The Macroeconomic Consequences of Population Ageing and The Population Policy Choice in China:

An Applied General Equilibrium Analysis

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ABSTRACT:

The issue of population ageing in China is receiving much attention from scholars and policy–makers. China's strict family planning policy has resulted in a dramatic decline in fertility since the 1970's. This decline has contributed significantly to the rapid ageing of the population. The common suggestion from scholars is that an appropriate set of policy responses may help to decelerate the rate of population ageing and avert its adverse effects on macroeconomic growth in China. Using a dynamic Computable General Equilibrium model, the paper evaluates the macroeconomic effects of three alternative population-ageing scenarios for the 21st century. The main finding is that for a given rate of productivity improvement, relaxation of the current one-child policy will increase the GDP growth rate but decrease the growth rate of per capita income and consumption. Consequently, extra GDP growth derived from higher population growth is not necessarily good for per capita material welfare. An implication of this finding is that population policy has to be combined with policies in other spheres in order to reap the potential economic benefits from liberalizing China's family planning regime.

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1. Introduction:

The population ageing issue has received much attention in China since the early 1990's. Scholars and policymakers have become concerned with the increasing life expectancy of the elderly and the rapid fertility decline since the 1970's that was caused mainly by the strict family planning policy. These two facts combined to create in China the most rapid rate of population ageing in the 21st century. According to the medium variant population projection from United Nations, the proportion of the population aged 65 and over will increase from 6.9% in 2000 to 8.1% in 2010, 15.7% in 2030 and 22.7% in 2050 (United Nations, 2000). Accordingly, many scholars suggest that appropriate changes to the current one-child family planning policy may decelerate the rate of population ageing and mitigate its negative effects on macro economic growth in China.

This paper, using a dynamic Computable General Equilibrium (CGE) model, simulates the impact of different population-ageing scenarios generated by alternative population policies on the Chinese economy for the 21st century. The focus of the analysis is on macroeconomic variables such as growth rate of real GDP, consumption, investment, the balance of trade and returns to labour. Welfare implications in terms of per capita income and the material standard of living will be highlighted.

There is a growing literature that deals with macroeconomic consequences of population ageing[1]. Most of the research in this field is focused on developed countries, especially

[1] See Bos and Weizsacker, 1989; Culter et al, 1990; Masson and Tryon, 1990; World Bank, 1994; Miles (1999); Faruqee, 2002; and etc.

on the OECD countries[2]. The population ageing problem in developing countries has attracted attention of scholars and policy-maker only since the late 1980's. As China, the most populous country in the world, is expected to experience extremely rapid ageing, she has attracted most attention. However, most research on China's population ageing focuses on the effects of the pension system and old age security arrangements (for example, Friedman, et al., 1996, McCarthy and Zheng, 1996, World Bank, 1997, Zeng and George, 2001, and Wang et al., 2001). To the best of my knowledge, there is only one paper, from IMF (Cheng, 2003), which explores the impact of different fertility levels on demographic structure and the corresponding macroeconomic implications. But it uses a multi-period overlapping-generations model which disregards productivity change.

The analysis of the present paper differs from others in the literature in several ways. First, rather than using an Overlapping Generations model or multi-country model, the present paper employs a Computable General Equilibrium (CGE) model to simulate the macroeconomic implications of different demographic structures that correspond to the different population policy options. Secondly, rather than looking at steady states, the paper uses dynamic CGE modelling to study the transition path, in the spirit of Auerbach and Kotlikoff (1983) and Cheng (2003). Thirdly, this paper goes beyond economic growth and looks at the material welfare implications of population ageing. This approach differs from the majority of work which looks only at growth in the aggregate. Fourthly, rather than describing the possible effects of population ageing on the basis of population projections and conjecture, the paper uses a CGE model to obtain concrete quantitative information about the macroeconomic consequences of different population policies.

The paper is organized as follows: the next section provides an overview of fertility change in China that occurred during the second half of the 20th century. Section three

[2] See, Auerbach et al. (1989); Hurd and Yashiro,1997; Hviding and Merette, 1998; Fouègre and Merétte (1999), McMorrow and Roeger,1999; Kosai, Saito and Yashiro, 1998; and a large number of research reports from the OECD, such as "Ageing in OECD countries: a status report", 1997; "Maintain prosperity in an ageing society", 1998; "Reforms for an ageing society", 2000 etc..

discusses the change in total population size and demographic structure associated with three alternative population projections. The model specification and methodology are explained next. Sections five and six report the simulation results, the penultimate section presents conclusions and policy implications, and the final section discusses the limitations and extensions of this study.

2. Background

2.1 Historical overview of China's fertility and age structure

After high population growth from 1950 to 1970 (the total fertility rate (TTR) was 6.4 in 1952 and 5.81 in 1970), China has experienced rapid fertility decline in response to various social and economic factors. Within a span of 10 years, the TFR plummeted from 5.71 children per woman in 1970 to just 2.24 in 1980. It continued to decline to 1.8 in 2000 (Figure 1). Better living conditions and medical services have reduced mortality and extended life expectancy in both urban and rural areas. Life expectancy at birth has increased from 36.3 years in 1960 to 70.3 years in 2000. Both increasing life expectancy of the elderly and the rapid fertility decline combined to create a dramatic change in the demographic structure and population size in China. Moreover, the ageing process is expected to accelerate in the coming decades as the baby boomers born in the 1950s, 1960s and early 1970s, currently numbering more than 527 million, approach retirement age in the period 2015 to 2040 (Zeng and George, 2000). The above facts combined to create in China an extremely rapid ageing during the 21st century[3].

