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TAKE-OFF, PERSISTENCE, AND SUSTAINABILITY: THE DEMOGRAPHIC FACTOR OF CHINESE GROWTH

CAI FANG

CHINESE ACADEMY OF SOCIAL SCIENCES (CASS), BEIJING, CHINA
caifang@cass.org.cn.

LU YANG

INSTITUTE OF POPULATION AND LABOR ECONOMICS OF CHINESE ACADEMY OF SOCIAL SCIENCES, BEIJING, CHINA
luyang2002@cass.org.cn

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Abstract

With the reduction of the working-age population and the increase of the population dependency ratio as the main characteristics of the demographic dividend having disappeared, China's potential growth rate decreases. And our results suggest that demographic dividend contributed to nearly one forth of the economic growth in China in the past three decades, while TFP growth explains another on third and the remaining mainly due to capital accumulation, it explains nearly half. China's potential growth rate will slowdown—from nearly 10 per cent in the past 30 years to 7.5 per cent on average during 2011-2015—due to the diminished demographic dividend, but reform measures is conductive to clearing the institutional barriers to the supply of factors and productivity, thereby slowing the declining trend of potential growth rate. The aggregate reform dividend (e.g., relax family planning policy, postpone the retirement age, improvement of education and training, tax cut, and improvement of TFP) could reach to 1-2 percentage points on average during 2016-2050.

Keywords: potential growth rate; demographic dividend; reform dividend; total factor productivity

I. Introduction

Economists always tend to be latter-wit. Since the second decade of the 21st century, the research interest of China's economists experienced a dramatic shift from explain China's economic miracle to explore the sustainability of China's economic growth. China is followed a 9.8 per cent growth rate on average during 1978-2010, which is the best performance in worldwide. According to the projection of World Bank and IMF, China's economic volume calculated by purchasing power parity (PPP) will surpass US and, then become the world's largest economy during 2014-2015 (IMF, 2014). China's economy slowdown significantly, however, and be broader accepted as a *new normal*. Prediction on China's economic growth has attracted many authorities.

With the slowdown of China's economic growth rate since 2012, domestic and foreign economists and Chinese policy researchers have been highly concerned with the prospects of future growth rates and have developed multiple forecast methodologies and confusing conclusions. Generally speaking, economic growth rate forecasts are based on certain methodologies such as the traditional extrapolation method, i.e., extrapolation of previous growth rates into the future. Although this forecast methodology is usually not supported by accurate models and does not appear to be employed by economists in practice, it is a popular way of thinking. In most studies, the extrapolation method does not mean unjustified simple extrapolation based on data but requires the integration of facts about growth potentials and the subjective assessment of economists. For instance, American economist Robert W. Fogel (Fogel, 2009) identified a series of factors favorable to the economic growth of China. According to his forecast, by 2040 China's economic volume calculated by purchasing power parity (PPP) will reach US$123.7 trillion, accounting for 40% of the world's GDP volume and representing 2.95 times that of the economic volume of the United States. Based on the forecasted population growth of China and the United States, China's per capita GDP will also exceed that of the United States by that time.

The fundamental problem of using such a methodology to forecast economic growth is that it does not take into account the fact that different countries are in different stages of economic development. Many developing countries will eventually change into another stage of development and thus the parameters affecting their growth rates will change as well. This is why advanced economies have slower growth rates while developing countries are able to achieve higher growth rates. With the Lewis Turning Point characterized by labor shortage and increased wages which occurred in 2004 and the diminishing demographic dividends represented by the negative growth of the working-age population in 2011, substantial changes have already taken place in the economic development stage of China. Therefore, traditional methods of forecasting will no longer be able to provide an accurate basis for the estimation of China's future

economic growth rate.

As a correction of this traditional methodology, some recent studies have adopted different tactics. The first among them is the forecast of China's economic growth rate based on the convergence hypothesis of economic growth. Proceeds from the convergence hypothesis of the neoclassical growth theory and the hypothesis of "late-mover advantage", this type of study has adopted per-capita GDP as a benchmark for comparison between China and other developing economies, particularly East Asian economies in specific periods of time, with a view to assessing the possible growth rate of China in a future period of time of similar nature. For instance, based on the benchmark that China's per-capita GDP in 2008 was equivalent to only 21% of the GDP of the U.S., the experiences of some early moving countries and regions suggest that a similar level of development was reached by Japan in 1950, Singapore in 1966, Chinese Taiwan in 1975, and South Korea in 1976. In about 20 years of time thereafter, all these economies maintained rapid economic growth rates. Hence, this type of study expects that China can maintain its fast pace of development and leverage its late-mover advantage (Justin Yifu Lin, 2013).

As a tool to assess economic growth potentials, forecasting based on this methodology is of great reference significance. However, this forecast itself cannot suggest what the results of the potential factors included in the estimation will be or how to leverage those factors. Consequently, these forecast results often lead to the misunderstanding that growth rates can be unconditionally achieved. Although the economic growth forecast made according to the convergence hypothesis compensates for the lack of consideration of changing stages of economic development by the traditional extrapolation method, this methodology defines per-capita GDP as the sole standard for the identification of economic development stage and therefore is defective as well. Given that we focus on the estimation of potential economic growth rates, per-capita GDP alone is obviously not enough to demonstrate the development stage of the economy at a particular period of time. In comparison with East Asian economies that heavily relied on demographic dividends as an engine of growth, the factor of demographic transition must be taken into account. For instance, if we use the peak working-age population and the turning point of dependency ratio as a benchmark reference, China is currently equivalent to the development stage of Japan in the early 1990s, while Japan's annual average GDP growth since that time has been less than 1%.

