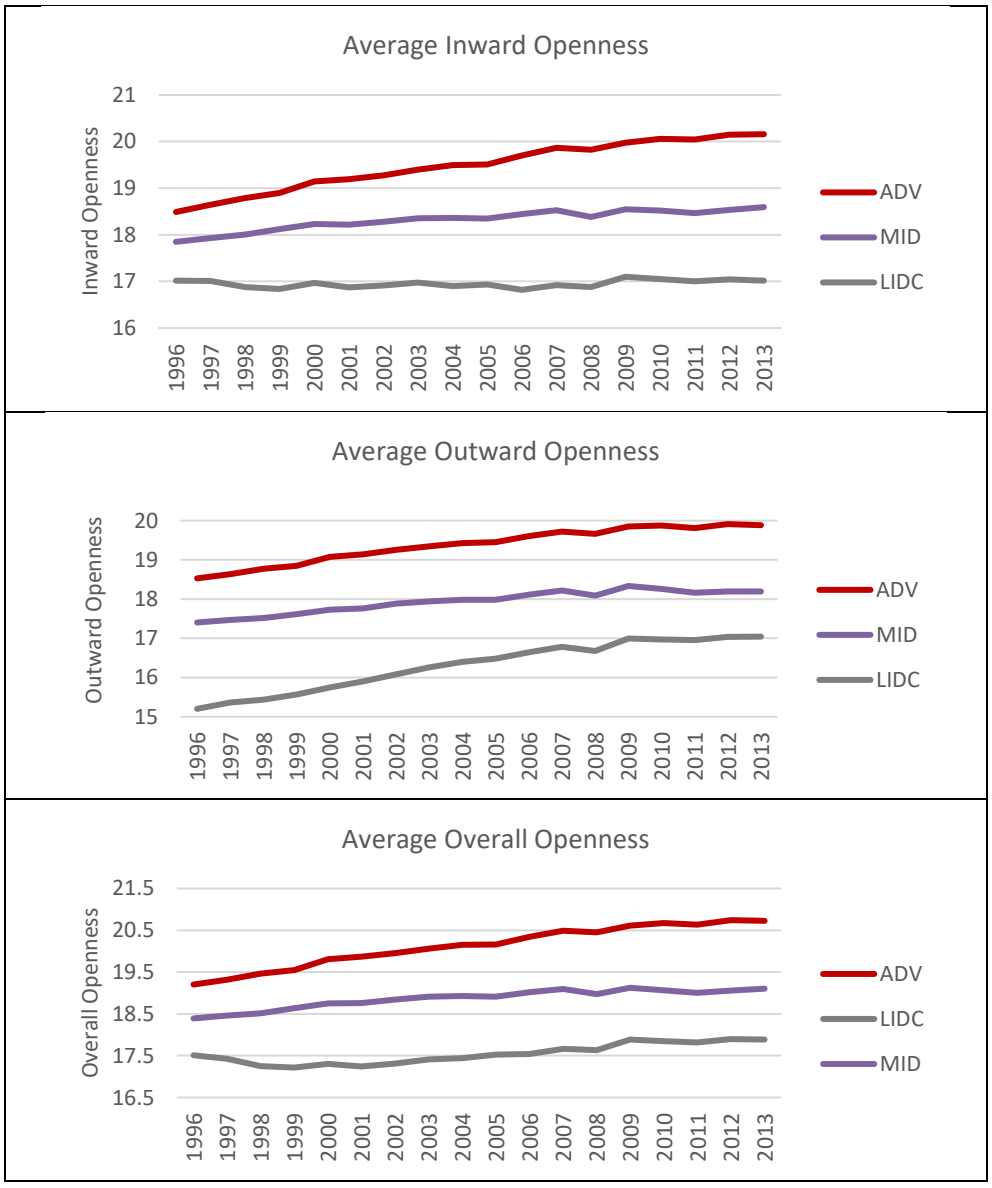
Table 2.6: Model Estimates of the Openness Frontier Models as per the BC, KLH and LKA Specifications

	BC Model		**KLH Model**		**LKA Model**	
	OCOM	**ICOM**	**OCOM**	**ICOM**	**OCOM**	**ICOM**
Panel A (Frontier)						
De Jure Index	0.840*** (0.140)	0.638*** (0.190)	0.241** (0.100)	0.896*** (0.148)	0.312*** (0.069)	0.509*** (0.095)
Financial Market Dev.	0.087*** (0.015)	0.093*** (0.014)	0.002 (0.007)	0.008 (0.007)	0.001 (0.007)	0.095 (0.008)
Equity Market Dev.	0.168*** (0.025)	0.076*** (0.025)	0.031* (0.017)	–0.028 (0.017)	0.078[(a)] (n.a.)	0.055[(a)] (n.a.)
Trade Openness	0.917*** (0.071)	0.648*** (0.107)	0.636*** (0.093)	0.647*** (0.094)	0.609*** (0.069)	0.430*** (0.094)
time	0.050*** (0.008)	0.026*** (0.008)	0.059*** (0.003)	0.033*** (0.003)	0.058*** (0.003)	0.035*** (0.004)
Constant	13.164*** (0.338)	17.114 (31.624)	14.869*** (0.416)	15.301*** (0.421)	0.146 (–0.019)	0.006 (0.142)
Panel B (Determinants of Inefficiency[(b)])						
Institutional Quality	–1.304*** (0.118)	–0.697*** (0.111)			–0.886** (0.168)	–0.307** (0.147)
Tax Burden	–0.113 (0.081)	–0.145 (0.090)			0.384*** (0.186)	0.409** (0.183)
Labour Market Freedom	0.166 (0.201)	0.208 (0.159)			–0.233 (0.269)	–0.878** (0.240)
Human Capital		–0.400*** (0.139)				0.442* (0.254)
Labour Force Participation		0.015 (0.040)				–0.015 (0.052)
Constant	1.138** (0.459)	2.616 (31.625)			–2.267*** (0.817)	–1.059 (0.897)

Standard errors are in parenthesis
*** *p<0.01*, ** *p<0.05*, * *p<0.1*
n.a. – not available
(a) Calculated
(b) $(U_{it} = \delta z_{it})$ for BC model and $\sigma_U^2(z_{it}) = \exp(\delta_0 + \delta' z_{it})$ for LKA model

I use potential capital openness estimates of the LKA model as the proposed new indicator of capital openness. Average capital openness indices for economies in advanced (ADV), middle-income (MID) and low-income (LIDC) categories as per the IMF classification of economies (according to per capita income) are presented in Figure 2.3.

Figure 2.3: Trends in Average Capital Openness by Income Category



A key observation as per the proposed measures of capital openness is that the overall capital openness of ADV countries has increased notably with the increases of both inward and outward capital openness. Capital openness of MID category countries

increased slightly during the sample period with increases in both inward and outward openness. However, the inward openness of LIDCs did not change that much during the sample period, while outward openness increased sharply, leading to an increase in overall capital openness. These trends are consistent with the findings of Broner, Didier, Erce and Schmukler (2011), where the median of country averages of capital flow to GDP ratios in the 2000s increased considerably compared to the 1990s for ADV and by some extent for MID countries, but not for LIDCs. The minor volatility in capital openness observed during 2009 is due to the drop in world trade (World Bank Data) and the changes in DJO implemented by countries during the global financial crisis.

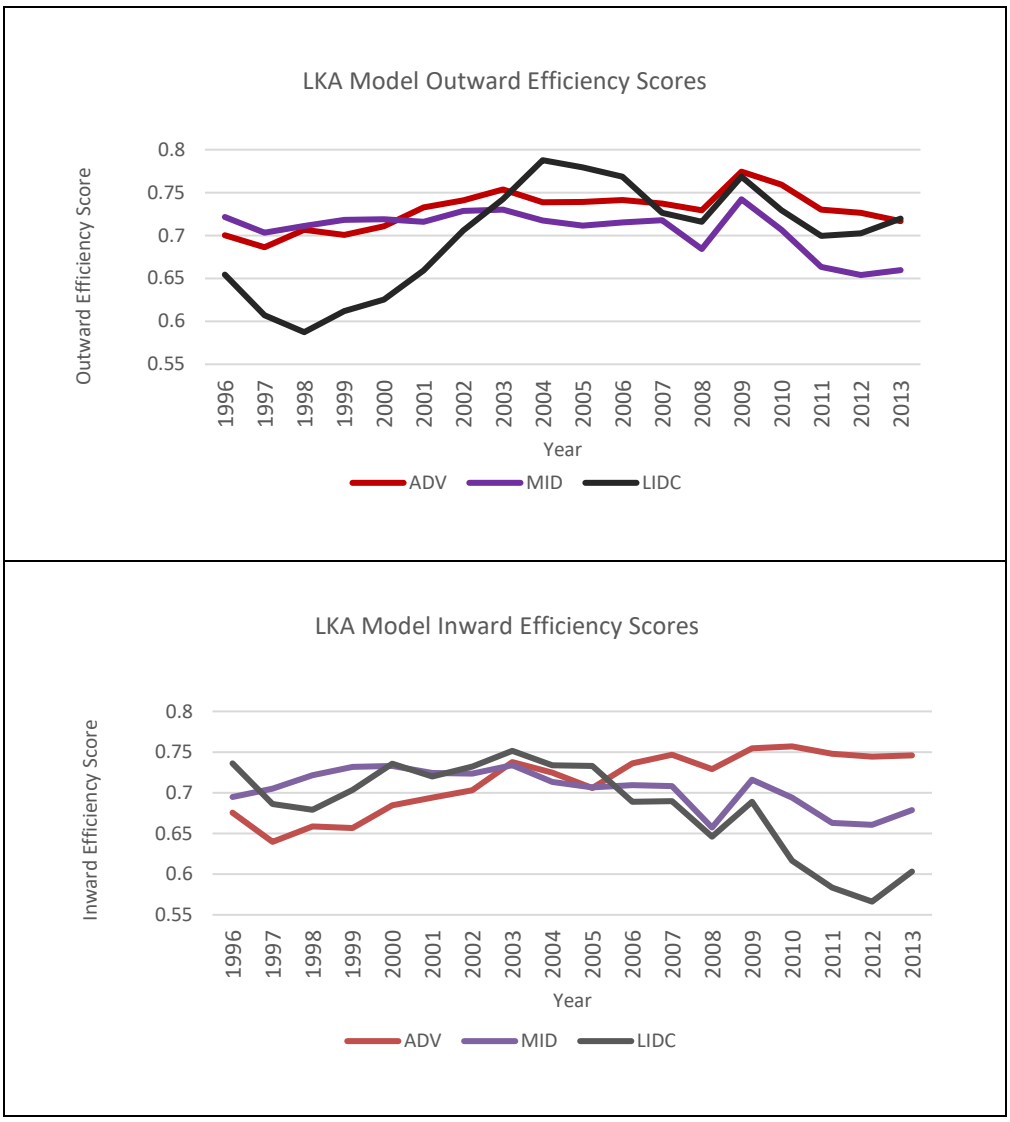
Appendix 2.2 presents average country-wise openness measures sorted from the least open to the most open country.

Determinants of the Efficiency of Openness

As per the coefficient estimates of the determinants of inefficiency in both BC and LKA models, institutional quality is an essential factor for both ICOM and OCOM. The negative sign indicates better institutions decrease the inefficiency and the volatility[15] of inefficiency of capital outflows (which implies that institutional quality increases efficiency). Mishkin (2006), Binici et al. (2010), Prasad et al. (2005) and Wei (2018) indicate that better institutions are essential for capital *outflow controls* to be effective or to facilitate capital *inflows*. There is little to no evidence on the effect of institutional quality on capital *outflow openness*. Better institutions instil a sense of credibility amongst investors and boost investor confidence. According to both models, human capital also contributes to the change in the efficiency of inward capital openness. Investors seeking opportunities abroad tend to look for skilled labour. In addition, the LKA model indicates that a lower tax burden reduces the volatility in efficiency in both inward and outward openness. Lower tax burden improves profit margins hance act as an incentive for investors. Labour market freedom reduces the volatility of the efficiency of inward capital openness. Through labour market freedom, investors look for the ease of hiring, maintaining and dismissing work force without unnecessary legal and trade union issues.

[15] LKA model estimates the determinants of the variance of inefficiency, whereas the BC model estimates the determinants of the (mean) of inefficiency. Both models estimate the level of efficiency.

Figure 2.4: Average Efficiency Scores of Advanced, Middle-Income and Low-Income Economies Based on the LKA Model



Efficiency scores show volatility during the global financial crisis period. Both inward and outward efficiency scores show an overall declining trend during the post-global financial crisis, particularly among MID and LIDC economies. Post-crisis inward efficiency scores increased in ADV economies, while outward efficiency scores show a marginally declining trend. These mixed movements can be explained as portfolio adjustments and loss of wealth due to capital flights, surges, sudden stops and retrenchments observed during and several years after the global financial crisis (Forbes & Warnock, 2012; Milesi-Ferretti & Tille, 2011). LIDCs show an initial decline from 1996 to 1998 of outward efficiency and then a notable increasing trend from 1999 to 2004. Forbes and Warnock (2012) find that the share of low-income countries

experiencing capital flight episodes during the same periods decreasing and then increasing in their sample.

Appendix 2.3 presents the average country-wise efficiency measures sorted from the least efficient to the most efficient country.

Table 2.7 presents the correlation matrix of all potential capital openness, efficiency scores and the DJO indices (Chinn and Ito's [2008] index and Jahan and Wang's [2017] DJO indices). All openness and efficiency scores show low positive coefficients between the DJO indices, indicating that a high level of DJO does not ensure higher efficiency of openness.

Table 2.7: Correlation Coefficients Between the Openness Estimates, Efficiency Scores and the DJO Indices

Variables	Overall Potential Capital Openness	Potential Inward Openness	Potential Outward Openness	LKA Model Outward Efficiency	LKA Model Inward Efficiency	Jahan and Wang's (2017) Overall DJO index	Jahan and Wang's (2017) Inward DJO index	Jahan and Wang's (2017) Outward DJO index	Chinn and Ito's (2008) Index
Overall Openness	1								
Potential Inward Openness	0.984*	1							
Potential Outward Openness	0.968*	0.918*	1						
LKA Model Outward Efficiency	0.204*	0.206*	0.190*	1					
LKA Model Inward Efficiency	0.214*	0.172*	0.317*	0.678*	1				
Jahan and Wang's (2017) Overall DJO index	0.214*	0.204*	0.244*	0.062*	0.092*	1			
Jahan and Wang's (2017) Inward DJO index	0.264*	0.248*	0.296*	0.080*	0.132*	0.948*	1		
Jahan and Wang's (2017) Outward DJO index	0.219*	0.211*	0.237*	0.029	0.039	0.936*	0.884*	1	
Chinn–Ito Index	0.336*	0.316*	0.366*	0.092*	0.118*	0.850*	0.799*	0.819*	1

** $p<0.05$.*

2.6 Discussion and Conclusions

In this study, I propose the concepts of potential capital openness and efficiency of capital openness and a method to measure them by applying SFM in the context of capital openness. I estimate a capital openness frontier and measure the potential capital openness as a new measure of capital openness. Thereafter, the difference between the potential and realised levels of capital openness is measured as the efficiency of capital openness. Inward and outward capital openness were dealt with separately, as it is evident that using one measure to represent both is not suitable. Six openness measures were developed using three SFM specifications covering the period from 1996 to 2013 for 66 countries

(inward openness) and 81 countries (outward openness). I propose using the LKA model estimates as efficiency measures of capital openness, as the model specification deals with heterogeneity and endogeneity while accounting for determinants of inefficiency. In contrast, the other two models do not deal with all three aspects at the same time.

It is important to note that the proposed indices do not capture efficiencies (or inefficiencies) in capital openness caused by the intentional measures of central banks or governments to encourage or discourage capital flows, particularly during crisis periods through indirect channels, apart from DJO measures. For example, during crisis periods, authorities take many conventional and unconventional policy actions aiming at a range of outcomes, such as domestic and foreign currency liquidity injections or restrictions and macroprudential guidelines for the financial sector.