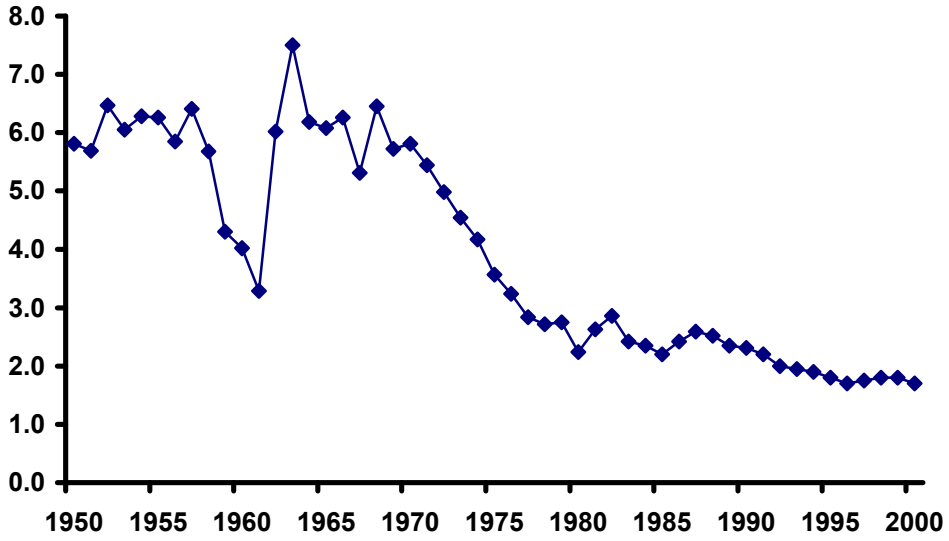
One potential solution to decelerate the extremely rapid ageing lies in an appropriate and prompt policy adjustment to China's current population policy. Any such policy change will affect the fertility rate with implications for the future demographic structure and population size. Both changes in population structure and in population size have wide-ranging economic implications.

[3] The proportion of the elderly in China will increase much faster than in almost all other countries in the world. It will take about 20 years for the elderly population to increase from 10 to 20 percent in China

2.2 The debate about adjustments of the current one-child-per-couple policy

In the early 1990s, government officials and scholars in China began to discuss and explore the possibility of adjustments to the present one-child policy (Qiao, 1995, 1999; Editorial Board of Population Research, 2000, 2002; China's Fertility Policy Research Group, 2004). So far, three major population policy options have been discussed.

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



Source: China Population Statistical Yearbook, various issues and China Family Planning Yearbook, various issues

Some scholars recommend that the current one-child policy should be changed smoothly to a universal two-child policy. The dominant rationale for the increase in the birth rate is to decelerate the rapid change in the population structure. Other scholars maintain that such a relaxation of the population policy will cause a new baby boom given the high fertility rates in many poor and backward rural areas. They worry that the induced increase in the population size will put high pressure on the labor market and on the ecological environment, and restrain rapid economic growth. Accordingly, they vigorously insist on retaining the current one-child policy. The third opinion is a compromise scenario that allows for a partial relaxation of the restrictive current policy regime, such as in big cities like Beijing and Shanghai. This focus on couples where both

(2017-2037), compared to 23 years in Japan (1984-2007), 61 years in Germany (1951-2012), 64 years in

come from one-child families, and allow to have a second child after several years spacing from the first child.

2.3 Three fertility scenarios corresponding to the three population policies

I use the following fertility based on the Development Research Centre of State Council in China (2000) to estimate the three population policy options:

- **Baseline scenario -- One-child policy[4]:** if the Chinese government maintains the current one-child policy, the TFR will decline further from 1.8 in 2000 to 1.62 in 2010[5], and remain there until 2100.
- **Scenario 2 --- Partial adjustment to the one-child policy:** this captures the compromise solution mentioned above. The partial adjustment to the current one-child policy with suitable "spacing" is also called "one and one half child policy". This option maintains the TFR at 1.8 until 2100, a rate corresponding to the average TFR level during the late 1990's. The first and second policy options are also referred to as "negative population increase strategies"
- **Scenario3 --- two-child policy:** The government replaces the current one-child policy with a universal two-child policy at the beginning of this century. In this scenario, the TFR increases from 1.8 in 2000 to 2.1 in 2010, where it remains until the end of this century. This population policy is also considered a "zero population growth strategy".

3. Population projections for the 21st century under three population policies in China

Population projections under the three fertility regimes were simulated by the Development Research Centre of State Council in China (DRC, 2000). The profiles for

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Sweden (1947-2011) (United Nations, 1999, also see Zeng and George,2000)

[4] One-child per couple policy in China is that an urban couple can only have one child, but a rural couple can have a second child if the first is a girl.

[5] Development Research Centre of State Council in China (DRC) (2000) uses 1.62 to represent the TFR under one-child policy. 1.62 is called "policy fertility level" in China by policymakers and scholars. It represents the fertility level under one-child family planning policy and reflects the fertility differential between urban and rural areas (see the Selected Research Reports of DRC, 2000 for details about the TFR of 1.62).

the 21st century of total population, labour force dynamics and proportion of elderly population under three fertility scenarios are shown in Tables 1, 2 and in Figure 3.

3.1 Total population size

In Table 1, the total population size differs significantly between the three scenarios, especially after the year 2030. If China keeps its one-child policy (TFR remains at 1.62), total population will peak at 1402 million in 2026, decline subsequently to reach 800 million in 2100. In contrast, under the two-child policy (TFR remains at 2.1), population reaches a peak of 1550 million in 2045. The total population will fall to 1533 million in 2100. There will be a gap of 733 million between the one-child and two-child policies at the end of this century. In scenario 2, population will peak at 1442 million in 2030. In 2100, the total population will be 1033 million. The gap of total population at the end of this century between scenario 2 and baseline is 233 million.

Table 1: China's Population projection: total population size (million)

year	Baseline (one-child Policy)	scenario 2 (partial adjustment of one-child policy)	scenario 3 (two-child policy)
2000	1270	1270	1270
2010	1344	1353	1369
2020	1393	1420	1466
2030	1396	1442	1518
2040	1352	1423	1547
2050	1272	1369	1544
2060	1168	1294	1528
2070	1068	1225	1527
2080	967	1154	1522
2090	879	1092	1529
2100	800	1033	1533
Peak of total population	**1402**	**1442**	**1550**
year	**2026**	**2030**	**2045**

Source: China Development Studies: Selected Research Report of Development Research Centre of the State Council, China Development Press, 2000

3.2 Working age population and its growth rate

In China, the working age population covers the male population aged from 16 to 59 and the female population aged from16 to 54. The three scenarios show the same growth rate of the working age population in China during the first decade (Table 2). The working age population will keep increasing to a peak of 870 million in 2016 under all scenarios.

