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Abstract

This study investigates the determinants of the fertility rate in China over the 1952-2000 period. Consistent with theory, the key explanatory variables in our fertility model are real per capita income, infant mortality rate, female illiteracy and female labour force participation rates. The long-run results and the test for cointegration are based on the Johansen (1990) and Johansen and Juselius (1988) approach. Our long-run results conform to theory in that all variables appear with their expected signs, and the dummy variable used to capture the effects of the family planning policy indicates that in the years of the policy, fertility rates have been falling by around 10-12%. We do not find support for the often-held claim of Chinese policy makers and scholars that China's fertility transition owes largely to the "awesome strength" of the family planning policy. Our results suggest that socio-economic development played a bigger role than the family planning policy – a result more consistent with the traditional structural hypothesis than with the recent 'ideational' hypothesis.
JEL classification: J13, C22, C52

Keywords: China, fertility, cointegration, family planning policy

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I. Introduction

China has experienced rapid fertility decline since the Chinese government began to implement the family planning policy at the beginning of the 1970s. The total fertility rate (TFR) plummeted from 5.71 children per woman in 1970 to just 2.24 in 1980 and it declined further to 1.8 in 2000. China has completed its population transition and has entered the modern population reproduction stage, characterised by low birth rate, low mortality rate and low growth rate. China's economy began to take off at the end of the 1970s. This induced dramatic socio-economic changes, such as increasing urbanization and educational development, falling infant mortality rate and a rising life expectancy at birth. The dramatic fertility decline and rapid socio-economic progress have attracted many scholars to analyse the factors influencing the fertility rate in China.

There is a long and intense debate about the factors influencing China's fertility transition. Until now, there have been three main explanations put forward for China's fertility change. The first one termed "induced fertility transition" stresses government intervention as the key determinant of fertility change (Cutright and Kelly, 1981; Hernandez, 1984; Kaufman, Zhang and Zhang, 1989). This view is based on the premise that the determinative factor that has fostered the birth rate reduction has been the government's birth planning policy, not socio-economic factors (Mauldin, 1982). Many scholars associate this view with China's fertility decline since most of the fertility decline in China occurred during the 1970s (Coale, 1984; Feeney et al.1989 and Lavely and Freedman, 1990) under the 'later-longer-fewer' policy (Blayo, 1997). The second explanation attributes the dramatic fertility decline in China to the significant changes in socio-economic status (Liu, 1992; Peng, 1993, Sun and Jin, 1994). The third view is one based on the consensus that both government's strict family planning policy and socio-economic development have played important roles in lowering fertility and in the early stage of fertility decline the family planning policy has played a more important role (Xu, 1994; Liu and Lin, 1997).[1]

While many papers on the determinants of China's fertility rate have been documented, they only concentrate on descriptive analysis and cross-sectional studies using household survey data. To the best of our knowledge,

[1] Xu (1994) applied regression and variance analysis based on cross- sectional data and found that before 1980, the main reason for fertility decline was national birth planning policy, but after 1980, the fertility decline is due to the socio-economic development and the change of people's value of children. Liu and Lin (1997) got similar results by using data for 1982 and 1990 from 30 provinces in China through path analysis.

no study has modelled the determinants of the fertility rate in China using time series data. Given the importance of fertility and its implications for population growth and economic development, it is imperative to understand the determinants of fertility change in China within a time series framework. In the light of this, we present an econometric model to examine the determinants of the fertility rate for China using time-series data from 1952 to 2000. This paper also makes a contribution on the methodological front. It, for the first time in the fertility literature, introduces the Hansen (1992) structural stability test. Previous studies (Masih and Masih, 1999, 2000 and Hondroyiannis and Papapetrou, 2002) have assumed a priori that the relative importance of factors affecting fertility have remained unchanged. We believe that this may not be true and can only be ascertained empirically.

The paper is organized as follows: The next section reviews China's family planning policy and its socio-economic development. This is followed by the explanation of the theoretical framework. The model specification, data and econometric methodology are explained next. The penultimate section entails the empirical results, and the final section presents the conclusions and policy recommendations.

II. Family planning policy, fertility decline and its socio-economic development in China

China's experience of fertility decline is different compared with other developing countries because of its special social system and strict birth control policy, especially the one-child policy. Since there is much debate on the role of family planning policy in China's fertility transition, in what follows, we review the evolution of China's family planning policy and the socio-economic development.

II.1 Overview of China's Family Planning Policy

China's family planning policy is regarded as the strictest in the world. It broadly includes three stages: the birth control campaign and its standstill from 1955 to 1970; the Later-Longer-Fewer (*wan xi shao*) policy from 1971-1979; and the one child-per-couple policy since 1980.