Openness frontier estimates indicate that trade openness is an essential factor for DJO to achieve higher levels of potential capital openness. From a policy perspective, it is important to establish trade relations with the rest of the world before embarking on broad level capital openness policies to achieve a higher level of potential capital openness. Further, a low tax burden and better institutions are important factors in the efficiency of both inward and outward capital openness. Better institutions provide investors a sense of credibility with regard to their investments and hence a conducive environment. Low tax burden expands the profit margins providing incentives for both local and foreign investments. Policymakers should consider improving the quality of institutions and developing attractive tax policies to encourage capital flows. Human capital and labour market freedom (i.e., fewer rigidities in the labour market) also affect the efficiency of inward capital openness. Investors that seek labour resource in other countries prefer the availability of the quality labour with freedom to hire and dismiss workers without unreasonable legal issues. Countries that aim to promote capital inflows need to establish education systems that promote human capital development in line with the global labour demand from investors and have labour laws attractive to international investors.

It is pertinent to note that although I propose a method to measure potential and the efficiency of capital openness, I do not intend to establish a notion that capital openness is a positive aspect through this study. Capital openness is not necessarily a desirable factor in the eyes of economists. As Erten, Korinek and Ocampo (2021) emphasise,

capital flows are associated with both costs and benefits because international capital integration exposes economies to boom and bust cycles.

Estimated efficiency and openness indices yield low positive correlation coefficients with existing DJO indices used in the literature, indicating that higher DJO does not ensure higher capital openness or higher efficiency in openness. The new openness and efficiency indices I propose provide a novel and holistic perspective of capital openness and complement the existing indices available in the literature.

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Appendices

Appendix 2.1: Hypothesis Tests for Model Specification

Table A 2.1.1: Hypothesis Tests for Model Specification

	Hypothesis	Outward Capital Openness Model			Inward Capital Openness Model		
		Test Statistic	**P-Value**	**Decision**	**Test Statistic**	**P-Value**	**Decision**
1.	There are no inefficiency effects ($U_{it} = 0$)	2740.13	0.000	Reject H_0	2339.59	0.000	Reject H_0
2.	There are no time fixed effects	16.263	0.505	Do not reject H_0	14.13	0.658	Do not reject H_0
3.	There is no technological progress (time trend) ($\alpha_t = 0$)	28.71	0.000	Reject H_0	10.61	0.001	Reject H_0
4.	The time trend is linear (No quadratic time trend term)	0.627	0.428	Do not reject H_0	0.435	0.509	Do not reject H_0
5.	Coefficients of inefficiency determinants are jointly equal to zero ($\delta_1 = \delta_2 = \delta_3 = 0$ for OCOM and $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$ for ICOM)	135.12	0.000	Reject H_0	910.44	0.000	Reject H_0

I test the first null hypothesis using the Likelihood Ratio (LR) test, which compares the values of log-likelihood functions obtained under the ordinary least squares estimates and maximum likelihood estimation of the stochastic frontier model. The critical value is from Kodde and Palm (1986). Under this test, the null hypothesis that no inefficiency effects are present in the data is rejected at a 1% significance level. Thus, the ordinary least squares function is not suitable to represent the openness frontier.

The second hypothesis test is to determine whether or not a model with time fixed effects is suitable. The null hypothesis is not rejected at a 1% significant level. Hence, a model with time fixed effects is not suitable for the data used.

The third hypothesis states that the coefficient of the time trend variable is equal to zero. The LR test compares the stochastic frontier model without the time trend (H0) and the frontier model with the time trend (H1). The null hypothesis is rejected at a 1% level

of significance. Therefore, the model with the time trend variable is selected. Combining the second and third hypothesis, a model with a time trend is used for the analysis.

The fourth tests the linear time trend (H0) against the quadratic time trend (H1). The null hypothesis is accepted at a 1% significance level. Therefore, the model with the linear time trend is selected.

The fifth hypothesis states that the coefficients of the inefficiency determinant variables are simultaneously equal to zero. The LR test compares the stochastic frontier model without the variables that determine the inefficiency effects (H0) and the full frontier model with all inefficiency determinants (H1). The null hypothesis is rejected at a 1% level of significance. Therefore, I conclude that at least one of the coefficients of the determinants of inefficiency is significantly different from zero.

Appendix 2.2: Average Indices of Capital Openness

Table A2.2.1: Average Capital Openness Indices and Rankings

Country	Inward Openness Score	Ranking		Country	Outward Openness Score	Ranking		Country	Overall Openness Score	Ranking
India	15.19967	1		Serbia	15.39919	1		Bangladesh	16.40215	1
Bangladesh	15.72273	2		Zambia	15.56386	2		India	16.94794	2
Pakistan	16.25109	3		Bangladesh	15.68158	3		Slovenia	17.09458	3
Slovenia	16.61505	4		Slovenia	16.12152	4		Pakistan	17.25234	4
United States	16.69141	5		Tanzania	16.62463	5		Serbia	17.29245	5
Nigeria	16.74475	6		India	16.74754	6		Zambia	17.35973	6
Brazil	16.83731	7		Ecuador	16.76217	7		Brazil	17.57521	7
Russia	16.86288	8		Pakistan	16.77714	8		Turkey	17.73518	8
Zambia	16.88514	9		Ghana	16.8079	9		Nigeria	17.81469	9
Serbia	17.0799	10		Tunisia	16.82641	10		Jamaica	17.83017	10
Turkey	17.15987	11		Brazil	16.84216	11		Tunisia	17.93525	11
Jamaica	17.26616	12		Nigeria	16.85799	12		Russia	18.0098	12
Japan	17.32178	13		Turkey	16.90178	13		Ghana	18.03822	13
Korea	17.36069	14		Indonesia	16.94616	14		Tanzania	18.11424	14
Tunisia	17.53047	15		Jamaica	16.97913	15		Colombia	18.16101	15
Australia	17.53557	16		Morocco	17.06046	16		Korea	18.16804	16
Ghana	17.55858	17		Colombia	17.07389	17		Morocco	18.17437	17
Uruguay	17.67539	18		Mexico	17.14937	18		Mexico	18.18614	18
Poland	17.70715	19		Egypt	17.19496	19		Poland	18.20029	19
Colombia	17.7462	20		Romania	17.21449	20		Uruguay	18.24183	20
Kazakhstan	17.74643	21		Costa Rica	17.2166	21		Romania	18.2501	21
Mexico	17.74645	22		Poland	17.24498	22		Egypt	18.28381	22
Morocco	17.75743	23		Paraguay	17.34393	23		Peru	18.35177	23
Romania	17.79514	24		Peru	17.38876	24		Kazakhstan	18.37097	24
Tanzania	17.8433	25		Uruguay	17.40357	25		Ecuador	18.39652	25
Egypt	17.85764	26		Kazakhstan	17.55677	26		Philippines	18.47297	26
Peru	17.86557	27		Philippines	17.56017	27		United States	18.55993	27
Philippines	17.9474	28		Korea	17.57566	28		Australia	18.58886	28
Croatia	18.10776	29		China	17.59127	29		Croatia	18.58996	29
Ecuador	18.14003	30		Croatia	17.60717	30		Japan	18.65137	30
Chile	18.26803	31		Russia	17.62317	31		Ukraine	18.77784	31
Kuwait	18.28125	32		Ukraine	17.71107	32		Czech Republic	18.88813	32
Ukraine	18.3374	33		Thailand	17.73726	33		Chile	18.90726	33
Czech Republic	18.37306	34		Argentina	17.80703	34		Bulgaria	18.94331	34
Venezuela	18.42343	35		Namibia	17.94409	35		New Zealand	18.98896	35
Bulgaria	18.43871	36		Czech Republic	17.96453	36		Venezuela	19.01814	36
New Zealand	18.47303	37		Bulgaria	17.96575	37		Kuwait	19.05594	37
Greece	18.68639	38		Swaziland	17.99919	38		Greece	19.12176	38
Botswana	18.79708	39		Greece	18.0226	39		Paraguay	19.12366	39

Jordan	18.86061	40		New Zealand	18.06735	40		Argentina	19.27846	40
Hungary	18.87243	41		Azerbaijan	18.12671	41		Hungary	19.32004	41
Italy	18.88306	42		Israel	18.1291	42		Jordan	19.3788	42
Paraguay	18.91317	43		Chile	18.1426	43		Italy	19.38448	43
Austria	18.95272	44		Venezuela	18.1459	44		Botswana	19.40187	44
Argentina	19.01592	45		Australia	18.15942	45		Austria	19.49867	45
France	19.30771	46		Malaysia	18.25055	46		Azerbaijan	19.74572	46
Denmark	19.31456	47		Hungary	18.27387	47		Denmark	19.86292	47
United Kingdom	19.32537	48		Japan	18.34112	48		Finland	19.88276	48
Finland	19.36623	49		United States	18.38915	49		France	19.91528	49
Sweden	19.38852	50		Kuwait	18.41617	50		Sweden	19.9391	50
Azerbaijan	19.44514	51		Italy	18.44559	51		Portugal	19.95764	51
Portugal	19.57129	52		Jordan	18.45426	52		Norway	20.03586	52
Norway	19.63677	53		Botswana	18.58428	53		Germany	20.27844	53
Cyprus	19.65639	54		Canada	18.60368	54		United Kingdom	20.29916	54
Hong Kong	19.67205	55		Austria	18.62836	55		Hong Kong	20.41351	55
Germany	19.97275	56		Mauritius	18.71878	56		Cyprus	20.44021	56
Switzerland	20.25681	57		Portugal	18.80967	57		Switzerland	20.85627	57
South Africa	20.49275	58		Germany	18.92261	58		South Africa	20.98436	58
Barbados	20.73148	59		Norway	18.92271	59		Barbados	21.22355	59
Ireland	20.76728	60		Finland	18.95185	60		Ireland	21.32821	60
Sri Lanka	20.89964	61		Denmark	18.99926	61		Sri Lanka	21.43549	61
Malta	21.08891	62		Panama	19.01788	62		Malta	21.45211	62
Slovak Republic	21.5772	63		Sweden	19.07871	63		Slovak Republic	22.06511	63
Singapore	22.32391	64		France	19.11927	64		Singapore	22.89089	64
Saudi Arabia	24.4074	65		Hong Kong	19.75865	65		Saudi Arabia	24.80905	65
Spain	26.31484	66		Belgium	19.77562	66		Spain	26.64146	66
				United Kingdom	19.82334	67				
				Cyprus	19.82417	68				
				South Africa	20.03446	69				
				Netherlands	20.04577	70				
				Switzerland	20.05246	71				
				Malta	20.25227	72				
				Barbados	20.25319	73				
				Bahrain	20.47147	74				
				Ireland	20.48072	75				
				Sri Lanka	20.52272	76				
				Slovak Republic	21.0855	77				
				Singapore	22.04962	78				
				Luxembourg	22.95964	79				
				Saudi Arabia	23.6189	80				
				Spain	25.36124	81				

Appendix 2.3: Average Efficiency of Capital Openness Indices and Rankings

Table A2.3.1: Average Efficiency of Capital Openness Indices (LKA Model) and Rankings

Country	Inward Openness (LKA Model)			Country	Outward Openness (LKA Model)	
	Average Efficiency	Ranking			Average Efficiency	Ranking
Zambia	0.626263	1		Venezuela	0.625263	1
Venezuela	0.628046	2		Nigeria	0.633112	2
Mauritius	0.645689	3		Serbia	0.674439	3
Tanzania	0.674283	4		Tanzania	0.676035	4
Ecuador	0.676994	5		Ecuador	0.676169	5
Egypt	0.682395	6		Paraguay	0.679669	6
Serbia	0.699745	7		Brazil	0.683769	7
Indonesia	0.709217	8		Egypt	0.684813	8
Ukraine	0.711975	9		Morocco	0.684948	9
Colombia	0.712703	10		Uruguay	0.685391	10
Saudi Arabia	0.716798	11		Zambia	0.687059	11
Paraguay	0.717667	12		Mexico	0.687737	12
Morocco	0.719808	13		Russia	0.689661	13
Mexico	0.720395	14		Slovenia	0.694291	14
Argentina	0.721668	15		Saudi Arabia	0.69505	15
Azerbaijan	0.721823	16		Hungary	0.696014	16
Jordan	0.722591	17		Norway	0.696629	17
Brazil	0.723664	18		Ukraine	0.697269	18
Tunisia	0.723835	19		Portugal	0.697271	19
Hong Kong	0.724515	20		Italy	0.698076	20
Costa Rica	0.726069	21		Philippines	0.698941	21
Pakistan	0.72724	22		Tunisia	0.699724	22
Philippines	0.727662	23		Colombia	0.700329	23
Turkey	0.731356	24		Hong Kong	0.701606	24
Panama	0.732168	25		Croatia	0.704217	25
Portugal	0.733652	26		Kazakhstan	0.705033	26
Swaziland	0.733792	27		Bangladesh	0.705753	27
Slovenia	0.734612	28		Singapore	0.706922	28
Nigeria	0.734973	29		Azerbaijan	0.707779	29
Russia	0.735261	30		Korea	0.708347	30
Romania	0.73614	31		France	0.709719	31
Ghana	0.736906	32		Greece	0.709783	32
Peru	0.73874	33		Argentina	0.710599	33
Greece	0.739298	34		Kuwait	0.711118	34
Norway	0.739771	35		South Africa	0.712046	35
Barbados	0.740321	36		Bulgaria	0.712571	36
Poland	0.741145	37		Ghana	0.713206	37
Croatia	0.741326	38		Peru	0.713496	38
Bangladesh	0.74191	39		Sri Lanka	0.714008	39
India	0.742613	40		Poland	0.716395	40

Israel	0.743247	41		Pakistan	0.717835	41
Hungary	0.745805	42		Romania	0.718403	42
Malaysia	0.745877	43		Turkey	0.721636	43
Uruguay	0.746117	44		Jamaica	0.724552	44
Bahrain	0.749061	45		Czech Republic	0.730638	45
Namibia	0.749362	46		India	0.731664	46
Kuwait	0.750061	47		Jordan	0.733196	47
Singapore	0.750925	48		Germany	0.734061	48
Italy	0.751254	49		Sweden	0.73553	49
Kazakhstan	0.754945	50		Cyprus	0.738187	50
Jamaica	0.755463	51		Slovak Republic	0.739847	51
Bulgaria	0.755509	52		Japan	0.740955	52
Czech Republic	0.757181	53		Barbados	0.742157	53
Korea	0.760071	54		New Zealand	0.74486	54
Thailand	0.760491	55		Austria	0.751024	55
Sweden	0.761851	56		Australia	0.759817	56
China	0.7646	57		United Kingdom	0.76295	57
Sri Lanka	0.764657	58		United States	0.766473	58
France	0.766036	59		Denmark	0.784904	59
South Africa	0.768649	60		Malta	0.786548	60
Germany	0.769541	61		Ireland	0.786688	61
Austria	0.771732	62		Chile	0.795174	62
Slovak Republic	0.77188	63		Spain	0.796779	63
New Zealand	0.772982	64		Finland	0.809943	64
Chile	0.777825	65				
Japan	0.780129	66				
Belgium	0.789571	67				
Australia	0.789975	68				
Luxembourg	0.792605	69				
Malta	0.795001	70				
United Kingdom	0.79504	71				
Spain	0.799553	72				
Cyprus	0.808221	73				
Finland	0.809129	74				
Ireland	0.813938	75				
Denmark	0.815861	76				
United States	0.826294	77				

Chapter 3: Back to Trilemma from Dilemma through Macroprudential Policies

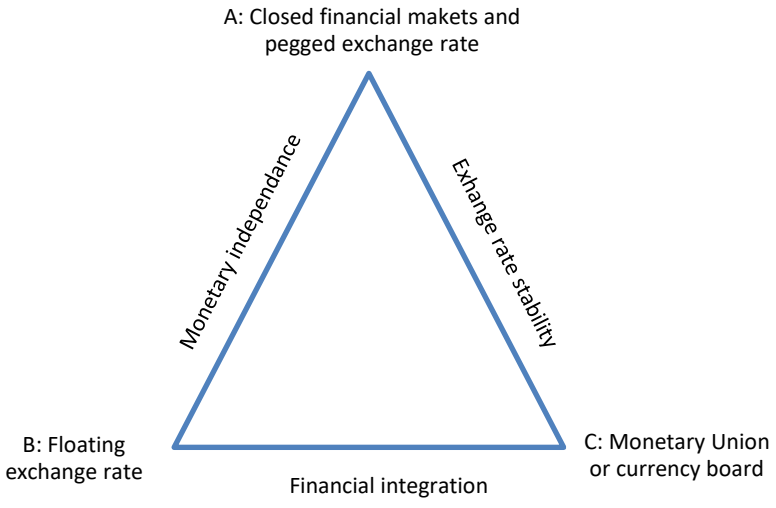
Abstract

In this study, I re-examine the monetary trilemma of Mundell (1963) using the new indicator of capital openness (developed in Chapter 2), which eliminates the unrealistic binary policy choice measurement of conventional capital openness indices. I further assess the impact of the implementation of macroprudential policies on the trilemma framework. I find evidence of a dilemma where a flexible exchange rate does not guarantee monetary policy independence from the centre country to peripheral countries with a high level of capital openness. However, the implementation of macroprudential policies helps to convert the dilemma back into a trilemma, assuring monetary policy independence for countries with a flexible exchange rate. I find evidence of a dilemma on long-term bond rates, with or without the implementation of macroprudential policies.