The growth paths of the working age population start to diverge after 2016. In the baseline scenario, the working age population decreases at the fastest rate. It will decline to 386 million by 2100, which is less than half the total working age population at year 2000. In scenario 3, the decline in the working age population is the slowest. The working age population will reach 785 million in 2100. This means if the government retains the current one-child policy beyond 2020 then China will have a rapidly shrinking labour force. Comparing the three scenarios, the difference in the size of working age population is relatively small throughout the initial two decades, but gradually increases after that.

Table 2: Working age population growth trend in China

(Male aged 16-59 and female aged 16-54)

	Baseline (one-child policy)		Scenario 2 (partial adjustment of one-child policy)		Scenario 3 (two-child policy)	
year	total (million)	Average annual growth rate (%)*	total (million)	Average annual growth rate (%)*	total (million)	Average annual growth rate (%)*
2000	780	1.34	780	1.34	780	1.34
2010	857	0.99	857	0.99	857	0.99
2020	856	-0.01	858	0.01	861	0.05
2030	778	-0.91	795	-0.73	823	-0.44
2040	727	-0.66	760	-0.44	816	-0.09
2050	643	-1.16	697	-0.83	789	-0.33
2060	576	-1.04	655	-0.60	795	0.08
2070	524	-0.90	617	-0.58	789	-0.08
2080	470	-1.03	577	-0.65	785	-0.05
2090	427	-0.92	547	-0.52	791	0.08
2100	386	-0.96	513	-0.62	785	-0.08

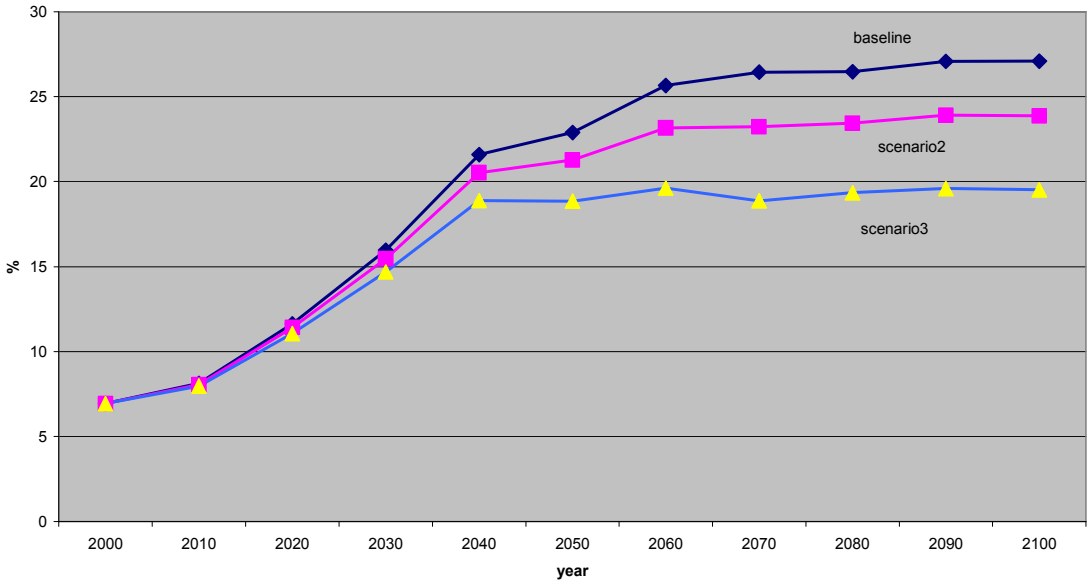
Source: China Development Studies: Selected Research Report of Development Research Centre of the State Council, China Development Press, 2000

* The growth rate refers to the average annual growth rate over each decade.

3.3 The proportion of elderly population and population ageing

The extent and speed of ageing in China during this century depend on the fertility level (Figure 3). The proportion of the elderly population, defined as the population aged 65 and above over the total population, in the baseline (TFR is 1.62) rises at a faster rate than in the alternative scenarios. It increases to 15.96% in 2030, 22.89% in 2050 and finally to 27.08% in 2100. In scenario 2 (TFR is 1.8), the proportion of the elderly will rise to 23.87% in 2100, while in scenario 3 (TFR is 2.1), this proportion will be 19.52%, that is approximately one-third lower than in the baseline scenario.

Figure 2: The proportion of elder population aged 65 and above over total population in China



Source: China Development Studies: Selected Research Report of Development Research Centre of the State Council, China Development Press, 2000

4. The modelling framework

This paper uses a computable general equilibrium model -- PRCGEM to explore the macroeconomic effects of alternative population policies in China. PRCGEM is a comparative static CGE model of China (See Zheng and Fan 1999 for details). The core CGE structure of PRCGEM resembles that of the ORANI model (see Dixon et al 1982 and Horridge 2001). In this analysis, PRCGEM is adapted to run in a recursive dynamic fashion (see Mai et al 2003 and Mai 2003).

Three sets of policy scenarios are simulated. The first population scenario (maintaining the current one-child policy) is defined as the baseline in the model. The effects of the second and third scenarios are represented as percentage deviations from the baseline. Analysis of the simulation results provides criteria for the economic evaluation of the alternative policy strategies.

Long-run closure of the model is achieved by assuming as exogenous the rate of return on capital and the employment level. The rate of return on capital is determined by the exogenously given world rate of return. Capital mobility, both internally between sectors and externally between China and the rest of the world, maintains interest parity fixing the domestic rate of return at the world level.

The level of employment is predetermined by the history of population and labour market. Changes in labour supply resulting from the alternative population policies are reconciled with the demand for labour by adjustments of the real wage rate to maintain labour market equilibrium (see Annex B for the illustration of the main structure of the model).