Birth control campaign and its standstill from 1955 to 1970

China's birth control campaign began in 1955. However, this campaign did not have any major effect in reducing China's fertility mainly due to the lack of an effective field organization for translating policies into action (Wang, Keng and Smyth, 2002). As a result, from 1962 until mid-1966, a renewed family planning campaign was adopted. The main emphasis in this campaign was late marriage, and it centred on big cities and some urban localities. Intrauterine devices (IUD) were introduced and more varieties of birth control methods were encouraged. This birth control effort was abandoned in 1966 because of the Cultural Revolution. As a result, the work of the state family planning agencies, which were founded in 1964, came to a standstill and China experienced sustained and rapid population growth between 1966 and 1971.

Later-Longer-Fewer (*wan xi shao*) Policy in China from 1971-1979

Given the large population size and the rapid population growth, in 1971, a large-scale "later, longer and fewer " (later marriage, longer spacing between births, and fewer children) policy was implemented in China.[2] The slogan of the 'wan-xi-shao' policy is "One is not too few, two is good and three is too many". But in 1978, it was changed to "one is best, two the maximum" (Yang, 1982). Under this policy, contraceptive use was encouraged and the state reimbursed hospitals, clinics, and paramedics for each contraceptive operation (Banister, 1987). The outcome was a dramatic decline in the birth rate. For instance, the birth rate declined from 33.4% in

[2] The total population in China increased to 820 million in 1970 from 550 million in 1950. The average natural increase rate per year was 27.8% during the two decades.

1971 to 18.2% in 1980. In the corresponding period, the total fertility rate fell from 5.8 to 2.7 (See figure 1). The Chinese government and most scholars attributed China's rapid fertility decline between 1971 and 1980 to this "later, longer, fewer" (*Wan xi Shao*) policy (Coale, 1984; Feeney et al. 1989; Blayo, 1997).

One Child-Per-Couple Policy since 1980

To further control its population growth rate, the more radical One-Child-Per-Couple policy came into effect in China in 1980. Under this policy, economic and administrative incentives were offered for a one-child family, while penalties were enforced on couples having out-of-plan births and for cadres failing to meet quotas for family planning work.[3] This policy adjustment caused fertility rebound (Feng, Ma, Mu and Li, 2000). Since 1980, the family planning policy has been promoted as one of China's most fundamental national policies. During the existence of this policy, the total fertility rate further declined from 2.7 in 1980 to around 1.8 in 2000.

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[3] The one-child policy met resistance from couples with only one child, especially if the first child was a girl, so an amendment was soon made. For example, it allows rural couples in some areas with only a girl to have a second birth after an interval of several years.

II.2 Significant socio-economic development

Economic development in China was slow during the 1952 to 1970 period. For instance, the average annual GDP growth rate during this period was a mere 1.2%. However, the social indicators reveal that China had performed better than other low-income countries. For example, infant mortality rate declined from 101% in 1952 to 69% in 1970, which was much lower than the average level for low-income countries (138.69%). Life expectancy at birth increased from 35.3 in 1952 to 61.7 in 1970, while the average level for low-income countries was 43.5. Similarly, the female labour force participation and female illiteracy rates are better than those of low-income countries (see Table 1). It follows from the data that before the large scale '*wan xi shao*' policy came into effect, China had experienced some socio-economic development, which had prepared her for the initial fertility decline – a notion consistent with the conventional 'structural' hypothesis.

Furthermore, since 1978, China shifted its development strategies from a planned economy to a market based one and its economy began to take off. The average GDP growth rate between 1978 and 1998 was 7.8%. The real per capita income rose from US$190 in 1978 to US$840 in 2000, which is much higher than the average level of low-income countries (US$410). The rapid economic growth induced dramatic socio-economic changes, such as urbanization, educational development, and technological progress and again in the post 1978 period, the level of social indicators are much higher than the average level of low-income countries (see Table 1).

III. Some theoretical considerations

There are two main theoretical categories which explore the determinants of fertility decline: the conventional 'structural' hypothesis and the 'ideational' (or diffusion) hypothesis. The conventional socio-economic structural hypothesis broadly includes microeconomic theories, the threshold hypothesis, the classical demographic transition theory, and Caldwell's theory of intergenerational flow of wealth. The structural hypothesis stresses the importance of conventional socio-economic factors. It states that a certain level of socio-economic development in terms of the level of per capita real income, the level of poverty and landlessness, rate of urbanization, female participation in the work force, level of education (particularly of female education), rate of infant mortality, life expectancy at birth, and the average age of females at first marriage is the prerequisite for an "initial" decline in fertility.

By contrast, the recent 'ideational' hypothesis, which is based mainly on the Asian experience (Cleland and Wilson, 1987; Hirschman and Guest, 1990; Caldwell, 1992) highlights the importance of family planning and a few years of mass female schooling in bringing about an "initial" fertility decline in developing countries. It divides the fertility transition into two temporal phases and suggests that although the second phase or the "sufficient" condition may depend on a complex and poorly understood set of socio-economic structural change, the first phase or the "necessary" condition of fertility decline may not need that significant structural change as a prerequisite, but may require a family planning programme integrated with the socio-cultural historical realities of the region (Masih and Masih, 2000).