3.1 Introduction

With the integration of global financial systems, central banks have a challenging task to conduct their monetary policy independently. Monetary policy independence is analysed predominantly using the open economy monetary trilemma framework of Mundell (1963). The monetary trilemma theory states that an economy can only achieve two of the three policy goals—monetary policy independence, fixed exchange rate and capital openness—at a given time. A textbook explanation of the trilemma framework is illustrated in Figure 3.1. The sides of the triangle represent the three policy goals. An economy can operate on one of the three corners of the triangle, achieving only two policy goals represented by the sides of the triangle in the corner in which it operates, but must abandon the policy goal represented by the side opposite to the corner in which it operates. For example, in the absence of capital controls, a central bank could have a broader scope for conducting monetary policy independent of what is practised by a dominant country (centre country) abroad by having a flexible exchange rate regime (point B). In other words, an economy that operates on point B can achieve monetary policy independence and free capital flows, but it must abandon the policy goal of exchange rate stability according to the monetary trilemma theory.

Figure 3.1: The Trilemma Framework



Source: Aizenman (2019).

Many authors (e.g., Aizenman, Chinn & Ito, 2016, 2017; Edwards, 2012; Klein & Shambaugh, 2015; Obstfeld, Shambaugh & Taylor, 2005, 2009, 2010) confirm the

validity of the trilemma hypothesis. However, in recent studies, Rey (2015), Cheng and Rajan (2019) and Han and Wei (2018) argue that the trilemma no longer exists, but that a dilemma or a '2.5 lemma' exists in the current integrated global financial environment.

The tendency of economies to adopt 'in-between' or mixed policy trio approaches in the post-1990s leads to the need to rethink the trilemma framework beyond its traditional stark binary policy choice nature (Aizenman, 2019; Aizenman & Pinto, 2013; De La Torre, Yeyati & Schmukler, 2002).

In this study, I assess the validity of the trilemma hypothesis with respect to short term policy rates and long term bond rates16 using the capital openness indicator developed in Chapter 2. There are three novelties in this study. First, I eliminate the stark binary nature of capital openness measurement (open/closed) by reclassifying countries into groups of high, moderate and low capital openness. Second, I modify the equation specification suggested by Han and Wei (2018). The HW equation does not include the main effects of the interaction term variables. I include main effects in the HW equation to ensure identification. Third, I extend the analysis to assess the impact of macroprudential policies in the context of the trilemma using the modified specification. To the best of my knowledge, the impact of macroprudential policies on long-term bond rates concerning the trilemma is not discussed in the literature.

I find evidence of a dilemma that could be converted into a trilemma by implementing macroprudential policies for policy rates. However, long-term interest rate decisions are subject to a dilemma, even with the implementation of macroprudential policies.

This chapter is organised as follows: Section 3.2 consists of a literature review. Sections 3.3 and 3.4 introduce the methodology and data. Section 3.5 presents the results, followed by Section 3.6, which concludes.

3.2 Literature Review

Many authors (e.g., Aizenman et al., 2016, 2017; Edwards, 2012; Klein & Shambaugh, 2015; Obstfeld et al., 2005, 2009, 2010) test the validity of the trilemma and

[16] The trilemma hypothesis mainly discusses monetary policy independence and, therefore, primarily associated with short term policy rates. However, analysing long term bond rates in the context of trilemma provides useful inputs for long term financing decisions.

find that the results are in line with the trilemma framework. Nevertheless, a stream of recent literature argues that the trilemma framework does not hold in the present context. It was valid during the 1950s and 1960s during the Bretton Woods regime and is no longer valid in the present context (Aizenman, 2019). In recent literature, many researchers support this argument, particularly with respect to the global macroeconomic framework observed in the aftermath of the financial crises in the 1990s and the global financial crisis. For example, Rey (2015) finds that US monetary policy overwhelmingly influences the monetary policy stance of countries with partial capital openness, irrespective of the exchange rate regime, reducing the trilemma to a dilemma. Han and Wei (2018) document patterns of '2.5 lemma', where, in the absence of capital controls, flexible exchange rates provide some degree of monetary policy autonomy when the centre country tightens its monetary policy, but not otherwise. Cheng and Rajan (2019) also find a pattern of a 2.5 lemma and argue that holding higher levels of reserves may help convert the 2.5 lemma back to a trilemma. It appears that international reserves are acting as a buffer in the trilemma framework. Aizenman (2019) states that a fourth factor, financial stability (which is linked to the analysis through international reserves), may transform the trilemma hypothesis into a 'quadrilemma'. Majumder and Nag (2021) also report evidence of a quadrilemma for India. However, the fourth factor they discuss is financial sector stability. Financial sector stability is channelled through the fear of sudden stops in capital flows and exchange rate volatility. Evidence of deviation from the trilemma are documented by several other authors. Hoang et. al (2019) find that the trilemma configuration was unable to stabilise the Vietnamese economy from the spill-over effects from the Global Financial Crisis (GFC). Gülşen and Özmen (2020) document evidence of substantially higher dilemma effects after the GFC than before GFC amongst emerging market economies and advanced economies. Wu (2015) finds that OECD countries with less developed financial systems deviate from the trilemma configuration during 2002 to 2009.

Financial stability started playing a significant role in ensuring macroeconomic stability in the aftermath of the GFC Many countries implemented policies to ensure financial stability through an arsenal of policies dubbed 'macroprudential policies'. However, the use of macroprudential policies pre-dates the GFC period. Macroprudential policies are aimed at borrowers and lenders of specific target sectors and domestic and foreign currency to ensure financial stability.

Aizenman, Chinn and Ito (2020) link financial stability to trilemma through a variable measuring the extent of implementation of macroprudential policies. They conclude that the extensive implementation of macroprudential policies help peripheral countries to regain monetary policy independence from the centre country when the centre country implements expansionary monetary policy, but not when it implements contractionary monetary policy. Rey (2015) argues that countries must impose capital controls or implement macroprudential policies to achieve monetary policy independence even with a flexible exchange rate. The impact of macroprudential policies on the validity of the trilemma is almost exclusively discussed with respect to policy rates. Trilemma in the context of long-run interest rates is rarely addressed.

Another discussion in the trilemma literature is the binary nature of the trilemma, which imposes a sharp choice of policy trio. The applicability of such sharp policy choices is rarely observed in the present context, where countries tend to choose less sharp but mixed policy regimes (Aizenman, 2019). Particularly since the financial crises of the 1990s, emerging market economies resorted to adopting 'in-between' policy approaches, such as managed exchange rate flexibility, partial capital openness and limited monetary independence (Aizenman & Pinto, 2013; De La Torre et al., 2002).

In this study, I assess the validity of the trilemma using a non-binary measure of capital openness and explore the impact of macroprudential policies on the trilemma framework for both policy rates and long-term bond rates.

3.3 Methodology

I use a modified specification of the methodology proposed by Han and Wei (2018) (hereafter referred to as HW). HW hypothesise that the change in the policy interest rate of a peripheral country 'i' in time 't' $\Delta r_{i.t}^{P}$ depends on four factors:

$r_{i.t-1}^{P}$: the value of the policy rate one period ago

$\Delta r_{i.t}^{P^*}$: a change in the desired policy rate, driven solely by domestic factors

Δr_t^{US} : a change in the interest rate driven by the centre country

ΔVIX_t: global financial cycle factor.

Hence, the relationship can be expressed as:

$$\Delta r_{i.t}^{P} = \lambda r_{i.t-1}^{P} + \gamma_1 \Delta r_{i.t}^{P^*} + \gamma_2 \Delta r_t^{US} + \delta \Delta VIX_t + e_{i,t} \quad (3.1)$$

Where λ, γ_1 and δ are coefficients to be estimated and $e_{i,t}$ is the random error.

The lagged policy rate, $r_{i.t-1}^{P}$, captures the direction of the policy space. A higher rate in the recent past gives more space for a downward adjustment of policy rates and vice versa. Hence, a negative coefficient, λ , is expected.

$\Delta r_{i.t}^{P^*}$ and Δr_t^{US} separate the domestic and centre country conditions that have affected the change in the policy interest rate.

$\Delta r_{i.t}^{P^*}$ is the desired change in the policy rate of country i, according to its domestic conditions. The authors combine the Taylor rule and the estimated surprise components in growth and inflation projections as per IMF's World Economic Outlook (WEO) projections and express $\Delta r_{i.t}^{P^*}$ as:

$$\Delta r_{i.t}^{P^*} = \tilde{c} + \widetilde{\phi_1} \Delta GDP\ growth\ forecast_{i,t} + \widetilde{\phi_2} \Delta Inflation\ forecast_{i,t} + \widetilde{e_{i,t}} \quad (3.2)$$

$\Delta GDP\ growth\ forecast_{i,t}$ and $\Delta Inflation\ forecast_{i,t}$ are the first difference of GDP growth and inflation projections by the IMF. Usually, projections are released in April and October (sometimes September).

The change in the implied volatility of S&P 500 index options, ΔVIX_t is used in the HW study to represent the global financial cycle factor. Obstfeld (2015) and Rey (2015) also use the same indicator in similar studies. Lower ΔVIX_t values are associated with higher global risk appetite or greater tolerance of risk-taking.

The main aim of the HW study is to assess how the combinations of capital control and nominal exchange rate (CCER) regimes allow monetary policy independence. In this model, γ_2 endogenised, and it represents the exchange rate and capital account regimes combinations.

In equation (3.1), γ_2 is endogenised as a function of different combinations of CCER regimes:

$$\gamma_2 = \beta_1 D_{fixed,NC} + \beta_2 D_{fixed,C} + \beta_3 D_{flexible,NC} + \beta_4 D_{flexible,C} \quad (3.3)$$

Table 3.1: Combinations of CCER Regimes in Han and Wei (2018)

	No capital controls	**Capital controls**
Fixed exchange rate	$D_{fixed,NC}$	$D_{fixed,NC}$
Flexible exchange rate	$D_{flexible,NC}$	$\beta D_{flexible,C_4}$

Combining equations (3.1), (3.2) and (3.3) provides:

$$\Delta r_{i.t}^{P} = c + \lambda r_{i.t-1}^{P} + \phi_1 \Delta GDP\ growth\ forecast_{i,t} + \phi_2 \Delta Inflation\ forecast_{i,t} + \beta_1 D_{fixed,NC}\, \Delta r_t^{US} + \beta_2 D_{fixed,C}\, \Delta r_t^{US} + \beta_3 D_{flexible,NC}\, \Delta r_t^{US} + \beta_4 D_{flexible,C}\, \Delta r_t^{US} + \delta \Delta VIX_t + e_{i,t} \quad (3.4)$$

Further, by examining the sign and the statistical significance of βs in equation (3.4) (hereafter referred to as the HW equation), one can assess the validity of trilemma (or the effectiveness of a given policy regime combination in providing monetary policy independence[17]) as indicated below.

Trilemma vs Dilemma: Trilemma

According to HW, $\beta_1 = 1$ (total monetary policy dependence) or at least $\beta_1 > 0$ indicates no monetary autonomy, with a stable exchange rate and financial integration (Point C). Further, according to the trilemma, one expects monetary independence with a flexible exchange rate, hence $\beta_3 = \beta_4 = 0$ (Point B). Fully effective capital controls conferring monetary policy independence indicate $\beta_2 = \beta_4 = 0$ (point A).

[17] In the literature, monetary dependence is characterised as the movement of domestic policy rates as a response to the change in centre country policy rates in the same direction.

Table 3.2: Interpretation of Trilemma with the β Values of HW Equation

Point in the trilemma triangle	**Policy choice**	**Abandoned goal**	**Value of coefficients ($\boldsymbol{\beta s}$)**
Point C	Fixed exchange rate and capital integration	Monetary independence	$\beta_1 = 1$ or at least $\beta_1 > 0$
Point B	Monetary independence and capital integration	Stable exchange rate	$\beta_3 = \beta_4 = 0$
Point A	Monetary independence and stable exchange rate	Capital integration	$\beta_2 = \beta_4 = 0$

To summarise Table 3.2, a trilemma exists when $\beta_1 = 1$ (complete dependence from the centre country) or at least $\beta_1 > 0$ (partial dependence) and $\beta_4 = \beta_3 = \beta_4 = 0$.

Trilemma vs Dilemma: Dilemma

In a dilemma situation, a flexible exchange rate regime does not provide monetary policy independence. A country must impose capital controls to achieve monetary policy independence. In the HW equation, this is represented by $\beta_1 > 0, \beta_3 > 0$ and $\beta_2 = \beta_4 = 0$.

In this case, $\beta_1 > 0$ indicates that countries with a fixed exchange rate and no capital controls experience monetary dependence, and $\beta_3 > 0$ indicates that countries with a flexible exchange rate and no capital controls also experience monetary dependence. (Whereas in the trilemma case $\beta_3 = 0$, the flexible exchange rate provides monetary policy independence for countries with no capital controls.)

$\beta_2 = \beta_4 = 0$ provides evidence of countries with capital controls experiencing monetary policy independence.

I extend the HW equation and methodology with respect to three main aspects.

First, the HW equation includes only the interaction terms of the dummy variables that represent CCER regimes and the Δr_t^{US}. I extend the equation by including the main effects of CCER dummy variables and Δr_t^{US}. Although the structural equation introduced by the HW equation does not include the main effects of the interaction term variables, one can argue that the main effects are essential in an estimation equation to make it

econometrically stable. Further, the main effects variables do capture the effect of Δr_t^{US} and CCER regimes on the dependant variable. One cannot argue that there is no direct impact of CCER on the dependant variable to exclude the main effects of the model.

Second, I relax the binary nature of the measurement of the degree of capital openness using the continuous indicator compiled in the previous chapter. As Aizenman (2019) points out, the binary choice nature of the policy trio in the trilemma theory is not practised by many economies in the present context. This is particularly the case in relation to capital openness, where countries practise partial capital openness rather than completely closed or open capital accounts. Rather than categorising countries into two categories of 'capital account closed' and 'capital account open', I divide the sample into three equal categories (least open, moderately open and highly open) for each year based on the new indicator of capital openness introduced in the previous chapter[18]. Consequently, the combinations of CCER regimes are now extended to six (from four in the HW equation). I believe that this classification eliminates the unrealistic and binary 'capital controls/no capital controls' classification and makes the analysis more relevant in the present context of partially open countries.

Table 3.3: Combinations of CCER Regimes After Extending the HW Equation

		Degree of capital openness		
		Most	**Moderate**	**Least**
Exchange rate regime	**Fixed**	D_1	D_2	D_3
	Flexible	D_4	D_5	D_6

Hence, the new estimation equation is:

$$\Delta r_{i.t}^{P} = c + \lambda r_{i.t-1}^{P} + \phi_1 \Delta GDP\ growth\ forecast_{i,t} + \phi_2 \Delta Inflation\ forecast_{i,t} + \gamma \Delta r_t^{US} + \sum_{i=1}^{6} \alpha_i D_i + \sum_{i=1}^{6} \theta_i D_i + \delta \Delta VIX_t + e_{i,t} \quad (3.5)$$

Where D_i is a dummy variable that represents the CCER regime combination 'i'.