5. The baseline scenario: one-child policy

5.1 Key baseline assumptions

Some important structural characteristics of the economy are established in the baseline simulation and retained in the policy simulations.

5.1.1 The rate of productivity improvement: the rate of productivity improvement is treated as exogenous and set at 3% per year. This assumption is informed by the following considerations:

- **Existing empirical research**: Young (2000) estimates the annual growth rate of Total Factor Productivity (TFP) in China from 1978-98. He finds the growth rate of TFP falls in the range of 3.0% to 1.4%. The upper limit of that range is based on the official GDP deflators. The lower result is obtained by a few adjustments to the official GDP growth rate[6]. Wang and Yao (2001) from the World Bank observe considerable volatility in the annual growth rate of TFP. They identify a negative average annual growth rate of -1.56% during the pre-reform period (1952-1977) and subsequently (1978-99) a positive annual growth rate of 2.80%. Both studies are based on the assumption that the labour share of input is 0.6.

- **Historical CGE simulation from 1993 to 2000:** I have used the PRCGEM to determine the implicit rate of productivity improvement in China for the period of 1993 to 2000. This historical simulation yields an annual rate of productivity increase over that period of 4.5%.
- **The macroeconomic environment in China:** with entry to the WTO and with the continued progress of globalization, economic activity in China is exposed increasingly to global markets. Increasing openness and the associated stimulus to competition and innovation are likely to raise the average productivity growth rate beyond historical levels.

These three sources of information yield quite varied estimates of productivity growth that range from 1.4% to 4.5%. The systematic econometric estimates by Young (2000) and Wang and Yao (2001) place the productivity growth rate below 3%. At the same time, the changes in China's economic environment establish a presumption in favor of a shift to a higher growth rate. Consequently, a rate of the order of 3% would seem to be a plausible working hypothesis.

5.1.2 Cost-neutral change in capital-labour ratio: the capital-labour ratio is assumed to increase by 1% per annum. This assumption is informed by the historical simulation of the CGE model which revealed a rising trend in the capital-labour ratio in China (Mai, 2003). This implies that industries are likely to use more capital-intensive technology.

5.1.3. The labor force participation rate: The labour force participation rate depends on the legal retirement age and a host of other socioeconomic factors. In China, the retirement age is 55 for women and 60 for men. I assume that the retirement age will not change until 2050, when it will increase to 60 for women and 65 for men. While this change will increase the overall participation rate, the participation rate in the age group 15 to 25 may decline as a result of developments in education. The overall labour force

[6] See Young (2000) for details about the adjustments to the official GDP growth rate in China.

participation rate of the entire working age population is assumed to remain constant at 80%[7].

5.1.4 The unemployment rate: According to the China Statistical Yearbook the unemployment rate has tended to fluctuate around 3% since 1995**.** It is assumed that this level of the unemployment rate will be maintained until 2100.

5.2 The shocks of supply of labour and population in the baseline

Given the foregoing assumptions, the annual percentage change of supply of labour and population (Table 3) derived from the baseline population scenario (refer to Tables 1 and 2) was fed in the model.

Table 3: Baseline Scenario: one-child policy:
Annual growth rate of population and labour force (per cent)∗

year	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
population	0.97	0.58	0.37	0.02	-0.32	-0.59	-0.82	-0.86	-0.95	-0.91	-0.9
labour force	1.34	0.99	-0.01	-0.91	-0.66	-1.16	-1.04	-0.9	-1.03	-0.92	-0.96

∗ The growth rate refers to the average annual growth rate over each decade.

5.3 Baseline simulation result - macroeconomic effects with one-child policy

Table 4 reports the growth paths of real GDP and primary factor inputs during the 21st century. The growth path of GDP basically coincides with the long-run development strategy of the Chinese government. The average annual growth rate of real GDP is 7.4% during the first decade, and then gradually decreases to 3.6% in the fifth decade. After that it fluctuates around 3.7% throughout the rest of the century.

[7] From China Statistical Yearbook, the participation rate in 1990 was 74.5%, 76.9% in 1994 and 80% in 2000. Since 80% is already a very high rate by world standards, it is assumed that the participation rate will stay at 80% till 2100.

Table 4: Baseline scenario --- One-child policy:
Average annual growth rate of real GDP and factor inputs (per cent)

Year	Real GDP	Employment	Capital stock	Productivity improvement
2001-2010	7.4	1.0	5.0	3.0
2011-2020	5.6	0	3.5	3.0
2021-2030	4.2	-0.9	2.3	3.0
2031-2040	4.3	-0.7	2.4	3.0
2041-2050	3.6	-1.2	1.9	3.0
2051-2060	3.7	-1.0	1.9	3.0
2061-2070	3.8	-0.9	2.0	3.0
2071-2080	3.6	-1.0	1.9	3.0
2081-2090	3.7	-0.9	1.9	3.0
2091-2100	3.6	-1.0	1.9	3.0