IV Specification of the empirical model

Based on the theoretical arguments advanced in the previous section and following Masih and Masih (2000),[4] we postulate the following empirical model of the determinants of the fertility rate in China.

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[4] Masih and Masih (2000) postulate a theoretical model: $fr = \psi(mr, st, ed, y, pr)$. Where fertility fr and infant mortality mr are the demographic variables; contraceptive use st and female secondary education ed are proxies for the 'ideational' or diffusion hypothesis; and real per capita income y and female labour force participation pr are proxies for the 'structural' hypothesis. They use cointegration, vector error-correction modelling and variance decomposition techniques to analyse the dynamics of fertility and its determinants with a particular focus on the role played by female education and family planning programme in the context of India. They found that the two policy variables:

$$\begin{aligned} lnF_t &= \alpha_o + \alpha_1 lnGDP_t + \alpha_2 lnIMR_t + \alpha_3 lnFLR_t \\ &+ \alpha_4 lnFLP_t + \alpha_5 FPP_t + \varepsilon_t \end{aligned} \quad (1)$$

where lnF denotes the log of the total fertility rate, $lnGDP$ is the log of the real per capita income, $lnIMR$ is the log of the infant mortality rate, $lnFLR$ is the log of the female illiteracy rate, $lnFLP$ is the log of the female labour force participation rate, FPP is a dummy variable representing the family planning policy, ε_t is the error term, t represents the time period, and $\alpha_1, \alpha_2, \alpha_3, \alpha_4$ and α_5 are the coefficients to be estimated. Consistent with theoretical norms, the total fertility rate F and infant mortality rate IMR are the demographic variables; female illiteracy rate FLR and family planning policy FPP represent the 'ideational' or diffusion hypothesis; and real per capita income GDP and female labour force participation FLP form able proxies for the 'structural' hypothesis.[5]

female secondary enrolment ratio and contraceptive use played a significant and predominant role in reducing the initial fertility rate, despite the underdeveloped status of India.

[5] Like Masih and Masih, we also found urbanisation and per capita income to be highly correlated. In order to avoid the multicollinearity problem we did not incorporate urbanisation in modelling the fertility rate.

A priori, consistent with theory, per capita income is expected to negatively impact on fertility rates. The idea follows from Becker and Lewis (1973) and Schultz (1976) who argue that if babies are regarded as consumption goods then there is a possible competition between the demand for babies and other consumption goods. It follows, then, that the cost of raising a child has to be weighed against the income foregone from working. This points to the fact that increasing incomes will tend to reduce the fertility rate as rising income means children are needed less as producer goods and also less as investment goods because they allow greater access to capital markets.

A fall in the female illiteracy rate is expected to reduce the fertility rate. This is based on the notion that higher female education allows better understanding of the logic of fertility controls. Further, increasing levels of education have the potential to delay the age of marriage and it also ensures effectiveness of the family planning policies. The female labour force participation rate is likely to have a negative effect on the fertility rate. This is because employment opportunities delay the age of reproduction. Finally, the infant mortality rate is likely to positively impact on the fertility rate. This follows from the fact that if large numbers of children die, parents must have large numbers of children to ensure survival.

Compared with Masih and Masih's (2000) model, we did not use contraceptive use and the female secondary enrolment rate because of the unavailability of time series data for our sample period. We use the female illiteracy rate instead of the female secondary enrolment rate and a dummy variable to capture the effects of family planning policy in China. We use dummy variables for 3 different periods: 1970-1979, 1970-2000, and 1980-2000. These periods are chosen because the intensities of the policy varied during China's fertility transition, as explained earlier.

The data (1952 to 2000) used in this study are obtained from the World Bank's World Table, DX for Windows, version 3.0, 2002; and China Population Statistical Yearbook published by China National Bureau of Statistics.

V. Methodology

V1. Unit root and cointegration tests

In this study the empirical methodology is based on recent techniques available to identify long-run equilibrium relationships between time series variables. Put differently, the recent developments in cointegration and error correction models, while allowing one to estimate both the short and long-run relationships, helps to avoid spurious regression problems. Prior to estimating the cointegration space and determination of the cointegration rank in a multivariate framework, it is essential to test for the order of integration of each variable or the presence of unit roots. This is an econometric rule, embedded to the cointegration premise that requires the variables to be integrated of the same order. To ascertain the integration of variables we apply the Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979, 1981), Phillips-Perron (PP) (1988) and Elliot Rothenberg Stock (ERS) (1996) point optimal tests for unit roots.