The third aspect comes from the method of accounting for the periods of zero lower bound periods of Δr_t^{US}. The HW study mostly focuses on the period from 1990 to 2009

[18] . For each year, I arrange the sample of countries in the ascending order based on the level of capital openness and divided the sample in to three equal groups.

in the analysis. This is because the post-2008 period contains zero lower bound episodes of r_t^{US}. With the quantitative easing (QE) approach of the US Federal Reserve, during this period, the US monetary policy was further relaxed. With the zero lower bound, observed r_t^{US} values do not reflect the correct monetary policy stance of the US during this period.

In an extension of the model to account for the correct stance of US monetary policy during zero lower bound episodes of r_t^{US}, HW extends the sample up to 2012 and replaces r_t^{US} with a latent interest rate that is determined by the US money supply relative to the aggregate output. In this extension of the model, HW estimate a three-equation model using maximum likelihood estimation based on equations (3.6), (3.7) and (3.8).

HW redefines equation (3.1) as:

$$\Delta r_{i.t}^{P} = \lambda r_{i.t-1}^{P} + \gamma_1 \Delta r_{i.t}^{P^*} + \gamma_2 \Delta r_t^{US\#} + \delta \Delta VIX_t + e_{i,t} \qquad (3.6)$$

Where

$$\Delta r_t^{US\#} = \begin{cases} \Delta r_t^{US}, & when\ \Delta r_t^{US} > Lower\ Bound \\ \Delta r_t^{US*}, & when\ \Delta r_t^{US} = Lower\ Bound \end{cases} \qquad (3.7)$$

and $$r_t^{US*} = \vartheta_1 + \vartheta_2 log M_t + \vartheta_3 log Y_t + \epsilon_t \qquad (3.8)$$

Where M_t is the real money supply, and Y_t is the real aggregate output at time 't'.

Alternatively, in recent literature, researchers use shadow rates to represent the true trend of r_t^{US}. In recent updates to their data (June 2020), Wu and Xia (2016) provide a series of shadow rates for r_t^{US} starting from the year 1990, which covers the entire sample period of this analysis. The availability of a consistent series shadow rates series for the entire sample period eliminates the data coarsens that could result from replacing the policy rate data with the shadow rates only for the period of zero lower bound policy rates. I use the shadow rate series compiled by Wu and Xia as r_t^{US} for the entire sample period.

I extend the analysis further by including the effect of implementing macroprudential policies on the monetary policy independence of peripheral countries from the centre country (US). According to the findings of Aizenman et al. (2020) and Rey (2015), peripheral countries regain monetary policy independence through the implementation of macroprudential policies. I assess the effect of macroprudential policies using the equation (3.5) specification and by splitting the sample into two sub-

samples based on a dummy variable that indicates the use of one or more macroprudential policies.

Trilemma, according to the new specification (equation [3.5]), should now be analysed based on the average marginal effects (AMEs) of Δr_t^{US} at $D_i = 1$ for all CCER regimes.

Table 3.4: Identification of a Trilemma Using Marginal Effects of Δr_t^{US}

Point in the trilemma triangle	**Policy choice**	**Abandoned goal**	**Trilemma based on average marginal effects of Δr_t^{US}**
Point C	Fixed exchange rate and capital integration	Monetary independence	Marginal effect of $\Delta r_t^{US} > 0$ at $D_1 = 1$
Point B	Monetary independence and capital integration	Stable exchange rate	Marginal effects of $\Delta r_t^{US} = 0$ at $D_4 = 1, \mathrm{D}_5 = 1$ and $D_6 = 1$
Point A	Monetary independence and stable exchange rate	Capital integration	Marginal effects of $\Delta r_t^{US} = 0$ at $D_3 = 1$ and $\mathrm{D}_6 = 1$ and $D_6 = 1$

Identification of a Dilemma Based on the New Specification

The dilemma is when at least the countries with high capital openness will experience interest rate policy dependence irrespective of the exchange rate, and others do not. This means at least the marginal effects of $\Delta r_t^{US} > 0$ at $D_1 = 1$ and $\mathrm{D}_4 = 1$ and marginal effects of $\Delta r_t^{US} = 0$ at $D_2 = 1, D_3 = 1, D_5 = 1$ and $\mathrm{D}_6 = 1$, implying that countries highly open to capital flows lose monetary policy independence, irrespective of the exchange rate regime, while others do not.

If countries with both high- and mid-levels of capital openness, irrespective of the exchange rate regime, experience interest rate policy dependence, then the dilemma is more severe than in the case explained above. The marginal effects of $\Delta r_t^{US} > 0$ at $D_1 = 1, D_2 = 1,$ $D_4 = 1$ and $\mathrm{D}_5 = 1$ and marginal effects of $\Delta r_t^{US} = 0$ at $D_3 = 1$ and $\mathrm{D}_6 = 1$.

3.4 Data

I use data from the HW[19] study, for which WEO projections and policy rates and long-term (10-year) bond rates are sourced from the IMF WEO and IMF IFS databases. For exchange rate regime data, I use the Ilzetzki, Reinhart and Rogoff (as cited by HW) data, which are modified by HW. HW reclassify countries that have pegged exchange rates with currencies other than the US Dollar (i.e., the German Mark or Euro) as a flexible exchange rate, as the main focus of the analysis is the effect of US monetary policy shocks because the US is considered the centre country in this study.

The indicator of capital openness was compiled in the previous chapter. The dummy variable indicating the implementation of macroprudential policies is constructed using the 2018 update of Cerutti, Claessens and Laeven's (2017) macroprudential policy dataset[20]. This dataset provides the number of macroprudential policies implemented by each country for each year from 2000 to 2015. I convert this data to a dummy variable with '1' indicating the implementation of one or more macroprudential policies and '0' otherwise.

Shadow Fed Funds Rates are from the 2020 update of Wu and Xia's (2016) shadow federal funds rate.

The sample consists of bi-annual data of 520 observations from 1996 to 2013, covering 20 countries for the short-run equation estimates and 638 observations covering 38 countries for the same period for the long-run estimates (both are unbalanced panels). Following HW, I use Germany to represent countries using the Euro.

3.5 Results

I estimate the baseline model using both policy rates and long-run (10-year) bond rates as dependant variables using equation (3.5) and the HW equation (for comparison purposes). The results of the baseline model are presented in Tables 3.5 and 3.6. Then, I split the sample into two groups based on data on the implementation of macroprudential policies. The first sub-sample includes only the cases that implemented macroprudential policies, and the second sample includes only the cases that did not. I re-estimate the

[19] HW data are publicly available at https://sites.google.com/site/xuehuihan2016/home.
[20] Available at https://www.imf.org/en/Publications/WP/Issues/2016/12/31/The-Use-and-Effectiveness-of-Macroprudential-Policies-New-Evidence-42791

model using the specification in equation (3.5) and the HW equation. The results are presented in Tables 3.7 and 3.8, and Tables 3.9 and 3.10, respectively.

3.5.1 Baseline Model

Policy Rate (Short-Run) Estimates

In the estimates of the short-run equation, the coefficients of $r_{i.t-1}^{P}$ are negative as expected but are not significantly different from zero. The stabilising tendency in the policy adjustments observed in the HW study is not present in the short-term (policy) rates. Battellino, Broadbent and Lowe (1997), Goodhart (1996) and Rudebusch (1995) relate that policy interest rates typically adjust in the same direction for several periods before the trend is reversed. However, the stabilising tendency observed in the HW study is present in the sub-sample in which only the countries that implemented macroprudential policies are included. (See Tables 3.7 and 3.8 and the relevant discussion).

Coefficients of Taylor Rule variables, $\Delta GDP\ growth\ forecast_{i,t}$ and $\Delta Inflation\ forecast_{i,t}$ are positive and statistically significant in both model specifications, indicating that monetary policy does consider the changes in GDP and inflation forecasts, which is the usual practice.

Coefficient estimates vary across different CCER regime combinations. However, the validity of the trilemma hypothesis cannot be assessed directly through CCER regime coefficients due to the presence of level variables in the model. It has to be assessed through the marginal effects of Δr_t^{US} at different CCER regime combinations (see Table 3.6). Countries with high- and mid-level capital openness and fixed exchange rate regimes (fixed high and fixed mid) experience monetary policy dependence as indicated by the positive and statistically AME. For economies with flexible exchange rates, only mid and low levels of capital openness (flex mid and flex low) provide monetary policy independence. Economies with a high level of capital openness and flexible exchange rates (flex high) do not experience monetary policy independence, contrary to the trilemma hypothesis. This pattern is observable in both specifications in the short-run equation, indicating strong evidence on a dilemma concerning policy interest rates.

Long-Run Estimates

In the long-run estimates, the coefficients of $r_{i.t-1}^{P}$ are negative and significantly different from zero. The stabilising tendency in the policy adjustments observed in the

HW study is present in the long-run bond rates. Similar results are observed in the models with a sample consists only of the countries that implemented macroprudential policies. (See Tables 3.7 and 3.8 and the relevant discussion).

However, unlike in the short-run estimates, coefficients of $\Delta GDP\ growth\ forecast_{i,t}$ and $\Delta Inflation\ forecast_{i,t}$ are statistically insignificant in both model specifications, which indicates that changes in GDP and inflation forecasts are not considered when setting long-term bond rates. The forecasts are nevertheless for a short time horizon, which may not have any relevance in long-term bond prices.

Long-run equation estimates also reveal evidence of a dilemma. Countries with high-level capital openness regimes (fixed high) experience dependence on the US when setting long-term interest rates, as indicated by the positive and statistically significant AMEs of Δr_t^{US}. Also, for countries with high- or mid-levels of capital openness, a flexible exchange rate (flex high and flex mid) does not provide interest rate independence. This pattern is observed in both specifications of the long-run equation estimates, providing strong evidence of a dilemma with respect to long-run interest rates. Further, the average marginal effect of Δr_t^{US} at flex high is larger than 1, indicating that when the centre country increases or decreases interest rates, the peripheral countries should increase or decrease interest rates at a higher degree.

Table 3.5: Estimates of Equation (3.5) and HW Specifications

	Short Run	Long Run	Short-Run HW Specification	Long-Run HW Specification
$r^{P}_{i.t-1}$	–0.029	–0.082***	–0.032	–0.084***
	(0.021)	(0.020)	(0.021)	(0.019)
$\Delta GDP\ growth\ forecast_{i,t}$	0.284***	0.004	0.280***	0.004
	(0.073)	(0.037)	(0.073)	(0.037)
$\Delta Inflation\ forecast_{i,t}$	0.549***	0.128	0.548***	0.130
	(0.110)	(0.082)	(0.109)	(0.082)
ΔVIX_t	0.090	0.118	0.087	0.117
	(0.212)	(0.096)	(0.209)	(0.096)
Fixed High	(a)	(a)		
Fixed Mid	0.222	(b)		
	(0.287)			
Fixed Low	0.157	0.116		
	(0.255)	(0.095)		
Flex High	0.029	0.016		
	(0.087)	(0.063)		
Flex Mid	0.027	0.018		
	(0.118)	(0.056)		
Flex Low	–0.111	–0.030		
	(0.151)	(0.090)		
Δr^{US}_t	0.689*	0.897***		
	(0.374)	(0.019)		
Δr^{US}_t x Fixed High	(c)	(c)	0.707*	0.898***
			(0.378)	(0.025)
Δr^{US}_t x Fixed Mid	0.225	(b)	0.904***	(b)
	(0.481)		(0.281)	
Δr^{US}_t x Fixed Low	–1.849*	–0.776**	–1.222	0.121
	(1.013)	(0.295)	(0.916)	(0.292)
Δr^{US}_t x Flex High	0.397	–0.709***	1.084***	0.184(d)
	(0.302)	(0.114)	(0.159)	(0.115)
Δr^{US}_t x Flex Mid	–0.526	–0.612***	0.164	0.281***
	(0.603)	(0.109)	(0.528)	(0.100)
Δr^{US}_t x Flex Low	–1.315*	–0.817***	–0.545	0.091
	(0.754)	(0.141)	(0.690)	(0.142)
Constant	–0.002	0.292***	0.033	0.310***
	(0.108)	(0.097)	(0.150)	(0.097)
Obs.	520	639	520	639
R–squared	0.226	0.136	0.225	0.135

Standard errors are in parenthesis
**** p<0.01, ** p<0.05, * p<0.1*

(a) Fixed High is the base category of all dummy variables
(b) There are no observations with Fixed Exchange Rate and Mid Capital Openness in the long-run sample.
(c) Δr^{US}_t x Fixed High is the base category of all interaction terms
(d) Significant at p<0.12

Fixed High—Dummy: Fixed Exchange Rate and High Capital Openness
Fixed Mid—Dummy: Fixed Exchange Rate and Mid Capital Openness
Fixed Low—Dummy: Fixed Exchange Rate and Low Capital Openness
Flex High—Dummy: Flexible Exchange Rate and High Capital Openness
Flex Mid—Dummy: Flexible Exchange Rate and Mid Capital Openness
Flex Low—Dummy: Flexible Exchange Rate and Low Capital Openness

Table 3.6: Average Marginal Effect of Δr_t^{US} at CCER Regime Combinations

	Short Run	Long Run	Short-Run HW Specification	Long-Run HW Specification
The average marginal effect of Δr_t^{US} at				
Fixed High = 1	0.689*	0.897***	0.707*	0.898***
Fixed Mid = 1	0.914***	(a)	0.904***	(a)
Fixed Low = 1	–1.160	0.121	–1.222	0.121
Flex High = 1	1.086***	0.187*	1.084***	0.184(b)
Flex Mid = 1	0.163	0.285**	0.164	0.281***
Flex Low = 1	–0.626	0.080	–0.545	0.091

**** p<0.01, ** p<0.05, * p<0.1.*

(a) There are no observations with Fixed Exchange Rate and Mid Capital Openness in the long-run sample.

(b) Significant at p<0.12.

As a robustness check, models with country fixed effects were estimated for both specifications, which yielded similar results (see Appendix 3.1).

3.5.2 Impact of the Implementation of Macroprudential Policies

Tables 3.7 and 3.8 contain estimates using the sub-sample of countries[21] that implemented macroprudential policies. In the short-run estimates, now all three coefficients of $r_{i.t-1}^{P}$, $\Delta GDP\ growth\ forecast_{i,t}$ and $\Delta Inflation\ forecast_{i,t}$ are statistically significant. The coefficients of $r_{i.t-1}^{P}$ are negative and significantly different from zero. When countries implement macroprudential policies, the stabilising trend in policy interest rates is preserved. Further, the usual practice of considering the forecasts of inflation and GDP in monetary policy decisions is evident. This sub-sample, which excludes countries that did not follow macroprudential policies, appears to represent most of the economic intuitions discussed in Section 3.3 when deriving the estimation equation.

Based on the estimates of AMEs of Δr_t^{US}, it is evident that countries that implement macroprudential policies experience a trilemma, but not a dilemma. The AMEs of Δr_t^{US} at the fixed exchange rate with both high- and mid-level capital openness regimes (fixed high and fixed mid) are positive and statistically significant, indicating that those countries experience monetary policy dependence. Now, unlike the previous estimates, economies with flexible exchange rates experience monetary policy independence (as indicated by statistically insignificant AMEs of Δr_t^{US} for all levels of capital openness), as expected in a trilemma framework.

[21] The sample covers data from 2000 to 2013 for 18 countries for short-run estimates and 28 countries for long-run estimates.

In the long-run equation estimates, still, the stabilisation tendency exists with the coefficient of $r_{i.t-1}^{P}$ being negative and statistically significant. Changes in the forecasts of inflation and GDP are not significant as in the long-run baseline model. However, in relation to interest rate independence from the centre country, the dilemma still exists, even with the implementation of macroprudential policies, as reflected through the statistically significant positive AMEs of Δr_t^{US} for fixed high and flex high CCER regime combinations. Nevertheless, the severity of the dilemma decreased (The value of the average marginal effect of Δr_t^{US} at flex high has declined) compared to the baseline estimates. Further, the average marginal effect of Δr_t^{US} at flex mid is now statistically insignificant, indicating that flex mid countries in the estimates in Table 3.8 do not experience dilemma as in the baseline estimates in Table 3.6.