A recent forecast on China's economic growth was conducted on the basis of the statistical law of "regression to the mean", and is an approach which has been gaining ground. According to this statistical law, any phenomenal economic growth will eventually return to the world average level. According to this law, some scholars estimate that China's annual mean growth rate between 2013 and 2023 will be 5.01% ,

which will drop to 3.28% between 2023 and 2033 (Pritchett and Summers, 2014). However, this fancy "law" is no more than a statistical phenomenon and cannot apply to all countries. Therefore, no science-based and reasonable economic explanation can be made to justify the forecast of deceleration made on the basis of such law. While intuitively it makes sense to project a slower growth rate for China's economy due to diminishing demographic dividends, the case of India indicates the opposite may hold true. India is a country still enjoying demographic dividends, but it does not make sense to forecast that country's economic deceleration based on the "regression to the mean." Goldman Sachs forecasted that India's economic growth rate will overtake that of China between 2016 and 2018 (Kong Jun, 2014).

Another frequently referenced study (Eichengreen, et al., 2011) is based on a similar methodology but attempts to make up for the deficiencies of analysis on the causes of deceleration. According to this study, rapid growth ultimately has to end at a specific level of economic development. According to extensive country statistics, the authors of this study found that rapid economic growth will start to significantly decelerate when the per-capita GDP calculated by the PPP of the base year 2005 reaches US$17,000 and that the degree of such deceleration is from the mean growth rate of 6.8% of the previous seven years to the mean growth rate of 3.3% in the following seven years. Considering that China is expected to reach this threshold by 2015, future growth rate deceleration can be expected. The authors have attempted to carry out extensive analyses on the causes of deceleration (particularly for China). However, such a statistical experience has included the data of too many countries at different levels of development so that consistent causes of deceleration cannot be identified.

The reason why there exists confusing conclusions of expectations for China's growth is mainly due to lack of understanding of Chinese historical growth. Compared with other literature, this paper has a different view of China's economic growth, by taking demographic dividend into account. The present paper is organized as follows. Section 2 present China's basic demographic transition during 1980-2030 and explain why China has a high-speed economic growth in the past 30 years. Second 3 demonstrate the slowdown of economic growth after 2010 due to the diminished demographic dividend. Second 4 shows three possible scenarios—low-speed, middle-speed, and high-speed—for China's potential growth rate and, then shows the reform dividend by which China' potential growth rate could be boost by 1-2 percentage points on average during 2016-2050.

## II. Demographics and Economic Growth in the Reform and Opening up Period

1. Demographic Change in China's Reform and Opening up Period

In the early days of the reform and opening up period, China's family planning policies had accelerated the process of demographic transition—increases in the