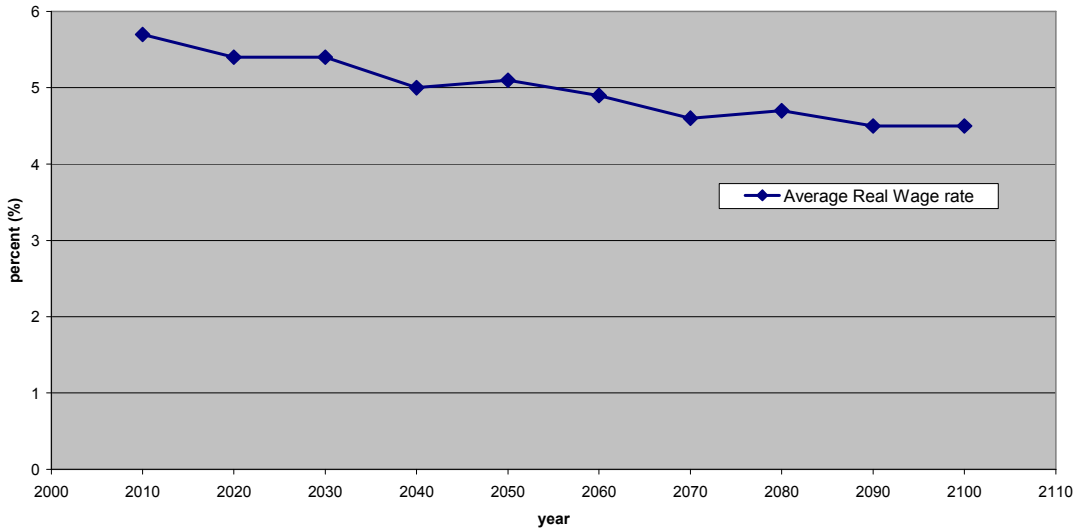
Source: Baseline simulation

As Table 4 shows, after the initial increase during the first decade, the growth rate of employment falls continually throughout the rest of the century. This reflects the progress of population ageing. As a result, China has to rely on increases in the physical capital stock and productivity improvement to sustain her rapid growth, given the fixed land resource.

Since the rate of growth of the capital stock deteriorates sharply after the first decade to approximately 1.9% at the end of the century, it follows that the last resort for supporting the growth rate of output is improvement of productivity. As previously mentioned, that rate is exogenously fixed at 3%.

The reason for the low rate of increase of the capital stock is that the demand for capital falls when the rate of growth of employment falls. A back-of–the-envelope (BOTE) model illustrates the positive co-variation between capital and labour (see Annex A). The productivity improvement and the rising capital-labour ratio cause the capital stock to increase, while the declining labour supply causes the capital stock to fall. The percentage change of capital stock reflects the combined effect of these opposing forces. Given the constant increase rate of productivity and capital-labour ratio throughout this century, the declining rate of increase of the capital stock as shown in Table 3, reflects the reduction of employment generated by the population ageing.

Figure 3: Baseline scenario -- one- child policy: the percentage change of average real wage



Source: baseline simulation

Figure 3 shows the percentage change of average real wage during the 21st century. The positive change of real wage mainly reflects the productivity improvement (see Annex A for the calculation of changes in the real wage rate using BOTE model).

Table 5 shows the baseline macroeconomic performance from the expenditure perspective. Since the ratio of investment to capital by industry is assumed to be fixed in the model, the rate of growth of investment is therefore determined by the growth rate of capital.

The low growth rate of investment and the relatively low growth of consumption make room for export expansion[8]. It is assumed that China's exportable goods have some market power to influence prices in global markets. Hence, the expansion of exports from China will tend to depress their world price. Given fixed import prices, this will cause China's terms of trade to deteriorate while her trade balance improves. A sustained improvement of the trade balance eventually moves the trade balance into surplus.

[8] The model assumes that the growth rate of private consumption is determined by the growth rate of GDP. Government consumption is linked with the private consumption.

Provided the trade surplus is sufficiently large to service China's foreign debt, a surplus will emerge on current account. The current account surplus may be associated with capital outflows from China that move the capital account into deficit. Alternatively, the current account surplus may be used to accumulate holdings of international reserves.

Table 5: Baseline scenario --- One-child policy:
The macroeconomic performance in China

(Average annual growth rate: per cent)

Year	Real GDP	Investment	consumption	export	import
2001-2010	7.4	5.3	6.6	10.4	4.4
2011-2020	5.6	3.7	5.0	7.9	3.6
2021-2030	4.2	2.5	3.8	5.8	2.7
2031-2040	4.3	2.6	3.9	5.7	3.3
2041-2050	3.6	2.0	3.3	4.6	2.5
2051-2060	3.7	2.1	3.4	4.5	2.5
2061-2070	3.8	2.1	3.5	4.4	2.7
2071-2080	3.6	2.0	3.3	4.1	2.5
2081-2090	3.7	2.0	3.4	4.1	2.5
2091-2100	3.6	2.0	3.3	3.9	2.4

Source: baseline simulation

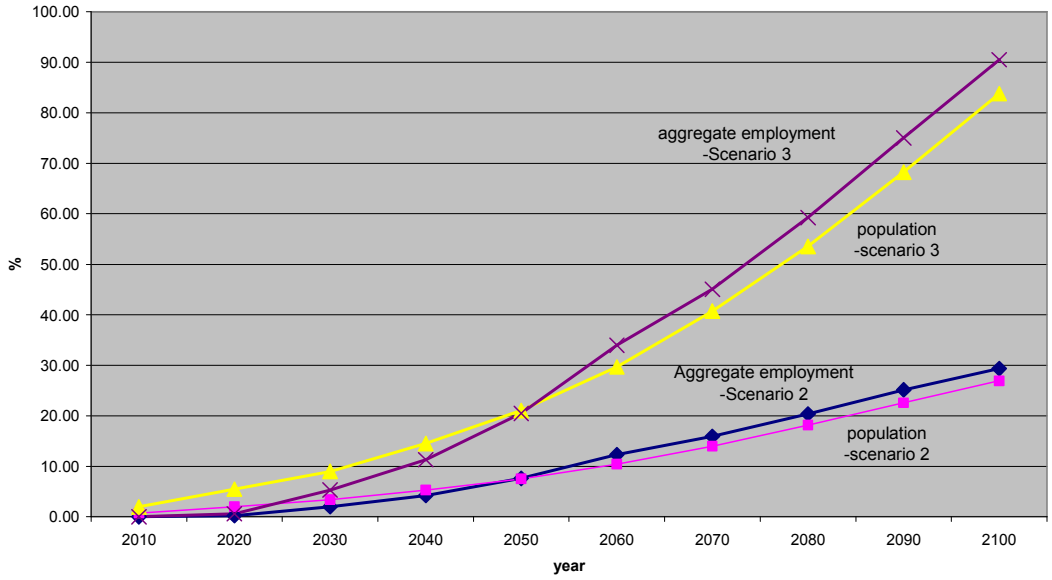
6. Simulation results for alternative population policies

6.1 The deviation from baseline of supply of labour and total population in scenario 2 and scenario 3

The supply of labour and total population in scenarios 2 and 3 are different from baseline because of the different population policy. Figure 4 shows the cumulative deviations of aggregate employment and total population size from the baseline scenario.