Table 3.7: Estimates of Equation (3.5) and HW Specifications for Countries Implemented Macroprudential Policies

	Short Run	Long Run	Short-Run HW Specification	Long-Run HW Specification
$r^{P}_{i.t-1}$	–0.105***	–0.100***	–0.094***	–0.083***
	(0.016)	(0.029)	(0.011)	(0.021)
$\Delta GDP\ growth\ forecast_{i,t}$	0.228***	0.006	0.228***	0.013
	(0.071)	(0.050)	(0.074)	(0.047)
$\Delta Inflation\ forecast_{i,t}$	0.465***	0.103	0.474***	0.094
	(0.123)	(0.079)	(0.114)	(0.083)
ΔVIX_t	0.127	0.135	0.131	0.139
	(0.184)	(0.138)	(0.185)	(0.139)
Fixed High	(a)	(a)		
Fixed Mid	0.295	0.186(b)		
	(0.189)	(0.186)		
Fixed Low	0.659**	0.120		
	(0.287)	(0.096)		
Flex High	–0.044	–0.025		
	(0.142)	(0.058)		
Flex Mid	0.059	–0.067		
	(0.162)	(0.077)		
Flex Low	0.269	0.180		
	(0.221)	(0.136)		
Δr_t^{US}	1.079**	0.885***		
	(0.397)	(0.027)		
Δr_t^{US} x Fixed High	(c)	(c)	1.094**	0.903***
			(0.407)	(0.035)
Δr_t^{US} x Fixed Mid	–0.696*	(b)–1	0.475**	1.218***
	(0.394)		(0.192)	(0.385)
Δr_t^{US} x Fixed Low	–3.380***	–0.836**	–2.162***	0.028
	(0.807)	(0.358)	(0.741)	(0.347)
Δr_t^{US} x Flex High	–0.428	–0.669***	0.694	0.230**
	(0.391)	(0.108)	(0.412)	(0.104)
Δr_t^{US} x Flex Mid	–0.783	–0.807***	0.316	0.109
	(0.685)	(0.195)	(0.557)	(0.174)
Δr_t^{US} x Flex Low	–1.346***	–0.681***	–0.329	0.170
	(0.425)	(0.226)	(0.375)	(0.236)
Constant	0.266***	0.366**	0.328***	0.300***
	(0.081)	(0.144)	(0.084)	(0.105)
Obs.	315	340	315	340
R–squared	0.359	0.164	0.348	0.154

Standard errors are in parenthesis.
*** *p<0.01*, ** *p<0.05*, * *p<0.1*.

(a) Fixed High is the base category of all dummy variables.
(b) There is only one observation with Fixed Exchange Rate and Mid Capital Openness in the long-run sample.
(b)-1 omitted due to collinearity.
(c) Δr_t^{US} x Fixed High is the base category of all interaction terms.

Table 3.8: Average Marginal Effect of Δr_t^{US} at CCER Regime Combinations for Countries Implemented Macroprudential Policies

	Short Run	Long Run	Short-Run HW Specification	Long-Run HW Specification
The average marginal effect of Δr_t^{US} at				
Fixed High=1	1.079**	0.885***	1.094**	0.903***
Fixed Mid=1	0.384*	(a)	0.475**	1.218***
Fixed Low=1	–2.301	0.049	–2.162**	0.028
Flex High=1	0.651	0.216**	0.694	0.230**
Flex Mid=1	0.297	0.078	0.316	0.109
Flex Low=1	–0.266	0.205	–0.329	0.170

*** $p<0.01$, ** $p<0.05$, * $p<0.1$.

(a) Not estimated as there is only one observation with Fixed Exchange Rate and Mid Capital Openness in the long-run sample.

3.5.3 The Impact of not Implementing Macroprudential Policies

I estimate equation (3.5) and the HW specification using the sub-sample that consists only of the countries[22] that did not implement macroprudential policies. The results are presented in Tables 3.9 and 3.10. In both sub-samples, there are no countries with a fixed exchange rate regime. This sample is adequate to provide evidence regarding whether or not a flexible exchange rate guarantees monetary policy independence irrespective of the level of capital openness, which is the central focus of identifying a trilemma or a dilemma. However, the absence of cases with the fixed exchange rate regime hinders the ability to determine if a fixed exchange rate and open capital account regime result in monetary policy dependence.

In the short-run equations, as in the baseline estimates, the coefficients of $r_{i.t-1}^{P}$ are negative, but statistically insignificant, indicating that the stabilising tendency of policy rates are not observed in the countries that do not follow macroprudential policies. It could be due to the difficulty of practising a stable monetary policy stance with a limited set of tools in the absence of a wide array of indirect tools available through macroprudential policies. The coefficients of $\Delta GDP\ growth\ forecast_{i,t}$ and $\Delta Inflation\ forecast_{i,t}$ are statistically significant and positive, reconfirming the importance of the role of the forecasts of inflation and GDP in monetary policy decisions.

[22] Sample covers data from 2000 to 2013 for five countries for short-run estimates and 12 countries for long-run estimates.

Based on the estimates of AMEs of Δr_t^{US}, it is evident that countries that did not implement macroprudential policies experience a dilemma. Note that the sample consists only of the countries with flexible exchange rate regimes. The AMEs of Δr_t^{US} at the flexible exchange rate with high-level capital openness regimes (flex high) are positive and statistically significant for both model specifications. A flexible exchange rate does not guarantee monetary policy independence for countries with a high level of capital openness.

In the long-run equation estimates, the stabilisation tendency continues to exist with the coefficient of $r_{i.t-1}^{P}$ being negative and statistically significant. Coefficients of the changes in forecasts of inflation and GDP are statistically significant at a 10% significance level for the equation (3.5) specification, and only the coefficient of changes in inflation forecast is significant in the HW specification. The dilemma situation continues to exist, as reflected through the statistically significant positive AMEs of Δr_t^{US} for fixed high and flex low CCER regime combinations.

Table 3.9: Estimates of Equation (3.5) and HW Specifications for Countries that Did Not Implement Macroprudential Policies

	Short Run	Long Run	Short-Run HW Specification	Long-Run HW Specification
$r^{P}_{i.t-1}$	–0.024	–0.081***	–0.034	–0.085***
	(0.038)	(0.012)	(0.020)	(0.014)
$\Delta GDP\ growth\ forecast_{i,t}$	0.477**	0.063*	0.478**	0.058
	(0.138)	(0.033)	(0.136)	(0.035)
$\Delta Inflation\ forecast_{i,t}$	0.548***	0.106*	0.543***	0.106*
	(0.092)	(0.049)	(0.103)	(0.048)
ΔVIX_t	–0.079	0.159	–0.073	0.165
	(0.211)	(0.135)	(0.200)	(0.147)
Flex High	(a)	(a)	(a)	(a)
Flex Mid	0.129	0.067		
	(0.321)	(0.088)		
Flex Low	0.140	–0.066		
	(0.214)	(0.142)		
Δr^{US}_t	0.833**	0.516***		
	(0.228)	(0.074)		
Δr^{US}_t x Flex High	(c)	(c)	0.812**	0.515***
			(0.220)	(0.071)
Δr^{US}_t x Flex Mid	–0.376	–0.541**	0.427	–0.052
	(0.381)	(0.195)	(0.284)	(0.180)
Δr^{US}_t x Flex Low	–0.288	–0.326*	0.531	0.226**
	(0.524)	(0.170)	(0.418)	(0.094)
Constant	0.000	0.314***	0.143	0.335***
	(0.404)	(0.078)	(0.137)	(0.078)
Obs.	84	162	84	162
R–squared	0.551	0.216	0.548	0.210

Standard errors are in parenthesis.
*** *p<0.01*, ** *p<0.05*, * *p<0.1*.

(a) Flex High is the base category of all dummy variables.
(b) There is only one observation with Fixed Exchange Rate and Mid Capital Openness in the long-run sample.
(b)-1 omitted due to collinearity.
(c) Δr^{US}_t x Flex High is the base category of all interaction terms.

Table 3.10: Average Marginal Effect of Δr_t^{US} at CCER Regime Combinations for Countries that Did Not Implement Macroprudential Policies

	Short Run	Long Run	Short-Run HW Specification	Long-Run HW Specification
The average marginal effect of Δr_t^{US} at				
Flex High=1	0.833**	0.516***	0.812**	0.515***
Flex Mid=1	0.457	–0.025	0.427	–0.052
Flex Low=1	0.544	0.189	0.531	0.226**

**** p<0.01, ** p<0.05, * p<0.1.*

Finally, ΔVIX_t, which represents the global financial cycle factor, is not statistically significant in any of the model estimates, indicating that it is not an essential factor in setting policy rates or long-term bond rates, consistent with the findings of HW. HW relate that the effect of the global financial cycle is more prominent in the QE period or due to difference in samples when the Eurozone economies are treated as separate observations, as seen by Obstfeld (2015). Based on the results of this study, it can be inferred that it is the latter case.

3.6 Conclusions

In the current integrated global economic conditions, the translation of foreign interest rate shocks is a primary concern for policymakers when deciding interest rates. This study revisited the monetary trilemma of Mundell (1963) using a new continuous scale indicator of capital openness, eliminating the stark binary nature of the other capital openness indices available. The stark binary policy choices regarding capital openness (i.e., open or closed) do not correctly represent the status of partially open economies to capital flows. I assessed the validity of the trilemma framework for both policy rates (short-run) and long-run interest rates (10-year bond rates).

In line with the findings of Rey (2015) and the baseline results of HW and Cheng and Rajan (2019),[23] I find evidence of a dilemma, where a flexible exchange rate does not provide monetary policy independence for countries with a high level of capital openness. For peripheral countries to achieve monetary policy independence from the centre

[23] Han and Wei (2018) and Cheng and Rajan (2019) extend the analysis to assess whether the dilemma occurs when centre country tightens and loosens its policy rates and find that it happens only at one instance concluding a 2.5 lemma.

country, they must abandon a high level of capital openness, irrespective of the fixed or flexible exchange rate.

I further study the impact of the implementation of macroprudential policies on regaining monetary policy independence for countries with flexible exchange rates. I find that countries that implement macroprudential policies experience a trilemma (not dilemma) for policy rates. However, the dilemma for long-term bond rates is not eliminated even with the implementation of macroprudential policies, although the severity is reduced. The findings of this study bring out essential contributions in the context of macroeconomic policy decision-making. In the present context, it is argued that the monetary policy trilemma is not valid, and that it is now an 'irreconcilable duo' Rey (2015). I find evidence of a reconciliation of the irreconcilable duo by implementing macroprudential policies, confirming the findings of Rey (2015) and Aizenman et al. (2020). However, regarding the long-term bond rate, the dilemma still exists even with the implementation of macroprudential policies, although with reduced severity. Therefore, if countries endeavour to lessen the dependence on the trend of long-term interest rates of the centre country, they must look beyond the traditional policy tool trio of the trilemma and widen the array of tools available through the implementation of macroprudential policies.

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Appendices

Appendix 3.1 Results of Fixed Effects Models

Table A3.1.1: Estimates of Equation (3.5) and HW Specifications with Country Fixed Effects

	Short Run	Long Run	Short Run HW Specification	Long Run HW Specification
$r^{P}_{i.t-1}$	-0.036	-0.183***	-0.029	-0.173***
	(0.034)	(0.033)	(0.032)	(0.029)
$\Delta GDP\ growth\ forecast_{i,t}$	0.272***	0.001	0.276***	0.001
	(0.077)	(0.038)	(0.075)	(0.037)
$\Delta Inflation\ forecast_{i,t}$	0.559***	0.091	0.558***	0.093
	(0.110)	(0.087)	(0.109)	(0.087)
ΔVIX_t	0.059	0.144	0.078	0.141
	(0.207)	(0.093)	(0.208)	(0.094)
Fixed High	(a)	(a)		
Fixed Mid	0.868**	(b)		
	(0.363)			
Fixed Low	0.459***	0.632**		
	(0.074)	(0.289)		
Flex High	0.598	0.986***		
	(0.411)	(0.362)		
Flex Mid	0.643	1.068***		
	(0.442)	(0.361)		
Flex Low	1.157	1.031***		
	(0.686)	(0.373)		
Δr^{US}_t	0.716*	0.831***		
	(0.375)	(0.020)		
Δr^{US}_t x Fixed High	(c)	(c)	0.719*	0.853***
			(0.373)	(0.017)
Δr^{US}_t x Fixed Mid	0.363	(b)	1.015***	(b)
	(0.557)		(0.274)	
Δr^{US}_t x Fixed Low	-1.748	-0.732**	-1.065	0.233
	(1.051)	(0.319)	(0.959)	(0.284)
Δr^{US}_t x Flex High	0.423	-0.637***	1.143***	0.197*
	(0.308)	(0.110)	(0.157)	(0.104)
Δr^{US}_t x Flex Mid	-0.628	-0.571***	0.098	0.255**
	(0.621)	(0.098)	(0.512)	(0.094)
Δr^{US}_t x Flex Low	-1.178	-0.740***	-0.606	0.089
	(0.755)	(0.137)	(0.683)	(0.133)
Constant	-0.657**	-0.072	0.006	0.857***
	(0.289)	(0.277)	(0.277)	(0.174)
Obs.	520	639	520	639
R-squared	0.229	0.165	0.225	0.161

Standard errors are in parenthesis
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

(e) Fixed high is the base category of all dummy variables
(f) There are no observations with Fixed Exchange Rate and Mid capital openness in the long run sample.
(g) Δr^{US}_t x Fixed High is the base category of all interaction terms
(h) Significant at p<0.12

Fixed High - Dummy : Fixed ER and High Capital Openness

Fixed Mid - Dummy : Fixed ER and Mid Capital Openness
Fixed Low Dummy : Fixed ER and Low Capital Openness
Flex High - Dummy : Flexible ER and High Capital Openness
Flex Mid - Dummy : Flexible ER and Mid Capital Openness
Flex Low - Dummy : Flexible ER and Low Capital Openness

Table A3.1.2: Average Marginal Effect of Δr_t^{US} at CCER regime combinations

	Short Run	Long Run	Short Run HW Specification	Long Run HW Specification
Average marginal effect of Δr_t^{US} at				
Fixed High=1	0.716*	0.831***	0.719*	0.853***
Fixed Mid=1	1.079***	(a)	1.015***	(a)
Fixed Low=1	-1.032	0.099	-1.065	0.233
Flex High=1	1.139***	0.193**	1.143***	0.197*
Flex Mid=1	0.088	0.260***	0.098	0.255***
Flex Low=1	-0.462	0.091	-0.606	0.089

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

(c) There are no observations with Fixed Exchange Rate and Mid capital openness in the long run sample.
(d) Significant at $p<0.12$

Chapter 4: Income Distribution Effects of Capital Openness

Abstract

This chapter provides new insights into the income distribution effects of inward and outward capital openness using a new duo of 'holistic' capital openness indices. Using a sample of 35 countries from 1996 to 2013, I find that the inequality effects depend on the direction of capital flows. I find evidence of outward capital openness exacerbating inequality in low-, middle- and high-income countries. Inward capital openness reduces inequality in middle- and high-income countries. Inequality-exacerbating effects of outward capital openness are higher in middle- and high-income countries than in low-income countries.

4.1 Introduction

Since the early 1990s, there has been a greater degree of capital account liberalisation in countries worldwide (Edwards, 2004; Klein & Olivei, 2008; Montiel & Reinhart, 1999). Inequality has also been on the rise since the late 1980s, particularly in middle- and high-income countries (Furceri, 2015). There are three main channels through which capital openness affects inequality discussed in the literature. First, greater capital account liberalisation fosters domestic consumption smoothing and international risk sharing (Kose, Prasad & Terrones, 2009). However, Furceri (2015) argues that in practice, strong financial institutions are crucial in realising the consumption smoothing effects of capital openness through the facilitation of inclusive credit. If financial institutions are weak and access to credit is not inclusive, capital account liberalisation may create biased access to credit, favouring only those who are well off, which exacerbates inequality. Second, Harrison (2005) argues that capital account openness may affect income distribution through the bargaining power of labour. A credible threat to relocate production overseas may lead to an increase in profit to wage ratio, thereby reducing the labour share of income. Du, Nie and Wei (2017) and Wei (2018) relate that labour market rigidities fail to allow developing countries to benefit from capital account liberalisation. Labour market rigidities are an important factor that explains the link between unemployment and capital account openness in developing countries (Du et al., 2017). Third, capital account liberalisation could affect inequality during a financial crisis. A financial crisis could have inequality-reducing effects through bankruptcies and falling asset prices, which reduce the income of the well off, hence increasing the relative income of the poor. However, the recessions that follow the financial crises may disproportionately hurt the poor (de Haan & Sturm, 2017) through the reduction of income caused by reduced economic activity and ensuing unemployment.