working-age population and decreases in the ratio of dependency to working-age population. Such demographic transition was conductive to economic growth, which is the so-called 'demographic dividend'. Under China's 'one-child' policy, however, the TFR theoretically not be more than two, and after 34 years population control measure, China's TFR has dropped to nearly 1.4. This is well below the 2.1 figure required to keep the population stable. It need emphasize that China's 'one-child' policy has restrained China's mushrooming population growth and brought economic prosperity at the beginning of the reform and opening up period, even though TFR will also declines with a country's economic development, however, such process would be slow and the effect of demographic dividend would be limited. China's population control policy generated a significant demographic dividend in a very short time, which is unique and different with any other country's experience.
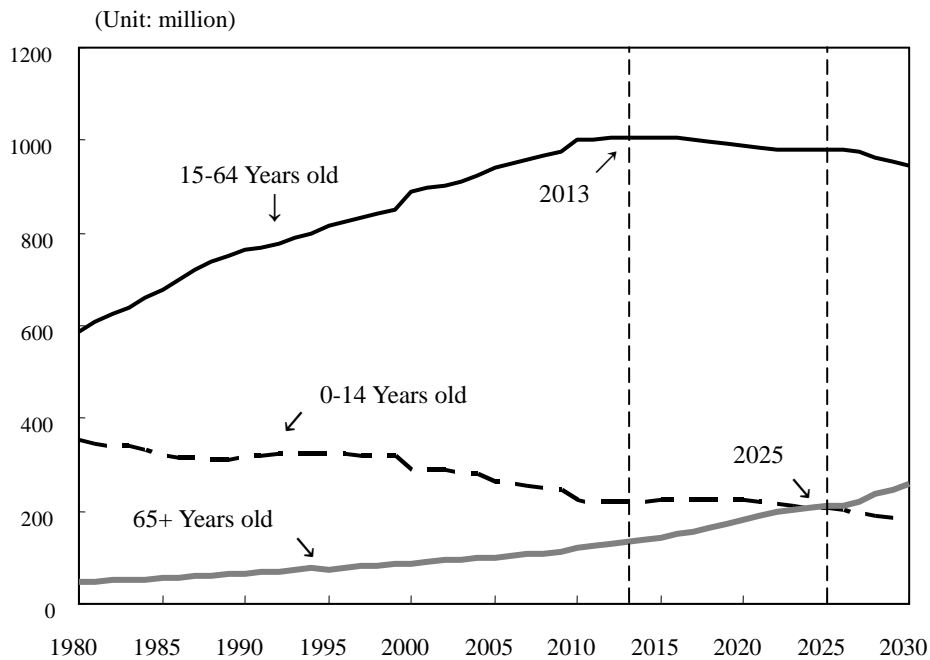
(A)   Working-age population
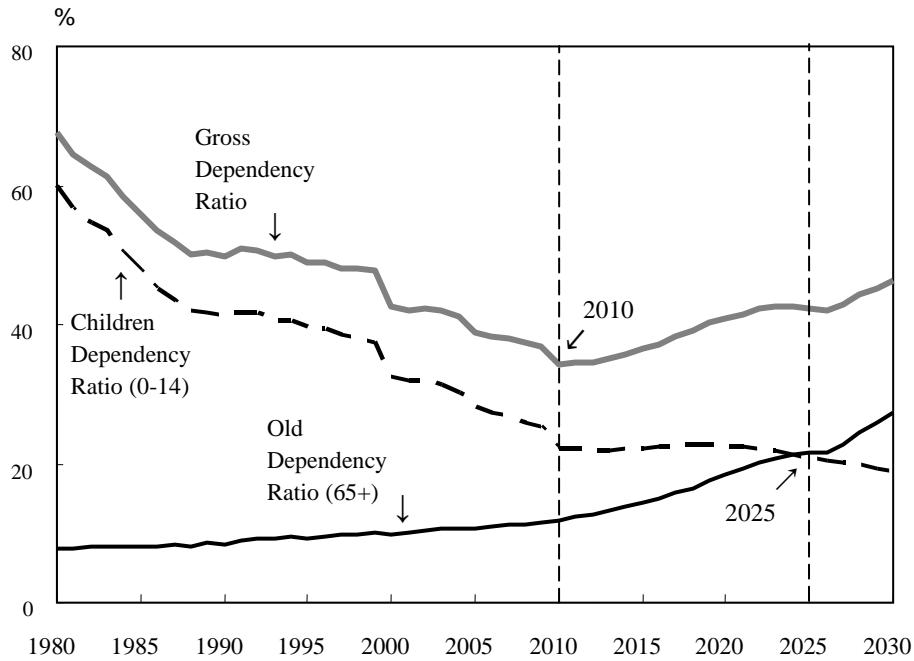
(B)   Population dependency ratio

Figure 1 China's demographic transition during 1980 to 2030

Fig 1 shows the trends of working-age population between 15 and 64 during 1980 to 2030. During that period, China's working-age population increase from 0.6 billion to 1 billion. And China's population dependency ratio declines from nearly 70% to 40%. China's working-age population, aged between fifteen and fifty-nine years, peaked in 2010, and the population dependency ratio increased from 2011. The supply factors required for the economic growth of a country increase when the dependency ratio falls and the working-age population rises.

2. The Contribution of Demographic Dividend to Economic Growth: A New Approach

The unprecedented economic growth in China over the past 30 years can be attributed largely to the demographic dividend. That is, the growth of the working age population guarantees an adequate supply of labor L; a decline in dependence ratio helps to maintain a high saving rate, which is the condition for capital formation K; and an unlimited supply of labor prevents return on capital from diminishing, which allows heavy investment to be the main source of GDP growth (Cai and Zhao, 2012). Growth accounting provides a convenient framework for decomposing the structure of economic growth and, hence, interpreting the underlying factors (including demographic dividend) shaping long-run growth performance. In terms of $Y = AK^{\alpha}(hL)^{1-\alpha}$, L stands for the quantity of labor force, h stands for the quality of

labor force. Demographic dividends include the positive effect on economic growth by the rises in *L* and *h*, and also the declines in population dependency ratio *D*.

The present study attempts to analysis the source of China's economic growth performance, using data from the period 1978-2010. The four main elements *A*, *K*, *h*, and *L* accounts for 100 per cent economic growth performance, by growth accounting method in Appendix 1(1-2), we decomposing the structure of economic growth in the past 30 years, however, the population dependency ratio has an indirect effect on economic growth. Specifically, there is a fundamental empirical relationship between dependency ratio and capital formation rate, by which the change of the dependency ratio has some effect on China's new capital accumulation and capital stock. That means a country's capital stock is a function of its dependency ratio *D*. Therefore, an empirical model is needed by historical data (see, Appendix 2-3 for data and explanation) and, then we need to further decompose the effects of *D* from *K*.

Table 1 shows least-squares estimate for the determination of gross fixed capital formation rate (% GDP) of China during 1980 to 2013, in which dep_ratio variable, tax_return variable and one lag of capital_f_rate variable that tend to be significant related to fixed capital formation rate. The estimated coefficients on dependency ratio, tax return, and one lag of capital formation rate are -0.185, -1.366, and 0.824, respectively. The estimation results consistent with theoretical expectations. And the regression R^2 changed from 0.691 to 0.929 when we add more explanatory variables into Equation 1.