Next, we explore the existence of any significant long-run relationships among the variables in our model. For this purpose we use the Johansen (1988) and Johansen and Juselius (1990) procedure which has the following specification:

$$\Delta Z_t = \Pi Z_{t-1} + \sum_{i=1}^{k-1} \Pi_i \Delta Z_{t-i} + \mu_t + \varepsilon_t \qquad (2)$$

where Z_t is an $(n \times 1)$ vector of $I(1)$ variables, Π and Π_i $(i = 1,\ldots,k-1)$

represent $(n \times n)$ coefficient matrixes, μ_t is an $(n \times 1)$ constant vector, ε_t is independently, normally distributed with mean zero and covariance matrix Ω, k denotes the lag length, and Δ is a difference operator. If Π has zero rank, no stationary linear combination can be identified. Put differently, the variables in Z_t are noncointegrated. If the rank r of Π is greater than zero, however, there will exist r possible stationary linear combinations, and Π may be decomposed into two matrices α and β; each $(m \times r)$ such that $\Pi = \alpha\beta'$. In this representation β consists of the coefficient vectors of r cointegration relationships and α is the relevant adjustment coefficient matrix.

Johansen (1988) and Johansen and Juselius (1990) have developed two tests for determining the number of cointegrating vectors: these are the likelihood ratio trace test and the maximum eigenvalue test. The likelihood ratio test (trace test) for the hypothesis that there are at most r cointegrating vectors is given by

$$\lambda_{tr} = -T \sum_{i=q+1}^{p} log\left(1 - \hat{\lambda}_i\right) \qquad (3)$$

where T is the number of observations used for estimation, and $\hat{\lambda}_i$ is the i^{th} largest estimated eigenvalue. The null hypothesis is that the number of cointegrating vectors is less than or equal to r, where $r = 0,1,2,\ldots$, etc.

On the other hand the maximum eigenvalue test is of the form

$$\lambda_{max} = -T\,log(1 - \hat{\lambda}_r \qquad (4)$$

for testing the null hypothesis of $r-1$ cointegrating vectors against the alternative of r cointegrating vectors. Both tests have non-standard distributions and critical values are tabulated in Johansen and Juselius (1990: 208-9).

V2. Error correction model

The Granger representation theorem states that in the presence of a cointegrating relationship among variables, a dynamic error correction representation of the data exists. Following Engle and Granger (1987) we estimated the following short-run model:

$$\begin{aligned} \Delta\, ln\, FR_t = \beta_0 &+ \sum_{q=1}^{m} \eta_{1q} \Delta\, ln\, GDP_t + \sum_{q=1}^{m} \zeta_{1q} \Delta\, ln\, IMR_t + \sum_{q=1}^{m} \phi_{1q} \Delta\, ln\, FLR_t \\ &+ \sum_{q=1}^{m} \rho_{1q} \Delta\, ln\, FLP_t + \delta_1 \varepsilon_{t-1} + \mu_t \end{aligned} \qquad (5)$$

All variables in Equation (5) were defined before. μ_t is the disturbance term; Δ is the first difference operator; ε_{t-1} is the error correction (one lagged error) generated from Johansen multivariate procedure (Sedgley and Smith 1996), and m is the lag length. Equation (5) captures both the short and long run relationship between fertility decline in China and a set of explanatory variables. The long-run relationship is captured by the lagged value of the long-run error correction term, expected to be negative, reflecting how the system converges to the long-run equilibrium implied by Equation (1); convergence is assured when δ_1 is between zero and minus one.

VI Empirical results and discussion

VI.1 Order of integration: unit root tests and tests of multivariate cointegration

The results of the augmented Dickey-Fuller (ADF) (1979, 1981) and Phillips-Perron (PP) (1988) and Elliot Rothenberg Stock (ERS) (1996) Point-Optimal tests for unit roots are presented in Table 2. The tests were performed on the full sample for the period 1952-2000 both on levels as well as first differenced forms to ascertain the order of integration. All variables were found to be $I(1)$ since the null of a unit root could not be rejected at the 5% level of significance.

To ascertain the existence and number of cointegrating relationships the likelihood ratio tests based on maximal eigenvalues and traces of the stochastic matrix in the multivariate framework, as explained earlier, were conducted. The results of the Johansen test for cointegration are summarised in Table 3.

The testing strategy begins with $r = 0$. One can reject the null $r = 0$ against the alternative $r = 3$ and $r = 2$, in the case of the trace and λ_{max}, respectively. This implies the absence of a unique cointegrating vector between the fertility rate and its determinants. In fact, there are more than one steady-state or long-run relationships between fertility levels and the variables in question. In this situation, according to Muscatelli and Hurn (1992), one should chose the vector relationship with estimated long-run elasticities corresponding most closely in terms of both sign and magnitude to those predicted by economic theory.

Following Muscatelli and Hurn (1992), the long-run elasticity estimates are obtained by normalising with respect to fertility levels. All of the long-run estimates have the theoretically anticipated signs (Table 4). Per capita income, for instance, is negatively related with fertility. The elasticity of the fertility rate is around –0.4 which suggests that a 1% increase in per capita income reduces fertility by 0.4%. The corresponding short-run effect is bigger: a 1% increase in income reduces fertility by 0.8% (Table 5). The results are significant at the 10% and 1% levels, respectively.