The effect of capital openness on various economic aspects such as growth, productivity and technology transfer is widely discussed in the literature (e.g., Gehringer, 2013; Gourinchas & Jeanne, 2013; Kose et al., 2009; Mishkin, 2006). However, very little attention is paid to the effect of capital account liberalisation on income distribution. The existing literature provides mixed evidence of the relationship between capital openness and inequality. For example, Quinn (1997), Calderón and Chong (2001) and Furceri (2015) find inequality-exacerbating effects of

capital openness and Agnello, Mallick and Sousa (2012), Bumann and Lensink (2016) and Delis, Hasan and Kazakis (2014) find positive effects.

Even though various capital openness indices have been used as explanatory variables in the literature, the attention is limited to the overall capital openness of countries. To the best of my knowledge, there are no past studies that analyse the effect of openness on inequality, with inward and outward capital openness included as two separate variables.

This study contributes to the literature in three main ways. First, the main contribution of this chapter is the analysis of the relationship between capital openness and inequality through disaggregating capital openness into the inward and outward openness indices compiled in Chapter 2. Second, the openness indices I use in the analysis are novel yardsticks of capital openness. The new indices give a holistic measurement of the level of potential capital openness as measured through DJO and the capital openness infrastructure of a country (for which the main factors are financial market development, capital market development and trade openness; see Chapter 2). Third, I extend the analysis by including the new indices of efficiency of inward and outward capital openness (see Chapter 2) to the model to evaluate if there is any effect of efficiency of capital openness on inequality, in addition to the effect of capital openness. The efficiency indices measure how close the economy is operating to its potential openness. Finally, I assess the income distribution effects of capital openness in countries in different per capita income groups (low, middle and high).

I find evidence of outward capital openness exacerbating inequality in countries in all three per capita income groups. This could be due to the increased relative earnings of top income earners who invest their savings abroad. I find that low-income and high-income countries experience the inequality-reducing effects of inward capital openness. Inward capital flows create employment opportunities that benefit the domestic workforce and increase their earnings. I find that inequality effects of capital openness differ depending on the per capita income level of the country, where middle-income and high-income countries demonstrate more prominent effects than low-income countries.

The rest of the chapter is organised as follows: The following section provides a literature review. Sections 4.3 and 4.4 explain the methodology and data used in the

study. The empirical results and discussions are provided in Section 4.5. Finally, Section 4.6 concludes the analysis.

4.2 Literature Review

The evidence on the effect of capital openness on inequality is mixed in the literature. Quinn (1997) finds evidence on a positive relationship between change in capital account openness (as measured by Quinn and Toyoda's [1997] capital openness index) and the Gini[24] coefficient for a sample of 66 countries covering the period from 1960 to 1989. For a sample of 97 countries covering the period from 1960 to 1995, Calderón and Chong (2001) report a significant negative relationship between income inequality, as measured by the Gini coefficient and the intensity of balance of payment controls as measured by the black market exchange rate (as an indicator of distortions in the foreign exchange market). They report that the intensity of capital controls matter, not just the presence. Meanwhile, in a recent study, Furceri (2015) finds that capital account liberalisation is associated with a persistent increase in inequality as measured by the Gini coefficient. He finds that countries with weak levels of financial development experience higher increases in inequality during a crisis. The study involves a panel of 149 countries from 1970 to 2010. He uses impulse response functions of an autoregressive model with dummy variables to indicate the time after the liberalisation of the capital account to determine the effect of liberalisation on inequality. Furceri (2015) finds evidence of income distribution effects of capital openness through all three channels discussed earlier.

Analysing the share of income owned by the j^{th} quintile of 11 developing countries from 1986 to 1995, Das and Mohapatra (2003) find that after financial reforms, inequality has increased, favouring the top quintile with an increase of 1.3% in the average income. The middle class experienced a negative correlation with liberalisation. They found mixed reactions of inequality to liberalisation in the lowest income quintile. Their findings are attributed to various mechanisms relating capital account liberalisation to income distribution, which could be narrowed down to non-inclusive financial markets and policy bias towards favouring the upper quintiles. A

[24] Gini coefficient lies between 0 and 1, where 0 indicates perfect equity and 1 indicates perfect inequality.

study by Jaumotte, Lall and Papageorgiou (2013) finds evidence of financial globalisation and FDIs, in particular, exacerbating inequality, benefitting only the richest 20% of the population. This is due to the technological change that occurs with FDIs creating demand for skilled and educated workers. Their analysis involves a panel of 51 countries covering the period from 1981 to 2003. The empirical analysis involves fixed effect regressions of various measures of inequality (the Gini coefficient and the share of income owned by the richest 20% were obtained based on the data available in the World Bank Database) on trade openness, financial globalisation, technology and a set of control variables that represent human capital and the level of economic development. Kunieda, Okada and Shibata (2011) find evidence supporting a positive relationship between financial openness and inequality if the financial markets are developed. This highlights the importance of recognising the different roles of financial development and financial inclusiveness in an economy. Harrison (2005) and Diwan (2001) report evidence on financial openness negatively affecting inequality, which is measured by the labour share of output. Their findings indicate the effects of openness on inequality channelled through the bargaining power of labour.

The literature discussed hitherto in this review provides evidence of inequality-exacerbating the effects of capital openness. However, some authors document the opposite results. For example, Agnello et al. (2012) find that the openness of securities markets to the rest of the world reduces inequality as measured by the Gini coefficient based on a study of an unbalanced panel dataset of 62 countries covering the period from 1973 to 2005. According to their findings, the size of the government is an essential factor in realising such effects. The size of the government could reflect some level of income redistribution within the economy, perhaps financed through taxes. Delis et al. (2014) also report that liberalisation of the banking sector to international capital flows reduce inequality. Capital account liberalisation reduces inequality in countries with high financial depth (as measured by the private sector credit to GDP ratio), according to a study by Bumann and Lensink (2016). They discuss the aspects of increased efficiency in the banking sector, financial sector development and financial depth contributing to the positive effects of capital openness on income distribution.

Apart from the main findings in the literature, it is essential to explore the choice of dependent and explanatory variables chosen by previous authors and the indicators used to represent those chosen variables. First, there are two main choices for the indicator of inequality. Some authors have exclusively used the Gini coefficient as the measure of inequality, despite its limitations related to inadequately explaining inequality. Gini coefficients cannot distinguish between income distributions that are thick upper tailed or thick lower tailed. In contrast, income shares can identify such differences while enabling the study of relative gains (Das & Mohapatra, 2003).

Second, to measure capital openness, the most commonly used method is the use of an index of DJO (e.g., Chinn and Ito's [2008] index or other indices based on the IMF AREAER data). Some authors have used the DFO, which is the ratio of total international capital flows to GDP. Irrespective of the approach used to measure capital openness (i.e., DJO or DFO), the focus is mainly limited to the overall openness or FDIs instead of separating inward and outward openness into two indices. Hence, the main scope for further analysis in the research area arises from considering two separate indicators that reflect inward and outward capital openness.

When considering control variables, many authors (e.g., Das & Mohapatra, 2003; Delis et al., 2014; Diwan, 2001; Harrison, 2005; Quinn, 1997) include government expenditure in their analyses. Government expenditure can impact inequality through several channels. First, if the expenditure were supported by tax income, it could reduce income shares (mainly for the top tier income earners) through increased taxes. Welfare payments to the poor could improve bottom income shares. Meanwhile, increased spending could boost economic activities, leading to creating jobs and increasing income levels of the overall economy or some segments of the economy. Delis et al. (2014) and Harrison (2005) use the inflation rate to control for monetary conditions since the changes in inflation could have various redistributional effects on income and wealth. Kuznets (1955) and Dollar and Kraay (2002) discuss the effects of per capita income on inequality. According to Kuznets's (1955) inverted-U hypothesis, inequality gradually increases with income per capita and then reduces. Human capital is an important factor that shapes income distribution through returns on education. Hence, many authors (e.g., Bumann & Lensink, 2016; Delis et al., 2014; Quinn, 1997) have controlled for human capital through various indicators. Bumann and Lensink (2016), Delis et al. (2014), Diwan (2001) and Quinn (1997) have

controlled for population structure through the inclusion of population growth rate in the model. If the percentage of persons who depends on other income earners is high in a country, inequality increases. Hence, the age dependency ratio[25] is a better indicator of representing the population structure in terms of the ability to earn income. Finally, rule of law, democracy and extent of political risk are important determinants of inequality (Das & Mohapatra, 2003; Delis et al., 2014; Kunieda et al., 2011). A summary of the variables used by different authors is provided in Appendix 4.1.

4.3 Methodology

I estimate a fixed effects regression model as specified in equation (4.1) as the baseline model.

$$E_{it} = a_i + y_t + \gamma_1 INW_{i,t} + \gamma_2 OUTW_{i,t} + \sum \delta_J X_{i,t} + \varepsilon_{it} \quad (4.1)$$

Where E_{it} is the measure of inequality, $INW_{i,t}$ is the inward openness index, $OUTW_{i,t}$ is the outward openness index, $X_{i,t}$ is a vector having 'j' number of control variables, a_i is the country fixed effect, and y_t is the time fixed effect. Subscripts *i* and *t* indicate the ith country and the tth period. Control variables include government consumption as a ratio of GDP, rate of inflation, the logarithm of GDP per capita, human capital, dependency ratio and institutional quality. In addition, I include the squared term of log (GDP per capita) to reflect Kuznets's (1955) inverted-U hypothesis relationship between inequality and per capita income.

I extend the baseline model to include the efficiency of inward and outward openness scores developed in Chapter 2 as exogenous variables. In this specification, institutional quality and human capital are excluded from the control variables to avoid multicollinearity, as they are determinants of the efficiency of openness indices compiled in Chapter 2.

$$E_{it} = a_i + y_t + \gamma_1 INW_{i,t} + \gamma_2 OUTW_{i,t} + \partial_1 EffINW_{i,t} + \partial_2 EffOUTW_{i,t} + \sum \delta_J X_{i,t} + \varepsilon_{it} \quad (4.2)$$

[25] Age dependency ratio is the ratio of the population below the age of 15 and above the age of 65 to the population between the ages of 15 and 65.

Where $EffINW_{i,t}$ and $EffOUTW_{i,t}$ are efficiencies of inward and outward capital openness, respectively, of the i[th] country during the t[th] period.

Then, I extend the baseline model including dummy variables to represent per capita income groups of the countries in the sample and their interaction terms with $INW_{i,t}$, $OUTW_{i,t}$, $EffINW_{i,t}$ and $EffOUTW_{i,t}$.

$$E_{it} = a_i + y_t + \gamma_1 INW_{i,t} + \gamma_2 OUTW_{i,t} + \partial_1 EffINW_{i,t} + \partial_2 EffOUTW_{i,t} + \sum \delta_J X_{i,t} + \propto_1 D_1 + \propto_2 D_2 + \sum_{i=1}^{2} (\beta_i^{INW} D_i \times INW_{i,t} + \beta_i^{OUTW} D_i \times OUTW_{i,t} + \beta_i^{EffInw} D_i \times EffOUTW_{i,t} + \beta_i^{EffOutw} D_i \times EffOUTW_{i,t}) + \varepsilon_{it} \quad (4.3)$$

Where D_1 and D_2 are dummy variables that indicate whether a country is a middle-income country and a high-income country, respectively, and β_i^ks are coefficients of the interaction terms.

4.4 Data

The sample contains an unbalanced panel dataset covering 35 countries for the period from 1996 to 2013. Data on government consumption as a ratio of GDP, rate of inflation, GDP per capita, dependency ratio and institutional quality are sourced from the World Bank Database. Human capital data are from the Penn World Tables (Feenstra, Inklaar & Timmer, 2015).

Indices of inward and outward capital openness and indices of efficiency of inward and outward capital openness are obtained from the compilations in Chapter 2. The openness indices measure potential inward and outward capital openness based on a country's DJO and openness infrastructure variables (credit market development, equity market development and trade openness). Hence, these openness measures are of a holistic nature. Efficiency indices measure how close the realised capital openness (DFO) is to the potential capital openness. In other words, efficiency measures the gap between the potential and realised capital openness. The smaller the gap, the higher the efficiency in openness.

In the literature, authors have included variables that reflect the level of financial market development as a control variable, as it supports the idea of consumption smoothing and international risk sharing the channel of income distribution effects of

openness. Since the capital openness indices that I use are holistic and cover such aspects, I do not use any additional variables.

All inequality related data are obtained from the World Inequality Database (WID hereafter) (Alvaredo, Chancel, Piketty, Saez, & Zucman, 2018). The WID provides data on the income share of the top 1%, top 10%, middle 40% and the bottom 50% and Gini coefficients. I use all five of these indicators as the dependent variable in separate regressions. Further, I use the difference between the top 10% and top 1% income shares as a dependent variable.

For comparison purposes, I use two alternative capital openness indices: Chinn and Ito's (2008) index and the capital openness indices compiled by Jahan and Wang (2017).

Assuming that openness is leading to exacerbated inequality, coefficient estimates of the models presented in the Section 4.3 section can be interpreted as follows: regressions with dependent variables that represent higher income (top 1%, 10%, and the difference between the shares of top 10% and top 1%[26]) and the regression with Gini coefficient as the dependent variable should produce positive significant coefficients for openness variables (as an *increase* in any of these dependant variables indicate an increase in the income shares of top tiers, hence an exacerbation of inequality) Regressions with the income share of the middle 40% and bottom 50% as the dependent variables should yield significant negative coefficients for openness variables (as a *decrease* in these dependant variables indicate a reduction in the income share of the bottom tiers, hence an exacerbation of inequality) .

4.5 Results

4.5.1 Baseline Model

Table 4.1 provides the estimates of the baseline specification. It appears that outward openness exacerbates inequality by increasing the relative income of the top 10% and the top 10% to 1%. Further, outward capital openness worsens the bottom 50% income share. When countries open their capital accounts for outflows, the rich become wealthier with the income from investments abroad (outward openness). As a

[26] This is referred to as the 'top 10% to 1%' hereafter.

result of capital outflows from the country (which could have been used for local investments and create employment opportunities for the locals), the earning opportunities of the middle and bottom tiers become limited. Overall, inequality is increased, as reflected by the positive and significant coefficient of outward openness in the regression of the Gini coefficient.

Inward openness does not have any effect on inequality, as per the baseline model estimates. However, one could expect inward capital flows to reduce inequality since they generally create employment opportunities for the working class and thereby increase their relative income compared to the top income earners.

Coefficient estimates of control variables in the baseline model indicate two key results. First, the baseline model confirms Kuznets's (1955) inverted-U hypothesis, which states that inequality gradually increases with income per capita and then reduces. Signs of coefficient estimates of log (GDP per capita) and its squared terms confirm the inverted-U hypothesis across all regressions and with statistically significant estimates for the top 1% and the middle 40% earners.

Second, an increase in human capital typically increases the earnings of wage income earners (who generally are the low- and middle-income earners of an economy) relative to the earnings of capital income earners (who generally are the high-income earners of an economy) as a result of returns on education. This relationship is reflected in the baseline estimates with statistically significant negative coefficients of the top 1% and 10% income share regressions and positive statistically significant coefficients of the middle 40% income share regression. Jaumotte et al. (2013) and Delis et al. (2014) document similar findings. Human capital is a critical factor in reducing wage inequality through higher returns on education (Goldin & Katz, 2007).