The higher fertility regime implies a faster increase in the growth of total population and of labour supply. As Figure 4 shows, at the end of the 21st century, the total population size will be 26.95% and 83.82% higher than the baseline in scenario 2 (TFR is 1.8) and scenario 3 (TFR is 2.1), respectively. Aggregate employment will be 29.37% and 90.51% higher than the baseline in scenario 2 and scenario 3, respectively.

Figure 4: the cumulative deviations from baseline of aggregate employment and population in scenario 2 and scenario 3



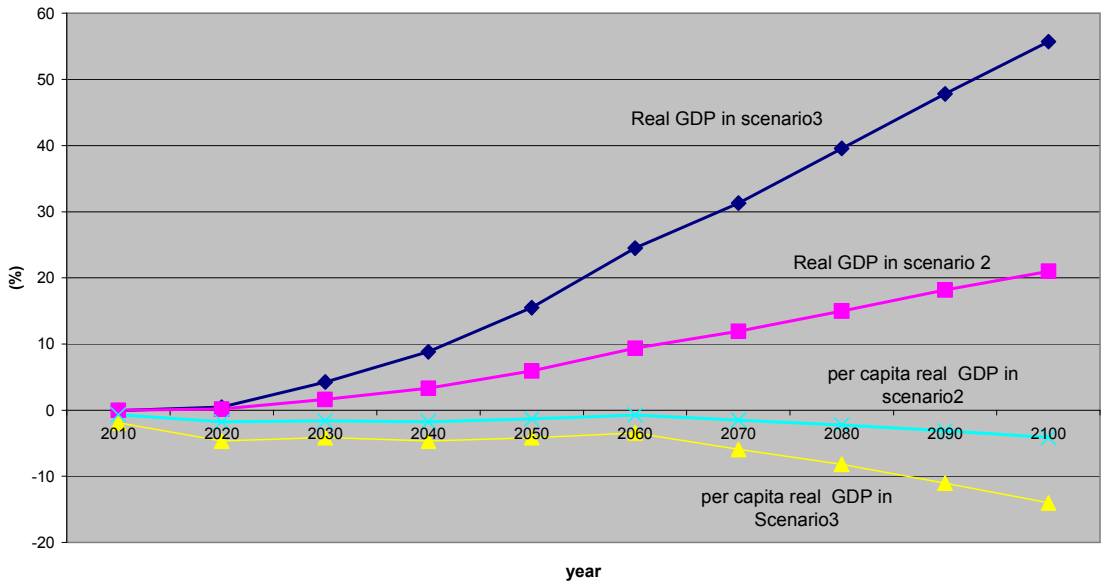
Source: alternative policy scenarios

6.2 The effects of relaxing one-child policy

The outcomes of the alternative policies of allowing households to have one-and-one-half and two children, respectively, were simulated. Figure 5 presents the cumulative deviations of these simulation results from the baseline scenario.

The distinguishing feature of these results is that real output grows significantly faster as the family planning policy is relaxed. However, in per capita terms, real output falls behind the baseline performance. That means that households' material living standards deteriorate with higher fertility rates (TFR is 1.62, 1.8 and 2.1 in baseline, scenario 2 and 3, respectively). A higher fertility regime supports higher growth rate of real GDP for identical rates of productivity improvement and cost-neutral change in the capital-labour ratio. At the end of the century, real GDP exceeds the baseline (one-child policy) by 56% and 21% under the two-child policy and 1.5 child policy, respectively. The reason is quite straightforward: a higher fertility rate supports a larger supply of labour; growth of labor supply drives growth of capital stock; both combine to create a higher GDP growth rate.

Figure 5:The cumulative deviation from baseline of real GDP and per capita real GDP under alternative popopulation policies

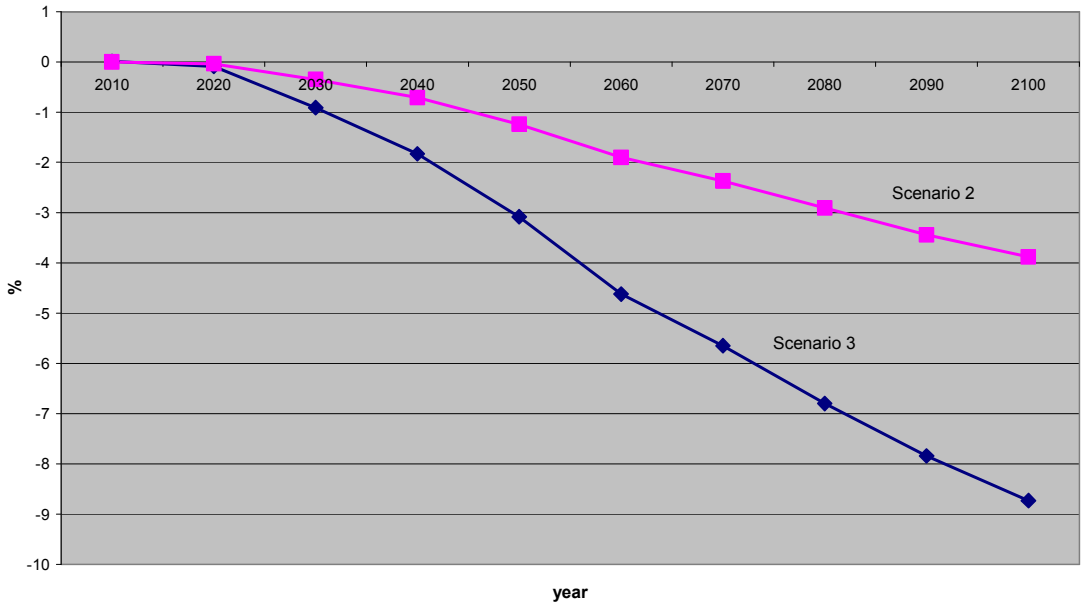


Source: alternative policy simulations

While multiple children may support higher growth rates of output, this does not translate into corresponding improvements in per capita terms. Figure 5 shows that per capita income is consistently lower than the baseline case in both hypothetical policy scenarios. The cumulative effect is that, at the end of this century, per capita income is 14% and 4% lower, respectively, in scenarios 3 and 2 compared to the baseline case.