The infant mortality rate displays a positive relationship with the fertility rate in the long run. This result suggests that the campaign for medical treatment since the 1950's, which reduced the infant mortality rate dramatically, has contributed to fertility decline in China. The short run result, however, indicates a negative relationship between mortality and fertility rates. This maybe due to the fact that increasing infant mortality rates may be a discouragement for having children – this seems a valid scenario in the short run.

The female illiteracy rate, that is, the education level of females is positively related to the fertility rate in the long run. A 1% decrease in the female illiteracy rate reduces the fertility rate by around 0.29%. This result supports the view that higher levels of female education reduce fertility levels. However, both the short and long run results are statistically insignificant. This is perhaps an indication that female illiteracy may not be a good proxy for the education levels but rather secondary school enrolment rate may be more suitable. This follows from the argument that it is only after women have attained secondary school education that there exists a negative relationship between the fertility rate and education level.

The female labour force participation rate also exerts a negative influence on the fertility rate. Of all the variables considered in our model, female labour force tends to exert the largest impact. The long run results suggest that a 1% increase in the female labour force participation reduces the fertility rate by some 1.4% while the corresponding short run result implies a fall in the fertility rate by over 1.8%. This result is not surprising given that since the 1950's the Chinese government had advocated a policy of equal employment and pay for both males and females. This result is also consistent with the facts that as females devote more time working the tendencies or opportunities for having children declines.

Lastly, the family planning policy in China has also assisted in pruning fertility levels. Here we examine the impact of the family planning policy, measured as a dummy variable, at different periods in China's fertility transition. The three different periods that we consider are the 1970-1980 period, 1970-2000 period, and the 1980-2000 period. The empirical results imply that in the years of family planning policy (since 1971) fertility rates have been falling by some 12%. Table 5 only reports the results of the model in which the family planning policy was incorporated for the years 1970-1980. During this period the fertility rates have been falling by around 10% per annum. The impact of the family planning policy during the 1970-2000 and 1980-2000 periods were around 12% - the result being statistically significant at the 5% level. For these models, apart from the error correction term which fell to around 0.11 but significant at the 5% level, all other variables appeared with a similar magnitude and statistical significance; hence, they are not reported here. The results of the impact of the family planning policy is different from the often-held claim of Chinese policy makers and scholars that the family planning policy has been an important and influential factor in China's fertility transition. It seems that the role of family planning policy in China has been exaggerated.

Granger (1986) notes that the existence of a significant error correction term is evidence of causality in at least one direction. The lagged error correction term ε_{t-1} is negative and significant at the 1% level, implying that the series is non explosive and that a long-run equilibrium exists. The coefficient of -0.1922 indicates a slow rate of convergence to equilibrium.

Our empirical results suggest that the statistical fit of the model to the data is satisfactory as indicated by the R^2 and the Adjusted R^2 (Table 6). Apart from the existence of a long-run relationship, our model is statistically well behaved. We applied a battery of diagnostic tests to the error correction model. There is no evidence of autocorrelation in the disturbance of the error term. The ARCH tests suggest that the errors are homoskedastic and independent of the regressors. The model passes the Jarque-Bera normality test suggesting that the errors are normally distributed. The RESET test indicates that the model is correctly specified. In addition, the adjusted R-squared of the model is high implying an excellent fit of the model – 62% of the variations in the fertility rate is explained by the regressors.

VI.2 Constancy of Cointegration Space

One problem with time series regression models is that the estimated parameters may change over time. Unstable parameters can result in model misspecification and, if left undetected, have the potential to bias the results. To account for this, here, we examine whether the estimated elasticities are stable over time. To do this we use the parameter non-constancy tests for $I(1)$ processes advocated by Hansen (1992). Hansen (1992) proposes three tests – $SupF$, $MeanF$, and L_C – which all have the same null hypothesis that there is no structural change but differ in their choice of alternative hypothesis. The $SupF$ test is predicated on ideas inherent in the classical Chow F-tests. The alternative hypothesis is a sudden shift in regime at an unknown point in time, and amounts to calculating the Chow F-statistic. This test statistic takes the following form: $SupF = SupF_{t/T}$, where $F_{t/T}$ is the F-test statistic. To perform the $SupF$ test requires truncation of the sample size T. We follow the approach in Hansen (1992) and use the subset $[0.15T, 0.85T]$.

The $MeanF$ test is appropriate when the question under investigation is whether or not the specified model is a good model that captures a stable relationship (Hansen, 1992). It is computed as an average of the $F_{t/T}$. Finally, the L_C statistic is recommended if the likelihood of parameter variation is relatively constant throughout the sample. The test results and their probability values are reported in Table 7. They indicate parameter stability, since the probability values for each test are significant at the 5 per cent level. This indicates that the structure of the parameters have not diverged abnormally over the period of the analysis.