Table 4.1: Estimates of the Baseline Specification

	(1) Top 1% Income Share	(2) Top 10% Income Share	(3) Income Share Difference between Top 10% and Top 1%	(4) Middle 40% Income Share	(5) Bottom 50% Income Share	(6) Gini
Inward Openness	–0.003	0.001	0.003	0.002	–0.002	0.002
	(0.004)	(0.005)	(0.003)	(0.004)	(0.003)	(0.005)
Outward Openness	0.007	0.018***	0.011**	–0.003	–0.015***	0.025***
	(0.005)	(0.006)	(0.004)	(0.005)	(0.005)	(0.008)
Gov. Consumption to GDP	–0.000	–0.000	0.000	–0.001	0.001	–0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Inflation Rate[(a)]	0.000	0.001	0.000	–0.000	–0.000	0.000
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)
Log (Per Capita GDP)	0.063**	0.097*	0.034	–0.069*	–0.028	0.071
	(0.030)	(0.055)	(0.029)	(0.036)	(0.022)	(0.047)
Log^2 (Per Capita GDP)	–0.003**	–0.005	–0.001	0.004*	0.001	–0.003
	(0.002)	(0.003)	(0.002)	(0.002)	(0.001)	(0.002)
Human Capital	–0.030*	–0.038*	–0.008	0.032*	0.006	–0.026
	(0.016)	(0.020)	(0.017)	(0.016)	(0.020)	(0.029)
Age Dependency Ratio	0.000	–0.001	–0.001	0.000	0.000	–0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Institutional Quality	–0.017	–0.025	–0.007	0.016	0.009	–0.021
	(0.011)	(0.021)	(0.012)	(0.010)	(0.012)	(0.022)
Constant	–0.202	–0.466	–0.264	0.687**	0.777***	–0.510
	(0.293)	(0.454)	(0.280)	(0.330)	(0.283)	(0.470)
Obs.	608	608	608	608	608	608
R–squared	0.179	0.270	0.245	0.221	0.255	0.271

(a) Inflation rates in the data are expressed as a percentage. Hence, the coefficient estimates are near zero.
Standard errors are in parenthesis and are clustered at the country level.
*** *p<0.01*, ** *p<0.05*, * *p<0.1*.

For comparison purposes, I estimated the baseline model with two alternative capital openness indices: Chinn and Ito's (2008) index and Jahan and Wang's (2017) indices. Both of these are DJO indices compiled based on IMF AREAER data. The estimates using Chinn and Ito's (2008) index yields inequality-reducing effects of overall capital openness. The Chinn and Ito's (2008) index does not provide a disaggregation of inward and outward capital openness. Regressions that use Jahan and Wang's (2017) index yield inconclusive results with respect to inward openness and inequality exacerbating effects of outward openness. (see Tables 4.2 and 4.3).

These alternative model estimates yield results consistent with returns on education and Kuznets's (1955) inverted-U hypotheses.

Table 4.2: Estimates of the Baseline Model Using the Chinn–Ito Index as Capital Openness

	(1) Top 1% Income Share	(2) Top 10% Income Share	(3) Income Share Difference between Top 10% and Top 1%	(4) Middle 40% Income Share	(5) Bottom 50% Income Share	(6) Gini
Capital Openness	–0.005*	–0.001	0.003	0.005**	–0.004	0.003
	(0.002)	(0.004)	(0.004)	(0.002)	(0.004)	(0.007)
Gov. Consumption to GDP	–0.000	0.001	0.001	–0.001	–0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Inflation Rate	0.000	0.001	0.000	–0.000	–0.000	0.000
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)
Log (Per Capita GDP)	0.055**	0.063	0.008	–0.064**	0.001	0.025
	(0.023)	(0.044)	(0.025)	(0.027)	(0.020)	(0.040)
Log ^{2} (Per Capita GDP)	–0.003**	–0.003	–0.000	0.003**	–0.000	–0.001
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)
Human Capital	–0.033**	–0.036*	–0.004	0.035**	0.002	–0.021
	(0.014)	(0.021)	(0.020)	(0.015)	(0.025)	(0.035)
Age Dependency Ratio	0.000	–0.001	–0.001	0.000	0.000	–0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Institutional Quality	–0.016	–0.026	–0.009	0.014	0.011	–0.024
	(0.010)	(0.020)	(0.012)	(0.010)	(0.012)	(0.022)
Constant	–0.072	0.157	0.229*	0.647***	0.196*	0.394*
	(0.141)	(0.237)	(0.126)	(0.149)	(0.109)	(0.218)
Obs.	608	608	608	608	608	608
R–squared	0.196	0.217	0.168	0.261	0.154	0.177

Standard errors are in parenthesis and are clustered at the country level.
*** *p<0.01*, ** *p<0.05*, * *p<0.1*.

Table 4.3: Estimates of the Baseline Model Using Jahan and Wang's (2017) Index as Capital Openness

	(1) Top 1% Income Share	(2) Top 10% Income Share	(3) Income Share Difference between Top 10% and Top 1%	(4) Middle 40% Income Share	(5) Bottom 50% Income Share	(6) Gini
Inward Openness	0.002	0.005	0.003	0.011	–0.016	0.021
	(0.015)	(0.019)	(0.011)	(0.013)	(0.012)	(0.020)
Outward Openness	–0.010	–0.004	0.006	0.009	–0.004	0.003
	(0.010)	(0.016)	(0.010)	(0.009)	(0.011)	(0.019)
Gov. Consumption to GDP	0.000	0.001	0.001	–0.001	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Inflation Rate	0.000	0.001	0.000	–0.000	–0.000	0.000
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)
Log (Per Capita GDP)	0.063**	0.066	0.003	–0.073***	0.007	0.019
	(0.023)	(0.047)	(0.029)	(0.027)	(0.025)	(0.047)
Log ^{2} (Per Capita GDP)	–0.003**	–0.003	0.000	0.004**	–0.001	–0.001
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.003)
Human Capital	–0.028*	–0.035*	–0.008	0.028*	0.007	–0.027
	(0.014)	(0.020)	(0.018)	(0.015)	(0.021)	(0.030)
Age Dependency Ratio	0.000	–0.001	–0.001	0.000	0.000	–0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Institutional Quality	–0.018*	–0.026	–0.008	0.018*	0.008	–0.020
	(0.011)	(0.020)	(0.012)	(0.010)	(0.012)	(0.022)
Constant	–0.117	0.140	0.257*	0.694***	0.166	0.421*
	(0.145)	(0.258)	(0.140)	(0.152)	(0.122)	(0.242)
Obs.	608	608	608	608	608	608
R–squared	0.180	0.217	0.161	0.261	0.175	0.190

Standard errors are in parenthesis and are clustered at the country level.
*** *p<0.01*, ** *p<0.05*, * *p<0.1*.

4.5.2 Extended Model with Efficiency Indices

Table 4.4 provides the extended model estimates with efficiency indices of inward and outward openness included in the regression (equation [4.2]). One can observe that the relationship between inequality and outward capital openness observed in the baseline model is still preserved.

When outward capital openness exacerbates inequality, one would expect the efficiency of outward capital openness to also exacerbate inequality. However, coefficients of the efficiency of outward openness in the regressions of the bottom 50% and the Gini coefficient reveal otherwise, being positive and statistically significant. This implies that, even though outward capital openness exacerbates inequality, if the capital flow process is efficient, it allows some level of equity. Such results can be attributed to income redistribution effects and effects of the financial crisis. The income redistribution could happen through two channels. First, when top income earners pay domestic taxes on their investment income, if the capital openness process is efficient, the benefits are distributed to the poor through income protection or subsidy programs. Second, if the top income earners spend their investment income from abroad domestically, it could boost domestic economic activity, create employment domestically and improve the earnings of low-income earners.

The inequality-reducing effects of the efficiency of capital outflows can also be linked to the transmitted effects of financial crises. A financial crisis could reduce inequality through falling asset prices and bankruptcies, reducing the overseas capital income of the rich and hence increasing the relative income of the poor (de Haan & Sturm, 2017; Furceri, 2015). Although inequality is reduced in such instances, it does not bring any economic gains. It could also be a result of the structure of the international capital portfolio of the country. Finding the precise channel through which the inequality-reducing effects are realised opens discussions for further research. Exploring through the first two reasons require investment, income, expenditure and tax data for top income earners. The third avenue involves disaggregated analyses of different types of capital flows such as FDIs, stock market investments and governments bonds.

Conversely, recessions that follow the financial crisis may disproportionately hurt the poor (de Haan & Sturm, 2017; Furceri, 2015) through the reduction of income caused by reduced economic activity and resultant unemployment, particularly when the country is heavily dependent on foreign investments (i.e., capital inflows). Such effects are evident in estimates of the model that controls for the per capita income groups, which is presented in Section 4.5.3 and Tables 4.5 and 4.6.

With respect to control variables, evidence confirming Kuznets's (1955) inverted-U hypotheses is observed in the regression of the top 1% income share in this model specification.

Table 4.4: Estimates of the Extended Model with Efficiency of Openness Indices

	(1) Top 1% Income Share	(2) Top 10% Income Share	(3) Income Share Difference between Top 10% and Top 1%	(4) Middle 40% Income Share	(5) Bottom 50% Income Share	(6) Gini
Inward Openness	–0.003	–0.000	0.003	0.002	–0.002	0.002
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)
Outward Openness	0.011*	0.026***	0.015***	–0.005	–0.021***	0.034***
	(0.006)	(0.008)	(0.005)	(0.006)	(0.006)	(0.009)
Efficiency of Inw.Open.	0.013	0.022	0.009	–0.005	–0.017	0.028
	(0.017)	(0.029)	(0.017)	(0.014)	(0.020)	(0.034)
Efficiency of Outw, Open.	–0.036	–0.066	–0.029	0.017	0.049*	–0.081*
	(0.028)	(0.045)	(0.023)	(0.025)	(0.025)	(0.047)
Gov. Consumption to GDP	–0.000	–0.000	0.000	–0.000	0.001	–0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Inflation Rate	0.000	0.000	0.000	–0.000	–0.000	0.000
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)
Log (Per Capita GDP)	0.052*	0.081	0.029	–0.060*	–0.021	0.056
	(0.028)	(0.050)	(0.028)	(0.034)	(0.020)	(0.042)
Log^2 (Per Capita GDP)	–0.003*	–0.004	–0.001	0.003	0.001	–0.002
	(0.002)	(0.003)	(0.001)	(0.002)	(0.001)	(0.002)
Age Dependency Ratio	–0.000	–0.001	–0.001	0.000	0.000	–0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	–0.311	–0.642	–0.331	0.758**	0.882***	–0.703
	(0.293)	(0.435)	(0.262)	(0.334)	(0.257)	(0.432)
Obs.	608	608	608	608	608	608
R–squared	0.152	0.253	0.247	0.183	0.267	0.272

Standard errors are in parenthesis and are clustered at the country level.
*** *p<0.01*, ** *p<0.05*, * *p<0.1*.

4.5.3 Dynamics of the Inequality and Capital Openness Relationship Based on Income Level of Economies

I group the countries in the sample into three categories based on the per capita income and estimate equation (4.3), which includes the interaction terms of openness indices and efficiency indices with per capita income group dummy variables to

analyse the dynamics of the relationships observed in the baseline and extended models further. The main sample is divided into three subcategories[27] based on the per capita income reported in 1996, which is the first period of the sample. Coefficient estimates of equation (4.3) are presented in Table 4.5. Statistically significant coefficients of interaction terms indicate that inequality effects of capital openness and efficiency in capital openness are different in both middle-income and high-income countries compared to low-income countries (the base category). This could be due to the variations in the level of financial system development and credit inclusiveness in countries in these three income categories. To see how inward and outward capital openness and efficiencies of inward and outward capital openness affect inequality in different income categories, the AMEs of these four variables at three per capita income levels are calculated and presented in Table 4.6 and are discussed in Sections 4.5.3 and 4.5.4.

Coefficient estimates of the control variables in the specification of equation (3) reveal the income redistribution effects of inflation. The coefficient estimate of the inflation rate is negative and statistically significant for regressions of the middle 40% earners, which could be explained as the income redistributive effect of inflation. Earnings of the individuals in top income earners are usually variable and inflation-indexed, while the earnings of middle- and bottom-income earners are fixed. When inflation increases, fixed-income earners' income decreases relative to the income of the variable income earners. Delis et al.'s (2014) study reveals similar results where an increase in inflation reduces the income share of the bottom 10%, increases the Gini coefficient and the poverty gap.

[27] Countries that belong into subcategories are listed in Appendix 4.2.

Table 4.5: Estimates for Income Group Analysis

	(1) Top 1% Income Share	(2) Top 10% Income Share	(3) Income Share Difference between Top 10% and Top 1%	(4) Middle 40% Income Share	(5) Bottom 50% Income Share	(6) Gini
Inward Openness	0.001	0.006	0.004	–0.004	–0.002	0.004
	(0.004)	(0.006)	(0.003)	(0.004)	(0.003)	(0.005)
Outward Openness	0.016	0.036*	0.020**	–0.020	–0.016*	0.032
	(0.015)	(0.021)	(0.008)	(0.013)	(0.009)	(0.019)
Efficiency of Inw. Open.	–0.289**	–0.387	–0.098	0.236*	0.150	–0.345
	(0.127)	(0.240)	(0.138)	(0.126)	(0.120)	(0.237)
Efficiency of Outw. Open.	0.009	–0.002	–0.011	0.000	0.002	0.000
	(0.044)	(0.057)	(0.029)	(0.034)	(0.027)	(0.055)
Gov. Consumption to GDP	–0.000	–0.000	0.000	–0.001	0.001	–0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Inflation Rate	0.000	0.001	0.001	–0.001*	–0.000	0.000
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)
Log (Per Capita GDP)	0.053*	0.078	0.025	–0.050	–0.027	0.062
	(0.028)	(0.052)	(0.029)	(0.032)	(0.022)	(0.046)
Log^2 (Per Capita GDP)	–0.003	–0.003	–0.001	0.002	0.001	–0.003
	(0.002)	(0.003)	(0.001)	(0.002)	(0.001)	(0.002)
Age Dependency Ratio	0.000	–0.001	–0.001	0.000	0.001	–0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Interaction Terms						
Middle x Inw. Open.	–0.028	–0.026**	0.002	0.027	–0.001	–0.013
	(0.017)	(0.012)	(0.011)	(0.017)	(0.012)	(0.015)
High x Inw. Open.	0.015	–0.006	–0.021**	–0.014	0.020*	–0.024
	(0.016)	(0.022)	(0.010)	(0.013)	(0.010)	(0.020)
Middle x Outw. Open.	0.019	0.012	–0.007	–0.004	–0.008	0.017
	(0.021)	(0.022)	(0.012)	(0.021)	(0.014)	(0.022)
High x Outw. Open.	–0.024	–0.017	0.007	0.035**	–0.018	0.013
	(0.019)	(0.026)	(0.010)	(0.015)	(0.012)	(0.024)
Middle x Eff. Inw. Open.	–0.116**	–0.132*	–0.015	0.067	0.064	–0.132
	(0.056)	(0.071)	(0.048)	(0.044)	(0.048)	(0.081)
High x Eff. Inw. Open.	–0.068	–0.152	–0.084*	0.019	0.133**	–0.216**
	(0.067)	(0.092)	(0.043)	(0.060)	(0.051)	(0.093)
Middle x Eff. Outw. Open.	0.344**	0.438*	0.094	–0.272**	–0.165	0.383
	(0.134)	(0.251)	(0.141)	(0.132)	(0.127)	(0.249)
High x Eff. Outw. Open.	0.326**	0.484*	0.158	–0.251*	–0.232*	0.477*
	(0.133)	(0.248)	(0.141)	(0.131)	(0.125)	(0.245)
Constant	–0.338	–0.630	–0.292	0.867**	0.762***	–0.559
	(0.323)	(0.521)	(0.255)	(0.336)	(0.225)	(0.467)
Obs.	608	608	608	608	608	608
R-squared	0.229	0.318	0.297	0.266	0.329	0.332

Standard errors are in parenthesis and are clustered at the country level.
**** p<0.01, ** p<0.05, * p<0.1.*
Income Dummy Variables are dropped due to multicollinearity.