Table 1：The Determinants of Gross Fixed Capital Formation Rate (% GDP)

Period: 1980-2013	(1)		(2)		(3)	
	Coef.	*Std. Err.*	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*
C	59.236***	(2.962)	73.881***	(11.220)	24.042**	(9.203)
dep_ratio $_{t-1}$	-0.508***	(0.059)	-0.573***	(0.112)	-0.185**	(0.082)
capital_return $_{t-1}$	—	—	-0.133	(0.367)	0.235	(0.218)
tax_return $_{t-1}$	—	—	-1.078	(1.340)	-1.366*	(0.777)
capital_f_rate $_{t-1}$	—	—	—	—	0.824***	(0.108)
R²		0.691		0.780		0.929

Note: The statistical significant at the 1%, 5% and 10% levels is denoted by ***, ** and ***. In which *dep_ratio* $_{t-1}$ is population dependency ratio in time t-1，*capital_return* $_{t-1}$ is the return on capital (exclude production tax) in time t-1, *tax_return* $_{t-1}$ is the return on capital of tax in time t-1, *capital_f_rate* $_{t-1}$ stands for capital formation rate in time t-1.

In terms of the empirical relationship between the fixed capital formation rate and population dependency ratio, the net effect on capital formation rate generated by the changed dependency ratio can be obtained by multiply the coefficient -0.185 by $\Delta D_t = D_t - D_{t-1}$. For example, the estimated coefficients mean, for the 1980-10

sample, that a decline in population dependency ratio (30 percentage points) raises the capital formation rate by 5.55 (-0.185×-30) percentage points. Further more, changes in the dependency ratio in all periods has some effects on one lag of capital formation rate and, hence influence on the current capital formation rate. The estimated coefficient between f_t and f_{t-1} is 0.824. There exists a nested relationship between dependency ratio and capital formation rate, the medium variable is the one lag of capital formation rate in equation 3.

$$f_{1977+n} = \chi D_{1977+(n-1)} + \chi \eta^{n-(n-1)} D_{1977+(n-2)} + \cdots + \chi \eta^{n-1} D_{1977+(n-n)} + \eta^n f_{1977}$$

$$(n=1, 2, 3\ldots.33) \qquad (1)$$

Equation (1) shows the nested model in the present paper, f stands for the changes of capital formation rate caused by x percentage points population dependency ratio changes. D stands for dependency ratio, χ stands for the estimated mean coefficient (-0.185) between capital formation rate and dependency ratio, η stands for one lag of capital formation rate (0.824). In which, $f_{1978} = \chi D_{1977} + \eta f_{1977}$, $f_{1979} = \chi D_{1978} + \chi \eta D_{1977} + \eta^2 f_{1977}$, and so on. 1997 is the starting time, according to our estimates, f_{1977}=3%. The implication is that a decline in population dependency ratio including current and lags raises the capital formation rate by 3 percentage points in 1997.

The additional capital formation rate generated by the changed population dependency ratio can be decomposed by the above methodology. Further more, the new capital formation rate generated by the changed dependency ratio can be obtained. According to the methodology provided by Appendix 1(1-2), we decomposed the structure of economic growth in the past 30 years.

Table 2: The Contribution of Demographic Dividend on Economic Growth

Period	Decompose of Economic Growth(%)				Demographic Dividend (%)		
1978-2010	K	h	L	A	h+L	D	h+L+D
A: Labor share was provided by Penn World Table 8.0							
1978-2010	49.10	6.56	12.00	32.33	18.57	5.33	23.90
1978-1980	40.42	10.02	22.14	27.42	32.16	11.85	44.01
1981-1990	40.54	6.27	22.53	30.66	28.80	9.42	38.22
1991-2000	46.57	8.04	6.56	38.83	14.60	2.14	16.73
2001-2010	62.79	4.34	3.89	28.98	8.23	2.49	10.71
B: Labor share was estimated by the author							
1978-2010	50.21	6.28	9.51	34.00	15.79	5.74	21.52
1978-1980	44.70	9.14	15.91	30.24	25.05	13.11	38.16
1981-1990	44.83	5.72	18.43	31.01	24.16	10.42	34.57
1991-2000	50.31	7.47	5.45	36.77	12.92	2.30	15.23
2001-2010	57.14	4.78	2.72	35.36	7.50	2.28	9.78

Note: *K* stands for capital stock, *h* stands for human capital on average, *L* stands for labor force, *A* stands for total factor productivity, *D* stands for population dependency ratio. In which, *h+L* stands for demographic generated by the quantity and quality of labor force, *h+L+D* stands for the aggregate demographic dividend.

The first four columns in Table 2, the growth rate of real GDP is decomposed into contributions from the growth rates of capital, labor and human capital and a residual for TFP growth. Part A of Table 2 reports the decomposition of growth into the same four categories based on the value of labor share calculated by Penn World Table 8.0, whereas the reports in Part B are estimated based on the value of labor share calculated by the author. The two sets of results are very close.

One observation is that the capital stock is a remarkably main contribution to China's economic growth in the last three decades. The increase of capital stock (including the effect generated by dependency ratio) accounts for almost about half of the overall growth for 1978-2010. TFP growth accounts for one-third of the overall growth in that period, and over one-sixth of the overall growth is contributed by the increase of labor force and human capital. Furthermore, the increase of labor force accounts for 10-12% of the total GDP growth rate of nearly 10% per year from 1978 to 2010, whereas the improvement of average human capital only accounts for 6-7% of total GDP growth rate. Based on Equation (1), the share of total growth accounted for by dependency ratio change is only 5 to 6 percent for 1978-2010. Controlling for the change of dependency ratio, the capital accumulation only accounts for 45% of overall GDP growth. The so-called demographic dividend, including labor force, human capital and dependency ratio, accounts for nearly one-fifth to one-fourth of overall growth for 1978-2010.