VI.3 Variance decomposition analysis

The variance decompositions reveal the percentage of forecast error variance for each variable that is attributed to its own innovations and to shocks to the other system variables. The variance decompositions (up to 10 years) for the model are presented in Table 8. These variance decompositions are generated by disturbing each variable in the estimated system by one standard deviation. Given this disturbance, the forecast error variance of any variable is decomposed into the proportion attributed to each of the random shocks.

Amongst the key findings: on average over the ten-year horizon, about 65% of the variations in the forecast error for the fertility rate can be explained by its own innovations. A shock in the female illiteracy rate explains, on average over the ten-year horizon, about 10% of the variance in the fertility rate. Similarly, a shock in infant mortality rate – on average over the ten-year horizon – explains about 9% of the variance in the fertility rate.

The results also indicate that a shock in GDP and female illiteracy and mortality rates, together, explain about 36.0% of the variation in the fertility rate in the short-run (a three-year horizon), rising to around 40.4% at the five-year horizon and finally accounting for about 41.3% of the variation in the long-run (at ten-year horizon). These results generally point to the fact that a large proportion of the variation in China's fertility rate is explained by the combined impact of variables. These results indicate that the role of family planning policy has been smaller than that of socio-economic development. This implies that the contribution of socio-economic development to the fertility transition in China has been underestimated.

It is worth comparing our results with those of Masih and Masih (2000). On the determinants of fertility rate for India, they found the use of contraceptives and female education explained around 94% of the variation in fertility over a 10-year horizon – a result contrary to our findings on China. However, there are important differences in the variables used in modelling the fertility rates for India and China. Masih and Masih (2000) used contraceptive usage and female secondary enrolment rate. It should also be noted that the Masih and Masih study is based on only 26 years of data (1965-1990), and the fact that the authors use the Johansen approach to cointegration, which is not robust to small sample sizes, means that the results should be viewed with caution. We did not use the contraceptives variable due to the unavailability of time series data for our sample period. Our use of the dummy variable to capture the effects of family planning policy indicates that it has contributed to around 12% fall in fertility in China since it began in 1970. And together, GDP, mortality and illiteracy rates explain over 40% of the variation in China's fertility rate.

VII Conclusions and policy implications

The present study uses a cointegration and variance decomposition analysis to examine the relationship between fertility rate and income, mortality rate, female illiteracy rate and female labour force participation rate for China over the period 1952-2000. Dickey-Fuller (1979, 1980), Phillip Perron (1988) and Elliot Rothenberg Stock (1996) point-optimal tests for unit roots indicate that all variables are integrated of order one. This allows us to proceed with the test for cointegration. We apply the Johansen (1990) and Johansen and Juselius (1988) test for cointegration which reveal the existence of a cointegration relationship among the variables. We find that in the long-run all variables appear with the expected signs. For instance, mortality and illiteracy rates positively impact the fertility rate while income and female labour force participation rates negatively impact the fertility rate in China.

We use a dummy variable to capture the effects of the family planning policy in China. We try to investigate its impact at different stages of China's fertility transition. We find that in the years the policy was in place (between 1970-1980) fertility rates have been falling by some 10%, while during the 1970-2000 and 1980-2000 periods fertility rates have been falling by around 12%. These results do not support the often-held claim of Chinese policy makers and scholars that China's fertility transition owes much to the "awesome strength" of the family planning policy. From this, we conclude that the role of family planning policy is exaggerated.

Apart from investigating this casual relationship, we undertake a variance decomposition analysis with the aim of finding the percentage of forecast error variance for each variable that is attributed to its own innovations and to shocks to the other system variables. We find that on average about 65% of the variations in the forecast error for the fertility rate is explained by its own innovations. The results also reveal that a shock in GDP, female illiteracy and mortality rates, together, explain about 36% of the variation in the fertility rate in the short-run and about 41% of the variation in the long-run. These results generally point to the fact that a large proportion of the variation in China's fertility rate is explained by the combined impact of the socio-economic changes.

In all, our analysis provides evidence that while the fertility decline in China is a product of both strict population policy and rapid socio-economic development, family planning policy has played a much smaller role than socio-economic development. In this light our empirical findings are more consistent with the conventional 'structural' hypothesis, which emphasizes the significant role of socio-economic structural change as a precondition for 'initial' fertility decline, than with the recent "ideational" hypothesis, which emphasises the crucial role played by the policy variables to ensure the "initial" fertility decline.

Finally, we can draw some important policy implications from these findings: Firstly, long-term socio-economic development, such as further female education and mortality decline will be essential for sustaining the low fertility levels. Secondly, prompt and appropriate adjustment of the current one-child policy will not induce fertility rebound. The Chinese government and most scholars recommend maintaining current family planning policy because of the perception that relaxing the one-child policy will induce fertility rebound. This concern is based on the misunderstanding that the principal factor of fertility transition is the government's family planning policy. However, according to our findings, it is clear that the role of the government's policy is exaggerated. In this light, we recommend prompt and appropriate adjustment of the current strict family planning policy. We believe that this course of action will alleviate the envisaged aging problem in China.