Table 4.6: Average Marginal Effects of Capital Openness and Efficiency of Capital Openness at Low-, Middle- and High-Income Levels

	(1) Top 1% Income Share	(2) Top 10% Income Share	(3) Income Share Difference between Top 10% and Top 1%	(4) Middle 40% Income Share	(5) Bottom 50% Income Share	(6) Gini
Inward Openness						
Low Income	0.001	0.006	0.004	–0.004	–0.002	0.004
Middle Income	–0.027*	–0.021**	0.006	0.023	–0.003	–0.009
High Income	0.016	–0.000	–0.016*	–0.018	0.018*	–0.020
Outward Openness						
Low Income	0.016	0.036*	0.020***	–0.020	–0.016*	0.032*
Middle Income	0.035**	0.048***	0.013	–0.024	–0.024**	0.049***
High Income	–0.008	0.019	0.027***	0.015	–0.034***	0.045***
Efficiency of Inward Openness						
Low Income	–0.289**	–0.387	–0.098	0.236*	0.150	–0.345
Middle Income	0.055**	0.051	–0.004	–0.036**	–0.015	0.038
High Income	0.037**	0.097***	0.060***	–0.015	–0.081***	0.132***
Efficiency of Outward Openness						
Low Income	0.009	–0.002	–0.011	0.000	0.002	0.000
Middle Income	–0.107*	–0.133**	–0.026	0.067**	0.066	–0.132*
High Income	–0.059	–0.154**	–0.095***	0.019	0.135***	–0.216***

*** $p<0.01$, ** $p<0.05$, * $p<0.1$.

4.5.4 AMEs of Capital Openness

The AMEs in Table 4.5 indicate that outward capital openness exacerbates inequality in all three income groups. However, the degree to which different groups of countries are affected varies across per capita income groups. Larger AMEs of regressions on Gini coefficients indicate that inequality-exacerbating effects of outward capital openness in high-income and middle-income countries are prominent compared to those in low-income countries. This result is consistent with the findings of Furceri (2015) and Jaumotte et al. (2013), although these studies use overall capital openness (Chinn–Ito index) as the explanatory variable.

Meanwhile, inward capital openness improves income distribution in middle-income countries (i.e., a decrease in top 1% and top 10% income shares) and high-income countries (i.e., an increase in the income share of the bottom 50% and a decrease in the income share of the top 10%). Inward capital flows generally create employment opportunities for the working class and thereby increase their relative

income compared to the high-income earners. The effects of inward capital openness on inequality in low-income countries are not statistically significant.

4.5.5 AMEs of Efficiency of Capital Openness

The AMEs of efficiency of inward capital openness for low-income countries indicate that an increase in efficiency in inward capital flows reduces inequality (i.e., a reduction in the top 1% income share and an increase in the middle 40% income share). Efficient capital inflows increase employment generation and hence, increase the relative earnings of the working class.

One would expect the signs of the AMEs of capital openness to match the corresponding AMEs of efficiency of capital openness. However, the AMEs of efficiency of inward openness for middle-income and high-income countries indicate that efficient inward capital inflows exacerbate inequality and efficient outward capital flows reduce inequality in middle-income and high-income countries. As discussed in Section 4.5.2, possible explanations for this result could be the effect of capital account liberalisation in the likelihood of a financial crisis, redistribution of top earners' income through taxes, and increased earnings of the working class caused by top income earners spending their foreign income domestically. This could also be a result of the capital investment portfolio structure of the economy. To elucidate these findings, further investigations are needed, as discussed in Section 4.5.2.

4.6 Conclusions

This study analyses the link between capital openness and income distribution from a novel perspective using the new capital openness indices developed in Chapter 2. Income distribution effects of capital account liberalisation have received very little attention in the literature. In those studies, the link between overall capital openness and inequality had been analysed. Moreover, to my best knowledge, the disaggregated effect of inward and outward capital openness on income distribution is not explored in the literature. The main contribution of this chapter is the disaggregation of the effects of inward and outward capital openness on income distribution. I find evidence of outward capital openness exacerbating inequality in countries of all income categories, while but only inward openness exerting positive effects on income distribution in middle-income and high-income countries. The degree of income

distribution effects of both inward and outward capital openness depends on the level of development (as reflected by the per capita income) of the country. Consistent with the findings of Furceri (2015) and Jaumotte et al. (2013), I find that the inequality effects of capital openness are prominent in middle-income and high-income countries.

I extend the analysis, including efficiency scores of capital openness computed in Chapter 2 as explanatory variables. I find that the efficiency of outward openness reducing inequality in middle-income and high-income countries. However, it is unclear whether the inequality reduction has occurred through the redistribution of income to the poorer segments in the economy or through the income erosion of top income earners caused by international asset price declines and bankruptcies, which increases the relative income of the poor, or due to the structure of foreign investment portfolio of countries. The concept of efficiency of openness itself is new; hence, further research is needed to identify the exact channels through which these effects are realised.

The findings of this study provide important insights into the existing debates in the literature on the channels through which capital account openness affects inequality. First, Kose et al. (2009) argue that greater capital account liberalisation fosters domestic consumption smoothing. Conversely, Furceri (2015) argues that the consumption smoothing effects of capital openness are possible only with strong financial institutions and inclusive credit that does not favour only a select group in the economy. The findings of this study indicate that consumption smoothing effects of capital account liberalisation are minimal and realised only in high-income and middle-income countries with respect to inward capital flows. Such effects are not adequately realised in middle-income and low-income countries. This provides significant policy implications for strengthening financial systems and increasing credit inclusiveness. However, these two aspects stand on the two sides of the scale, as achieving the balance is extremely challenging, particularly for low-income countries. Second, the inequality-exacerbating effects of outward capital openness indicate the need to strengthen domestic investments and resultant employment opportunities. Third, determining the exact reasons behind the inequality-reducing effects of efficient capital outflows needs further in-depth analysis. If such effects are transmitted through a financial crisis, it warns the policymakers that the efficiency of

capital flows is not necessarily a good thing. If a country endeavours to make the capital openness process efficient, it must carefully and continuously act to protect the economy from the effects of international financial crises.

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Appendices

Appendix 4.1: Summary of Variables used in Previous Studies

Table A4.1.1: Summary of Variables used in Previous Studies

Author/s	Sample	Dependent Variable	Explanatory Variables
Quinn (1997)	64 countries from 1958 to 1989	Gini Coefficient	• Capital openness - Quinn and Toyoda (1997) index • Per capita income growth • population growth • Percentage of population with secondary school enrolment • Percentage of population with primary school enrolment • Change in capital • Growth of government share of consumption
Calderón and Chong (2001)	97 countries from 1960 to 1995	Gini Coefficient	• Capital Openness- Black market exchange rate as a proxy • Real GDP per capita • Fraction of population completed primary education • Liquid liabilities in banking sector to GDP ratio • Terms of trade • Real exchange rate • Trade volume as measured by the total of exports and imports to GDP • Balance of payment restrictions
Furceri (2015)	149 countries from 1970 to 2010	Gini coefficient	• Capital openness- Chinn-Ito Index • Dummy variable to indicate the start of a major capital account liberalisation episode
Das and Mohapatra (2003)	19 countries from 1986 to 1995	Quintile Income Share from World Income Inequality Database	• Capital Openness -Dummy variable to indicate liberalised or not • Stock market size • Stock market value • GDP per capita • Percentage of population completed secondary school education • Government consumption • Gross Investment • Rule of law • Banking sector development

Author/s	Sample	Dependent Variable	Explanatory Variables
Jaumotte, Lall, and Papageorgiou (2013)	51 countries from 1981 to 2003	Gini coefficient	• Capital Openness – Chinn-Ito Index • Non-oil exports to GDP • Non-oil imports to GDP • Average tariff rate • Financial assets to GDP • Financial liabilities to GDP • ICT Capital • Physical capital • Credit to private sector to GDP • Secondary school education of population • Percentage employed in the Agriculture sector • Percentage employed in the Industry sector
Kunieda, Okada, and Shibata (2011)	119 countries from 1985 to 2009	Gini coefficient	• Capital openness- Ranked based on de-facto openness and categorised in to two categories above and below medial • Private sector credit to GDP • Real per capita GDP • Average years of schooling • Democracy • Extent of political risk
Harrison (2005)	15 to 131 countries from 1960 to 1990s	Labour share of income	• Capital openness – Index based on IMF AREAER data compiled by the author • Ratio of labour to capital • GDP per capita • Nominal exchange rate • Trade openness (total of exports and imports to GDP) • Relative price • Crisis Dummy variable • Inward FDI • Outward FDI • Inward remittances • Outward Remittances • Government spending to GDP • Inflation
Diwan (2001)	81 countries from 1970 to 1986	Labour share of income	• Capita openness – Index based on IMF AREAER data • Population • Size of the rural sector • Trade • Government expenditure to GDP • Debt to GDP

Author/s	Sample	Dependent Variable	Explanatory Variables
			• M2 minus M1 to GDP (Short term deposits to GDP) • M3 minus M2 to GDP (Long term deposits to GDP) • Crisis year dummy variable • Crisis country dummy variable
Delis, Hasan, and Kazakis (2014)	87 countries from 1977 to 2005	Gini coefficient	• Capital openness- Openness to international capital flows index by Abiad et al. (2010) • Population • Per capita GDP • Trade openness • Government expenditure • Inflation • Bank liquidity • Bank crisis dummy variable • Education • Dummy variable to indicate a Left centred political party in power
Agnello, Mallick, and Sousa (2012)	62 countries from 1972 to 2005	Gini coefficient	• Capital openness - de-facto openness and openness to international capital flows index by Abiad and Mody (2005) and Abiad et al. (2010) • Income • Government size
Bumann and Lensink (2016)	106 countries from 1973 to 2008	Gini coefficient	• Capital openness- Chinn-Ito index • De facto liberalisation • Financial depth as measured by private sector credit to GDP • Trade openness as measured by the sum of exports and imports to GDP • Secondary level of schooling of the total population ages>25 • Ratio of dependents, people younger than 15 or older than 64, to the working-age population--those ages 15-64. • Population growth • Real GDP per capita growth

Appendix 4.2: Sample of Countries

Table A4.2.1: Sample of Countries and the Income Categories

	Country	**Income Category***
1	Botswana	Low
2	Bulgaria	Low
3	Egypt	Low
4	Ghana	Low
5	India	Low
6	Jordan	Low
7	Morocco	Low
8	Nigeria	Low
9	South Africa	Low
10	Tanzania	Low
11	Tunisia	Low
12	Turkey	Low
13	Zambia	Low
14	Brazil	Middle
15	Croatia	Middle
16	Cyprus	Middle
17	Czech Republic	Middle
18	Greece	Middle
19	Hungary	Middle
20	Malta	Middle
21	Poland	Middle
22	Portugal	Middle
23	Slovenia	Middle
24	Spain	Middle
25	Austria	High
26	Denmark	High
27	Finland	High
28	France	High
29	Germany	High
30	Ireland	High
31	Italy	High
32	Norway	High
33	Sweden	High
34	Switzerland	High
35	United Kingdom	High

* These income categories are based on the per capita income (US$) reported in 1996.

Chapter 5: Conclusions

This thesis contributes to the literature on capital account openness by introducing a novel measures of capital openness that I use to revisit the evidence on the trilemma theory and income distribution effects of capital openness.

5.1 Summary of Findings and Policy Implications

Chapter 2 introduces the concept of a holistic capital openness measurement, which looks beyond the traditional DJO and DFO indices of capital openness. Capital flows are not solely dependent on DJO measures. They depend on macroeconomic factors such as equity and financial market development and trade openness, which affect capital flows directly, and other indirect factors, such as institutional quality, human capital and tax burden. I propose a method to construct indices that capture the capital account position of a country that considers factors that drive the capital flows in and out of economies, along with the DJO and DFO aspects of capital openness.

I apply SFMs in the compilation of the new index. SFMs are widely used in the productivity and efficiency literature to estimate production frontiers and efficiency in a production process. In my application, I derive two sets of indices. The first represents the capital openness frontier (or the potential capital openness) of an economy. The second measures the level of (in)efficiency in the openness process, which is the distance between the estimated frontier and the observed level of capital openness. I find that trade openness is a strong driver of both inward and outward capital openness along with DJO. Further, I find that institutional quality and a lower tax burden on the corporate sector affect the efficiency of both inward and outward capital openness, while human capital and labour market freedom affect the efficiency of inward capital openness. The findings provide several insights into capital openness policy. First, they highlight the importance of having a sound trade openness policy before embarking on broad level capital openness policies. Countries must first embark on good trade relations with the rest of the world to establish trust and familiarity as investment partners before opening up capital accounts. Second, the efficiency of capital flow openness depends on better institutions and a low tax burden, which

reflects the importance of the government's role in promoting capital flows. Third, having skilled human capital is also essential to promoting efficient capital inflows. If countries endeavour to promote capital inflows, human capital is a crucial prerequisite, and this takes time to develop. The domestic labour market has to be less rigid towards employers so that international investors find it less challenging to run businesses.

Chapter 3 re-examines the trilemma theory introduced by Mundell (1963) in the present context of partially open capital accounts using the new indices I propose in Chapter 2. The trilemma theory dictates that an economy cannot simultaneously achieve all three policy objectives: fixed exchange rate, open capital account and monetary policy independence from an economically dominant centre country. The traditional approach of assigning a stark binary measurement of capital openness in the assessment of trilemma theory is no longer realistic in an environment in which many countries practise partially open capital account policies (Aizenman, 2019). Further, I extend the methodology used by Han and Wei (2018) by enriching the empirical model and test the trilemma theory for short-term policy rates and long-term bond rates. I find evidence of a dilemma for both types of interest rates, which confirms the baseline findings of Han and Wei (2018) and Cheng and Rajan (2019). I then further extend the analysis to assess the role of macroprudential policies in preserving monetary policy independence. The findings related to short-term interest rates resonate with the findings of Rey (2015), which state that recent global financial events transform the trilemma into a dilemma, where monetary policy independence is possible only if the capital account is managed through indirect measures such as macroprudential policies. Nevertheless, in relation to long-term rates, countries with a high level of capital openness continue to face a dilemma regarding interest rate policy independence even with the implementation of macroprudential policies.

The key takeaway for policymakers from Chapter 3 is that it is difficult for an economy to maintain monetary policy independence from a centre country in the current interconnected global capital market conditions. Many countries face challenges in implementing economic policies directed towards their domestic macroeconomic targets such as inflation or growth amid the international effects propagated by the actions or conditions of key global economies. As per the findings of this study, the recent approach of introducing macroprudential policies appears to provide some degree of policy independence for countries with high levels of capital

openness. Nevertheless, the effectiveness of macroprudential policies lies in the hands of many players in the economy, and it requires a higher level of discipline from the market players and confidence towards regulators. Building such dynamics between the regulators and the market players is no small task, particularly for countries with governance and institutional quality issues. The successful implementation of macroprudential policies also requires several other factors. First, it requires sound knowledge, skill and creativity in policymaking to develop suitable policy tools that help achieve the desired outcome while keeping other macroeconomic variables on track. Second, there should be enough policy space in the economy to implement such measures after considering the main macroeconomic and fiscal goals, such as inflation targets, economic growth, foreign reserves and debt ratios. The introduction of new policies to achieve one goal often requires at least partially giving up achieving another macroeconomic goal. Finally, there are no 'fit for all macroprudential policies', as different economies have different channels of transmitting such policies, particularly with varying degrees of financial market development. Nevertheless, long-term bond dynamics appear to be tied to the trend of centre country bond rates with or without macroprudential policies. Hence, when planning future long-term financing, one must have a sound understanding of the direction of centre country bond rates.

In Chapter 4, I analyse the income distribution effects of capital openness using the new indices developed in Chapter 2. The existing literature focuses on assessing the income distribution effects of overall capital openness but not the disaggregated effect of inward and outward capital openness. Chapter 4 assesses the income distribution effects of both inward and outward capital openness in low-, middle- and high-income countries. I find evidence of outward capital openness exacerbating inequality in countries of all income categories. Inward capital openness reduces inequality in middle- and high-income countries. The degree of the income distribution effect increases with the level of per capita income, which echoes the findings of Furceri (2015) and Jaumotte, Lall and Papageorgiou (2013).

The findings of Chapter 4 have several policy implications. First, they highlight the need for careful sequencing of opening capital flows. Low-income countries must be cautious about opening up their capital accounts too much too soon, which might exacerbate their inequality through outward capital flows. Opening capital inflows first and later allowing for capital outflows would be sending a negative signal to

international investors. Second, to benefit from open capital accounts, an economy needs to have a strong financial system and inclusive credit opportunities that do not favour only one segment of the population. As these two aspects stand at the opposite ends of the scale, striking the right balance is challenging. As outward capital flows exacerbate inequality, strengthening domestic investment opportunities for the rich to create employment opportunities for the poor is particularly important for developing countries.

5.2 Further Research

The proposed series of holistic capital openness and efficiency indices will enable researchers to explore deeper into other areas of capital openness research, such as its effect on growth, productivity, efficiency, government finance, innovation, technology and employment.

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