Even though higher supply of labour stimulates the growth rate of both output and capital stock, it is not sufficiently higher to maintain per capita real income and living standards. The reason is that higher population growth requires higher exports leading to lower terms of trade (see Figure 6). The higher fertility regime also impinges negatively on per capita output and consumption by reducing the availability of the fixed factor (land) per person. Another factor, not recognized in the present version of the model is that high fertility regime requires increased demand for investment in housing, transportation and other living infrastructures to accommodate the increased rate of population growth. These resource demands crowd out consumption.

Figure 6: the cumulative deviation of the terms of trade from baseline in scenario 2 and scenario 3

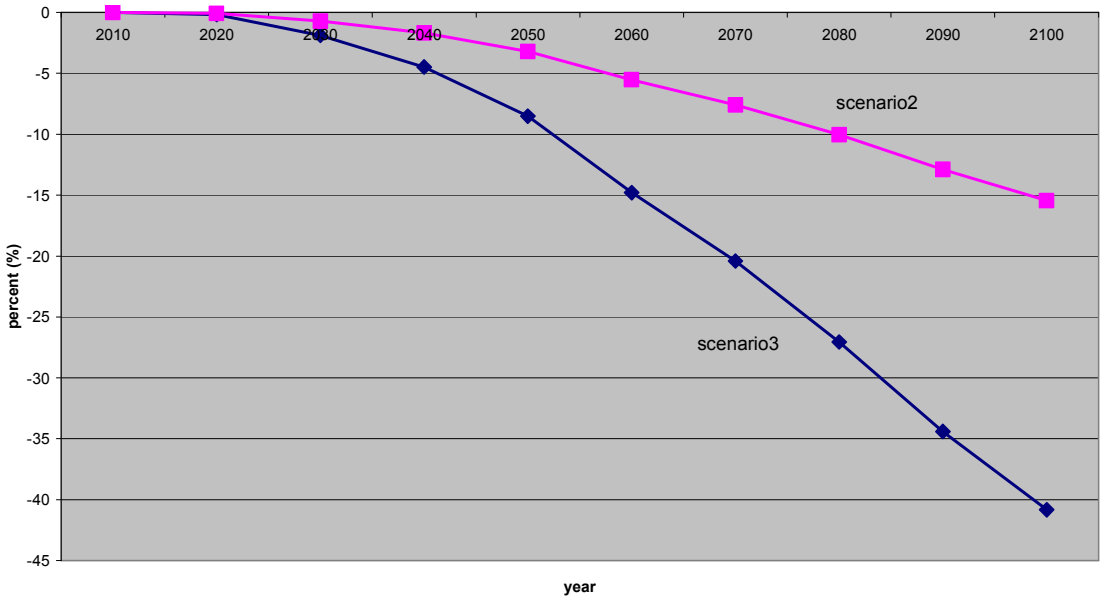


Source: alternative policy simulations

The growth path of per capita consumption displays the same pattern as per capita income.

Figure 7 shows the cumulative deviation from baseline of percentage changes of the average real wage in scenarios 2 and 3. The real wage rate is lower in higher fertility regimes because of two reasons: first, the further deterioration of the terms of trade in the higher fertility regime reduces the real income; secondly, the greater abundance of labour labour in the higher fertility regime reduces real wages.

Figure 7: The cumulative deviation from baseline of change of average real wage in scenario2 and scenario3



Source: alternative policy simulations

7. **Conclusions and Policy implications**

This paper uses a dynamic Computable General Equilibrium model to assess the macroeconomic effects in China of different population scenarios for the 21st century. It goes beyond economic growth and looks at the material welfare implications of population ageing.

A core finding of these simulation exercises is that for a given rate of productivity improvement, liberalization of China's family planning regime may increase the rate of growth of the economy while decreasing the growth rate of per capita income and consumption. The interesting and provocative implication is that growth and material well-being may not move in the same direction: that is, growth is not necessarily good for per capita real income. The adverse welfare effect reflects erosion of per capita income that occurs under multiple children policies. While those policies increase the rate of growth of output, they do not increase it enough to maintain living standards. In general, the CGE simulations indicate that the adverse macroeconomic welfare effects of population ageing may be avoided if total factor productivity improves sufficiently.

This finding carries two fundamental policy implications

- Any population policy has to be combined with policies in other spheres in order to reap the potential economic benefits from liberalization of family planning regimes.
- China may rely mainly on technical progress and productivity improvement to support her rapid economic growth. The government should implement policies to stimulate technical progress and productivity improvement to prepare for the challenge of population ageing.

8. Limitations and the extensions of the model

The present paper does not consider the macroeconomic implications of differences in the consumption patterns of different age groups. Differences in spending between the young generation, working age population and elderly people may change the composition of aggregate consumption expenditure in favour of more or less capital-intensive output. These induced changes in factor requirement have not been considered in the present simulation exercises.

Secondly, the present paper assumes a common real wage rate in rural and urban industries. This assumption may not correspond to reality. In China, there exists a large wage rate differential between rural and urban industries. This implies that urbanization and migration will induce further changes in relative factor demands.

Finally, the current paper only focuses on domestic income and does not explicitly recognize the influence of cross-border factor ownership. The inclusion of Net Foreign Liability (NFL) will show more exactly the macroeconomic effects of changes in the age structure. With higher population growth, the economy requires a larger capital stock and, therefore, a larger investment demand. To the extent that this demand for capital is provided by foreign investors, the gap between GDP and GNP increases as does the debt servicing liability to foreigners which will put pressure on the current account, and may exert further influence on the terms of trade.