Breaking into shorter periods, capital stock (excluding the effect generated by dependency ratio) contributes about 30%, 35%, and 60% for 1978-1990, 1991-2000, and 2001-2010, respectively. Total factor productive (TFP) accounts for 30%, 40%, and 30% in the corresponding periods, whereas, demographic dividend accounts for 40%, 15%, 10% for the three shorter periods. In the early stage of reform, demographic dividend, among all factors influencing economic growth, is the most important element to accelerate China's economic growth. However, the contribution of capital and TFP all exceed that of demographic dividend for China for the next two periods. It should be noted that the contribution of capital on economic growth is increasing significant, whereas the contribution of demographic dividend is shown a diminishing trends. Note also that China has experienced a substantial reduction in its contribution of demographic dividend, from over one-third for 1981-90 to one-tenth, for a more recent period, 2000-10. The maintenance of a high growth rate of real GDP for 1978-2010—roughly 10 percent per year—relied on a remarkably high contribution from the growth of capital input.

There are two main reasons. First, the demographic transition begins with the advent of the era of a low rate of fertility. Under China's population control policy, the size of the working-age population falls and the population dependency ratio increases, leading to the fall and eventual disappearance of the demographic dividend. The working age population, when assumed to be aged 15 to 59 years, started to decline in size in 2011, while the population dependency ratio began shrinking in the same year. This trend will not be reversed, even if there is a moderate relaxation of family planning policy. That means the contribution of *L* and *D* to economic growth will change from 'positive' to 'negative'. Second, China's extensive economic development mode under the support of high investment in the past 30 years has constrained the improvement of technological innovation and productivity, however, an increase in dependency ratio will cause a decrease in capital formation rate, and by then the unsustainability of the traditional economic model was already quite clear. Due to the end of demographic dividend and the unsustainability traditional growth model, the major source of long-run GDP growth rates will highly rely on the increase in TFP.

III. The End of Demographic Dividend and Slowdown of Potential Growth Rate

1. China's Potential Growth Rate during 1980 to 2010

Given that the current literatures for China's economic growth forecasting fail to take into account the changing development stages of the Chinese economy, we have explored a different approach to forecast China's future growth rate—by estimating the potential growth rate. The potential growth rate refers to the GDP growth rate that can be achieved under the supply capacities of certain factors of production and productivity growth and under the assumption that a country is free from cyclical unemployment and significant inflation. Theoretically, economic growth, in the short-term, is mainly caused by an increase in aggregate demand—investment, consumption, and export, however, in the long-term, is determined mainly by improving productivity and the supply side factors—capital, labor/human capital, and TFP, which are the determinants of a country's potential growth rate. In other words, potential growth rate is a long-term explanation for a country's economic growth.

In economics, the Philips curve is a historical inverse relationship between unemployment rates and corresponding inflation rates. When actual growth rate exceed its potential rate, the implication is that capacity utilization has exceeded the potential level of production factors. For instance, in order to meet a higher output requirement, real employment has to exceed potential employment, while the real unemployment rate is below the natural unemployment rate, the macroeconomy will experience inflationary pressures. On the contrary, if real growth rates are under the potential growth rates, cyclical unemployment will occur and the real unemployment

rate will be above the natural unemployment rate. As a matter of fact, what the Phillips curve describes is the mechanism for the impact of short-term factors affecting demand on the real GDP growth rate, and the impact of long-term factors affecting supply on potential GDP growth rate.

Table 3： Actual GDP Growth Rate and Potential GDP Growth Rate during 1980 to 2010 (%)

Period Variable	1980 —2010	1981 —1985	1986 —1990	1991 —1995	1996 —2000	2001 —2005	2006 —2010
Potential Growth Rate	10.23	9.84	10.04	10.83	10.02	9.98	10.87
Actual Growth Rate	10.02	10.76	7.92	12.28	8.64	9.76	11.20