Thirdly, we believe that using the market to regulate population growth will be more effective in maintaining low fertility levels. China's strict one-child policy, which depends on coercion and force to curtail excess births, has been criticised by the international community and is also not acceptable to most people in China. Further, with the diminishing of government power in the aftermath of the market-oriented reform since 1978, the effectiveness of family planning policy has been eroding. Hence, it is recommended that the government use market-based incentives and disincentives to motivate couples to reduce family size. Meanwhile, the government's family planning resources should be diverted towards encouraging a greater use of contraceptives and supplying reproductive health services, especially in the rural areas.

In closing, the key contribution of our study is worth documenting. There is little doubt that a time series analysis of the determinants of the fertility rate in China was timely, if not overdue. In doing so, we departed from the plethora of cross-sectional studies on the fertility rate in China. The outcome is that we have provided a useful set of results that, we believe, will appeal to both Chinese scholars and policy makers, particularly, given the importance of fertility in determining economic growth (Barro, 1997). Further, there remains scope for extending the present model by incorporating the contraceptive use variable – a variable found to be a significant determinant of India's fertility rate (Masih and Masih, 2000) – data for which was not available for the sample size used in the present study. Lastly, for the first time in the fertility literature we introduced the Hansen (1992) stability test. Empirical results support the stability of the estimated elasticities over time. It follows, then, that our results are reliable.

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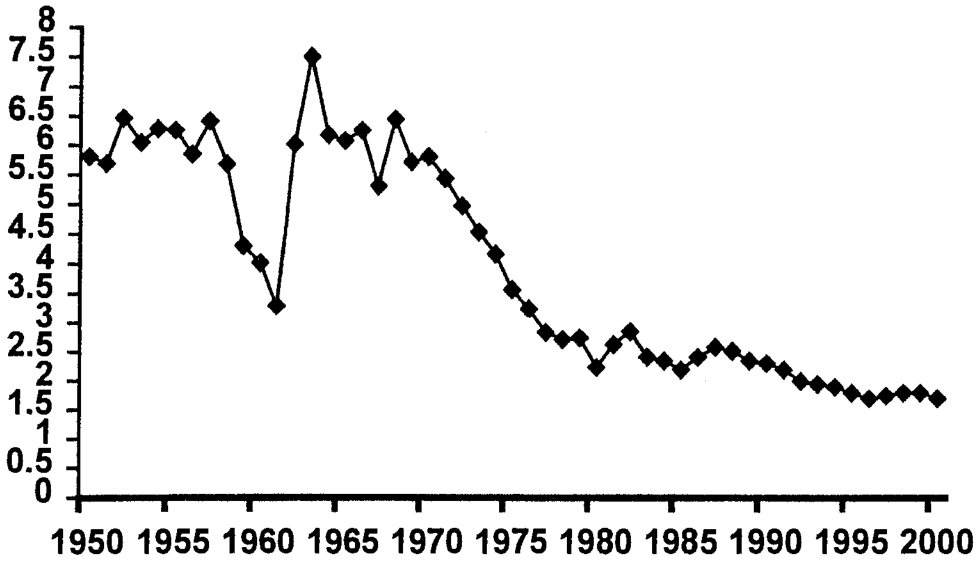
Figure 1: China's Total Fertility Rate, 1950-2000



Source: United Nations Data Sheets, 2001.

Table1: Comparison of socio-economic development levels between China and Low-income countries

Social Development indicators	China			Low-income Countries	
	1952*	1970	2000	1970	2000
Per capita GDP (US$)	40	120	840	136	410
Total fertility rate	6.47	5.81	1.7	6.7	4.0
Urban population (% of total)	12.5	17.4	32	13.95	31
Life expectancy at birth	35.3	61.7	70	43.5	59
Female labour force participation rate (%)	39.4	41.7	44.9** (1990)	25.8	34.6** (1990)
Infant mortality rate (‰)	101	69	32	138.69	76
Female illiteracy rate (%)	76	64.5	23.7	75.2	47

*The data of the low-income countries in 1952 is unavailable.
** The data of female labour force participation rate in 2000 is unavailable
Source: World Bank On-line database (**www.worldbank.org**) and World Bank database from DX for windows

Table 2: Augmented Dickey-Fuller, Phillips-Perron and Elliot Rothenberg Stock (ERS) Point-Optimal Unit Root tests, 1952-2000