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Annex A:

CGE models have many equations and variables and detailed databases. Nevertheless, as explained in Dixon and Rimmer (2002), key results from CGE simulations can often be explained by calculations carried out with back-of-the envelope (BOTE) models. This idea is illustrated here with a BOTE explanation of the results reported earlier for the real wage and the capital stock.

The following two equations explain the annual growth rate of real wage and of the capital stock:

$$S_k q + S_l w - a = p_g \quad (1)$$

$$k - l = \delta(w - q) + twistlab \quad (2)$$

where S_k and S_l represent the input shares of capital and labour, respectively, w and q are the percentage changes of the nominal wage rate and the rental price of capital, a is the rate of productivity change (assumed to be 3% per annum), and p_g is the percentage change of the price level of output. k and l represent the percentage changes of capital and supply of labour, respectively, δ is the elasticity of substitution between labour and capital (set at 0.5), and twistlab is the cost-neutral change in the capital-labour ratio (set at 1%).

Given the assumption that the real return to capital is fixed, it follows that

$$q = p_g \quad (3)$$

From equation (1), (2) and (3), it follows that the growth rate of real wages is determined by the rate of productivity improvement, adjusted for labour share of output:

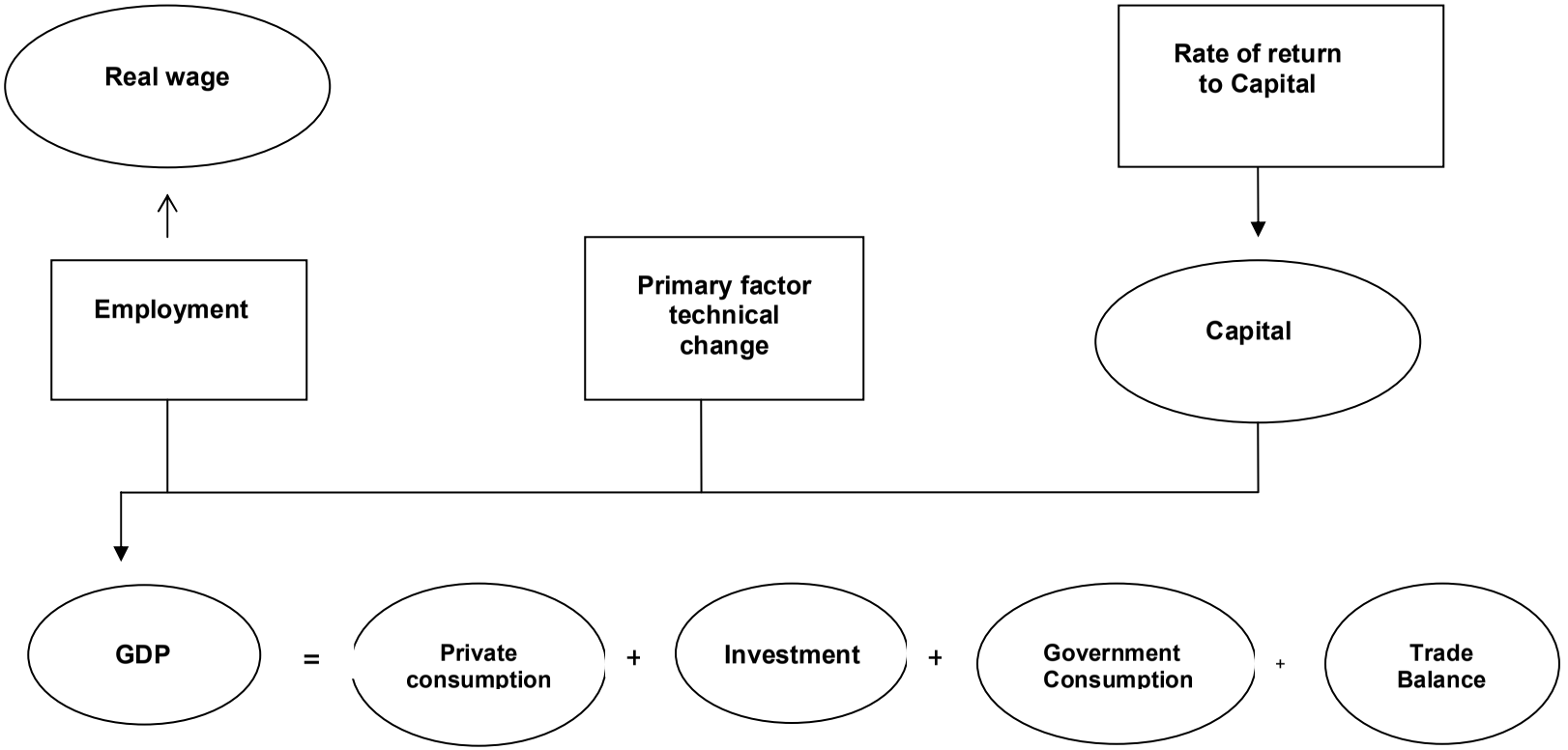
$$w - p_g = \frac{a}{S_l} \quad (4)$$

$$k = \frac{\delta}{S_l} a + twistlab + l \quad (5)$$

For a given degree of factor substitutability (exogenous δ), equation 5 shows that the growth rate of the capital stock varies directly with the growth rates of labour and productivity, "twistlab", and the labour share of input. For the same growth rate of productivity, capital-labour ratio under different policy scenarios, the change in the capital stock is mainly determined by the rate of change of employment and the labour share.

To illustrate, for the decade 2031 to 2040, the simulation generates an average labor share of 0.7. Given the productivity growth of 3% per annum, equation (4) suggests that real wage rate will increase a rate of 4.3% per annum. For the percentage change of capital stock, using the above parameter values, given the supply of labour declined by 0.66, it is apparent (from equation 5) that the capital stock grows approximately 2.4% per annum.

ANNEX B: main structure of the model



Note: rectangles represent exogenous variables; endogenous variables are shown in ovals.