As such, the potential growth rate can be treated as the main basis for forecasting China's future economic growth. A production function method for the calculation of potential growth rate in this paper illustrated in appendix 1 (1-1). Our finding that the annual actual growth rate of the Chinese economy for the period 1980 to 2010 was closed to its potential rate (see Table 3), however, the trends of potential growth rate is more gentle than actual growth rate (see Figure 2), e.g., the actual growth rate is merely 4 per cent in 1989-1990 because of the insufficient demand, but the corresponding potential rate without any significant change because of the unchanged potential employment and capital stock in that period.
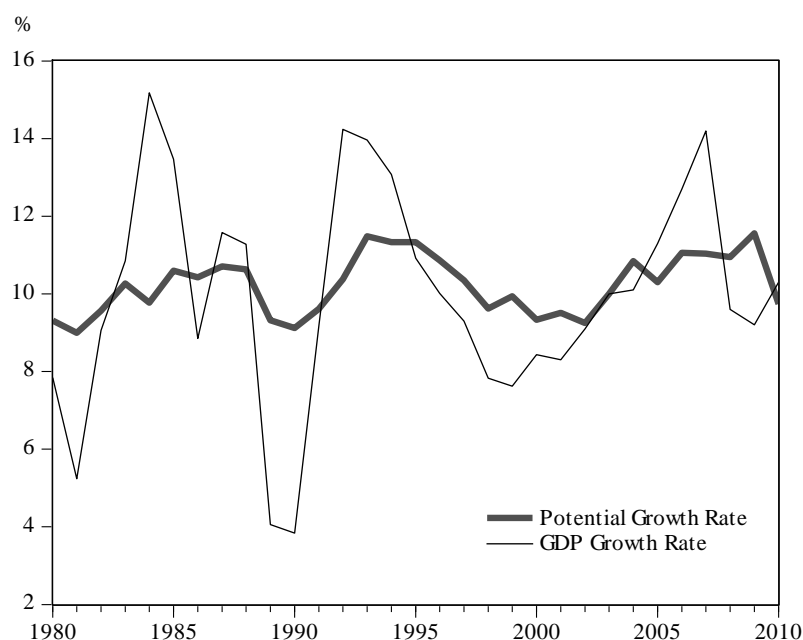

Figure 2 Relationship between China's actual rate and potential rate in 1980-2010

Therefore, when the potential growth rate remained high, it was necessary to maintain a growth rate above 8%; otherwise severe employment pressures would be

encountered. However, since the 12th Five-Year Plan (2011~2015), China's working age population aged 15-59 in absolute terms has been declining and population dependency ratio has been raising (see Figure 1), China's demographic dividends favorable to economic growth have diminished and led to a continuous decline of the potential growth rate. At this juncture, any attempt to maintain a GDP growth rate above 8% is very likely to cause overcapacity of the real economy and possible economic bubbles. Determination of growth targets based on the potential growth rate is an appropriate response to adapt to the 'new normal' of economic growth.

2. Middle-Speed Potential Rate Scenario based on the Diminishing of Demographic Dividend

It was necessary to forecast China's potential growth rate in the next 40 years (2011-2050) by incorporate potential capital stock (Appendix 2-3), potential employment (Appendix 2-4), and potential human capital index (Appendix 2-5) into Formula 4 (Appendix 1). It is important to emphasize that the potential capital stock and potential employment in the next four decades are all change with the changes of demographic by age and sex and population dependency ratio. Therefore, the forecasting potential growth rate estimated by this method is being relied on population projections.

Table 4: Potential growth rate—Low-speed, Middle-speed, and High-speed

Scenario	2011-15	2016-20	2021-25	2026-30	2031-35	2036-40	2041-45	2046-50
A: Low-speed potential rate: if the return on capital will cut back by 1/2, 1/3, 1/4, and 1/5								
Cut back 1/2	7.493	6.399	5.394	4.809	4.306	3.544	2.401	1.231
Cut back 1/3	7.493	6.483	5.522	4.934	4.418	3.653	2.527	1.393
Cut back 1/4	7.493	6.524	5.585	4.995	4.473	3.706	2.587	1.470
Cut back 1/5	7.493	6.549	5.623	5.031	4.505	3.737	2.622	1.514
B: Middle-speed potential rate								
Baseline	7.493	6.649	5.773	5.173	4.631	3.857	2.758	1.685
C: High-speed potential rate: the positive effect of reform dividend on potential rate								
c_1: Relax the family planning policy (TFR could raise to 1.6, 1.77 or 1.94)								
TFR=1.6	7.493	6.600	5.633	4.983	4.540	3.935	3.151	2.474
TFR=1.77	7.493	6.547	5.482	4.783	4.464	4.011	3.302	2.632
TFR=1.94	7.493	6.493	5.296	4.513	4.344	4.132	3.519	2.832
c_2: Postpone the retirement age								
5 year direct	7.493	6.767	5.837	5.196	4.636	3.862	2.782	1.712
Step by step 5	7.493	6.682	5.897	5.201	4.640	3.864	2.784	1.714
Step by step 8	7.493	6.682	5.897	5.400	4.681	3.873	2.820	1.740
c_3: Increase the training time to 1.2 month per year								
1.2 month/year	7.493	7.032	6.180	5.577	5.037	4.239	3.052	1.977
c_4: Increase the average years of schooling								

Extend 0.5 year	7.493	6.997	5.839	5.226	4.678	3.896	2.786	1.704
Extend 1 year	7.493	7.454	5.911	5.275	4.713	3.920	2.802	1.714
Extend 2 year	7.493	8.416	6.059	5.376	4.784	3.968	2.833	1.733
c_5: Tax cut: production tax will cut back by 1/3, 1/4 and 1/5								
Cut back 1/5	7.493	7.409	6.862	6.155	5.461	4.614	3.574	2.656
Cut back 1/4	7.493	7.596	7.117	6.373	5.636	4.767	3.731	2.833
Cut back 1/3	7.493	7.905	7.530	6.715	5.905	4.997	3.962	3.089
c_6: Improve TFP								
0.2 points	7.493	6.873	6.038	5.465	4.939	4.168	3.058	1.967
0.5 points	7.493	7.209	6.437	5.904	5.402	4.638	3.511	2.393
1 points	7.493	7.769	7.103	6.641	6.182	5.429	4.275	3.113
c_5: tax cut by 1/5, TFR raise to 1.6, postpone the retirement age by 5 years (step by step)								
Simulation1	7.493	7.393	6.860	6.027	5.424	4.739	3.979	3.358
c_6: tax cut by 1/5, TFR raise to 1.6, postpone the retirement age by 5 years (step by step), Improve TFP								
Simulation2	7.493	7.620	7.135	6.328	5.741	5.063	4.303	3.681

Resources: According to author's calculation.