Variables in level form	ADF statistic (LL) [CV]	PP statistic (BW) [CV]	ERS (LL) [CV]
$\ln FR$	-2.62 (0) [-3.50]	-2.70 (1) [-3.50]	8.75 (0) [5.72]
$\ln GDP$	-0.83 (2) [-3.51]	-0.58 (1) [-3.50]	62.40 (0) [5.72]
$\ln IMR$	-2.13 (1) [-3.51]	-3.37 (4) [-3.50]	12.99 (1) [5.72]
$\ln FLR$	-2.62 (0) [-3.50]	-2.70 (1) [-3.50]	8.75 (0) [5.72]
$\ln FLP$	1.59 (0) [-3.50]	1.15 (2) [3.50]	54.13 (0) [5.72]
Variables in first difference form			
$\Delta \ln FR$	-6.85 (0) [-2.92]	-7.07 (6)[-2.92]	1.05 (0) [2.97]
$\Delta \ln GDP$	-3.61 (1) [-2.92]	-3.42 (7) [-2.92]	1.77 (1) [2.97]
$\Delta \ln IMR$	-10.66 (0) [-2.92]	-11.34 (2) [-2.92]	1.33 (0) [2.97]
$\Delta \ln FLR$	-6.85 (0) [-2.92]	-7.07 (6) [-2.92]	1.05 (0) [2.97]
$\Delta \ln FLP$	7.02 (0) [-2.92]	5.00 (6) [2.92]	1.87 (1) [2.97]

MacKinnon critical values for rejection of hypothesis of a unit root at the 5% level of significance

Table 3: Johansen cointegration test, 1952-2000

H_0	H_A	λ_{max} test	$\lambda_{max}(0.95)$	H_A	λ_{tr} test	$\lambda_{tr}(0.95)$
$r=0$	$r=1$	60.65*	41.00	$r\geq 1$	149.40*	90.45
$r\leq 1$	$r=2$	36.02*	35.17	$r\geq 2$	88.74*	66.52
$r\leq 2$	$r=3$	28.22	28.82	$r\geq 3$	52.72*	45.58
$r\leq 3$	$r=4$	12.66	22.99	$r\geq 4$	24.49	29.75

Notes: *indicates statistical significance at the 1% level. r stands for the number of cointegrating vectors.
Source: Eviews 4.0.

Table 4: Long-run results of China's fertility decline, 1952-2000

Variables ($lnFR$ is the dependent variable)	Coefficient	Standard errors
$lnGDP_t$	-0.3998	0.2113*
$lnIMR_t$	0.3368	0.1439**
$lnFLR_t$	0.6351	0.6149
$lnFLP_t$	-1.3789	0.5038***

Notes: *(**)*** indicates statistical significance at the 10%, 5% and 1% levels respectively.

Table 5: Error correction model, 1952-2000

Variables (ΔFR_t is the dependent variable)	Coefficient	t-statistics
Constant	-0.0467	1.0104
ΔFR_{t-1}	-0.1969	1.3511
ΔGDP_t	-0.8373***	3.4038
ΔIMR_t	-0.5748***	6.7155
ΔMR_{t-1}	-0.2159*	1.8169
ΔLR_t	2.9627	1.4184
ΔFL_{t-1}	-1.8749**	2.1373
FPP_t	-0.0944***	2.8148
EC_{t-1}	-0.1922***	3.6637

Note:*(**)*** significance at the 10% 5% and 1% levels, respectively.

Table 6: diagnostic tests for the error correction model

Diagnostics	Results
R^2	0.7013
$\overline{R}^2$	0.6222
σ	0.0862
$\chi^2_{Auto}(2)$	1.3230
$\chi^2_{Norm}(2)$	2.4709
$\chi^2_{ARCH}(2)$	0.0393
$\chi^2_{White}(21)$	16.0319
$\chi^2_{RESET}(2)$	1.9500

Where σ is the standard error of the regression; $\chi^2_{Auto}(2)$ is the Breusch-Godfrey LM test for autocorrelation; $\chi^2_{Norm}(2)$ is the Jarque-Bera normality test; $\chi^2_{RESET}(2)$ is the Ramsey test for omitted variables/finctional form; $\chi^2_{White}(11)$ is the White test for heteroscedasticity. Critical values for χ^2 (2)= 9.21 and for χ^2 (21)=38.93.

Table 7: Hansen test for parameter stability

Tests	Test statistic	Probability value
L_C	0.1208	>0.20
MeanF	1.1209	>0.20
SupF	2.8532	>0.20

Note: The test program is available from http//www.ssc.wisc.edu/bhansen/

Table 8: Decomposition of variance (percentage of forecast variance explained by innovations)

Years	Fertility rate	GDP	Mortality rate	Illiteracy rate	Female lab. Force
1	100.00	0.000	0.00	0.00	0.00
2	80.09	12.88	3.97	1.14	1.92
3	61.79	17.73	11.64	6.62	2.21
4	59.39	17.39	11.76	8.93	2.53
5	57.09	18.29	11.29	10.85	2.47
6	57.89	18.12	10.68	11.91	2.19
7	57.45	17.85	10.02	12.68	1.99
8	57.19	17.36	9.89	13.71	1.84
9	57.26	16.45	9.81	14.75	1.74
10	56.99	15.57	9.85	15.89	1.68

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