In fact, demographic predictions are based on the value of total fertility rate (TFR). The forecast data for population by age and sex were provided by Guo (2013). There were four scenarios in Guo (2013). In the fist three scenarios, TFR was assumed to be 1.6, 1.77 and 1.94 and remain constant in the next four decades, the population by age and sex during 2011-2050 can be obtained. The fourth scenario assume that TFR could remain 1.4 before year 2035, after that TFR dramatically increase to 1.94. It worth noting that China's current TFR is more closed to 1.4, so we use the fourth scenario as the baseline and the potential growth rate estimated by such assumption was called the middle-speed potential rate.[1]

Due to the end of demographic dividend, the paper simulates a decline in the average annual rate of potential GDP growth from 10 per cent over the period 1980 to 2010, to 7.5 per cent during the 12th five-year plan period (2011-2015) and 6.6 per cent over the 13th five-year plan period (2016-2020). It is estimated that this slowdown trend of potential rate will continue in the years to come (see Table 4 B). This simulation result is what we called China's middle-speed potential growth rate.

We use growth accounting framework for decomposing the sources of middle-speed

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[1] It worth noting that if we pay close attention to the accuracy of the potential growth rate in the short term and the reform dividend before the year 2035, the forth scenario is more appropriate. However, for the simulation results after 2035, the reform dividend will be overestimated because we assume a jump in TFR at the year 2035—TFR rise from 1.4 to 1.94. Of course, the benefits of the forth scenario is that we can observe reform dividend drastically affected by relaxing of family planning policy after 2035. The reality is that the 'selective second-child' policy—introduced in 2014 has limited positive effect on TFR—aggregate effect no more than 0.2, and theoretically, the economic development and education improvement may also produce a negative effect on TFR, therefore, if government choose a modest mode to adjust to the family planning policy before 2035, China's TFR will keep 1.4 for a long time; if government substantial adjust to the family planning policy or even cancel it after 2035, a dramatically increase in the TFR is not impossible. It worth noting that China's current TFR more closed to 1.4, if we assume TFR remain 1.6 over the forecast period, reform dividend can be identified and comparable in the all time period, but the potential growth rate in the short term will be underestimated.

potential economic growth for the period up to 2050 and, hence, interpreting the underlying factors shaping long-run growth performance (see Table 5). We can decompose the change of potential growth rate as three categories: accumulation of capital stock, improvement of TFP and demographic dividend. The demographic dividend accounts for 20% for China's potential economic growth from 1981 to 2010. However, with the declining trend of demographic dividend, the contributions of demographic dividend will close to zero during the 13th five-year plan period. After 2020, the demographic dividend will turn into 'demographic debt', as is happening in most of developed countries. This trend will continue to deteriorate during the whole simulation period.

Specifically, the negative effect on potential growth rate, which will crop up during the 13th five-year plan period will be mostly caused by large potential employment ($L*$) declines and dependency ratio (D) rises; while the positive effect on potential growth rate, which still keep 4 per cent mainly caused by the improvement of human capital (h). Even so, over the whole simulation period, the positive effects generated by labor quality are always overwhelmed by the negative effect generated by demographic transition. In fact, the diminishing of demographic dividend is an inevitable trend in all countries.

Table 5: The contribution of demographic dividend to middle-speed potential growth: 1981-2050

Period	Contribution of input factors (%)				Demographic dividend (%)		
	K	h	L	A	h+L	D	h+L+D
A: Period 1981-2010							
1981-2010	46.73	5.51	10.21	37.56	15.72	3.95	19.66
1981-1990	35.23	4.45	16.45	43.86	20.90	7.45	28.35
1991-2000	48.88	7.37	9.13	34.62	16.50	2.23	18.73
2001-2010	56.07	4.70	5.05	34.19	9.74	2.16	11.91
B: Period 2011-2050 (middle-speed potential growth rate)							
2011-2015	60.04	4.49	3.34	32.13	7.82	0.95	8.78
2016-2020	61.46	3.84	-1.12	35.83	2.71	-0.69	2.02
2021-2025	58.92	3.98	-4.02	41.12	-0.04	-1.11	-1.15
2026-2030	55.78	4.49	-6.02	45.76	-1.54	-1.16	-2.70
2031-2035	52.08	5.26	-8.42	51.07	-3.15	-2.41	-5.57
2036-2040	45.54	6.35	-13.32	61.44	-6.97	-5.65	-12.62
2041-2045	28.91	8.74	-23.89	86.24	-15.15	-10.94	-26.09
2046-2050	-11.30	13.40	-45.86	143.75	-32.45	-11.29	-43.74

Note: K is capital stock, h is human capital, L is labor force, A is total factor productivity, and D is dependency ratio. In which, $h+L$ stands for the improvement of labor force in quantity and quality, $h+L+D$ stands for demographic dividend.

Before 2040, the potential capital stock will still account for nearly 50% for potential economic growth; in which the potential capital stock will even account for over 60% for potential growth during 12th and 13th five-year plan period, however, with the reduction of capital accumulation, the contribution of capital stock will turn into -11.3% after 2040. What we need emphasize that TFP in the middle-speed scenario is assumed to be unchanged, however, unlike dual economy, in the neoclassical growth framework, it's really difficult for a county to add additional one percentage point of TFP. Therefore, the contribution of TFP to potential economic growth, in the middle-speed scenario, is definitely overestimated. Conversely, if the growth rate of TFP will remain the same as it was in 2010, the long-run economic growth will depend greatly on the performance of TFP. After 2045, except for human capital, the growth rate of all other input factors will decrease and, hence the potential growth rate will less than TFP growth rate.

3. Low-Speed Potential Rate Scenario based on a lower rate of return to capital

The reasonable baseline projection for the middle-speed potential growth rate is based on the hypothesis that all parameters are remained the same as it was in 2010 except for the demographic change, however, there are two possibilities—'low-speed' and 'high-speed' in the projection of potential growth rate, which will be deviate from the middle-speed growth trajectory. There is a high possibility that the return on capital will decline with a country's economic development and capital-output ratio rises. If so, the potential growth rate will lower than the baseline. That is the so-called low-speed potential growth rate. Furthermore, it is necessary to consider the possibility of an increased potential growth rate as a result of more reform dividends to be released, if so, the potential growth rate will exceed the baseline trajectory. That is the so-called high-speed potential growth rate. According to the middle-speed (baseline), low-speed and high-speed trajectory forecasting, the range of China's potential growth rate during 2011-2050 can be obtained.
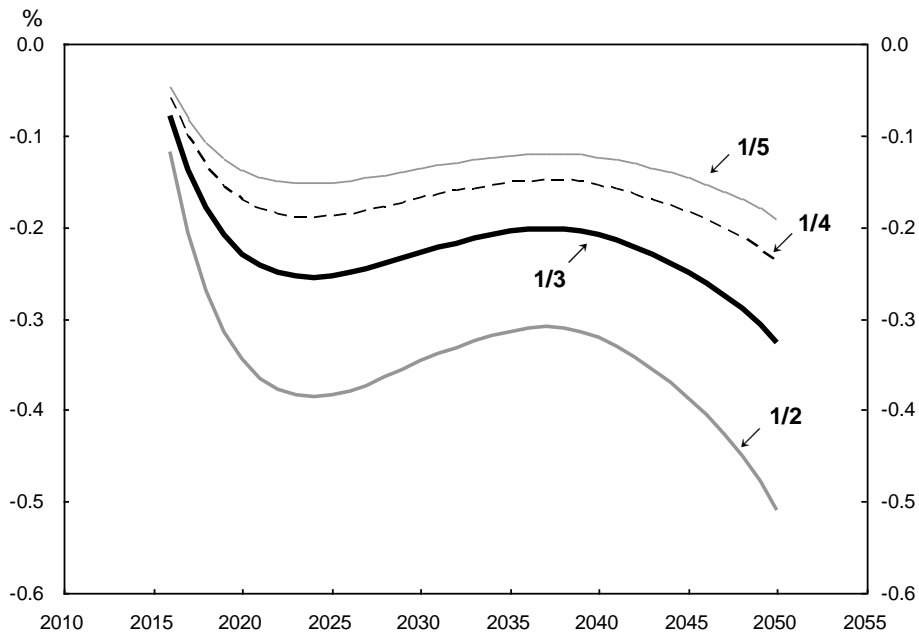
Figure 3 The 'Negative Effect' Generated by the Decreases of Return on Capital

According to last year's real return on capital, a typical firm will decide whether to offer additional investments or how much investment is needed in this year. When the real return on capital declines, firms will reduce the capital investment and, hence, the capital formation rate will decline, which will not conductive to the accumulation of capital stock. Accompany with the slowdown of economic growth, a country's long-run return on capital will further decline. It's not possible for China to maintain the same as the return on capital was in 2010. If so, China's future potential growth rate would lower than the 'middle-speed' scenario.

The present study projects the trends of 'low-speed' potential growth rate in China by assuming the return on capital could be reduced by 1/2, 1/3, 1/4 and 1/5, respectively, e.g., if the return on capital could be reduced by 1/2 in future, that means the return on capital will fell from 6.9% in 2013 to 3.45% and, then, China's average potential growth rate will further fell from 6.65% to 6.40% during the 13th Five-Year Plan period. Compare with the middle-speed scenario, a lower rate of return on capital will generate a lower potential growth rate and, the potential growth rate is decreased 0.25 percentage points. It need emphasize that the gap between the middle and low speed potential growth rate will continue increase to 0.45 percentage points at the end of 2050 (see Fig 3).

IV. Reform as the New Driving Force of Economic Growth

In discussing the issue of China's reform, many express the view that there will be a trade-off between reform and economic growth. That means in order to implement the

proposed reforms, the Chinese Government needs to sacrifice the economic growth rate; however, this present paper shows that reforms could be conductive to potential economic growth. The relationship between China's reform and its economic growth is 'mutual promotion' rather than 'substitution'.

Table 6: The effect of Reform Dividend on Long-term and Short-term Growth Rate

Simulation	2016-20	2021-25	2026-30	2031-35	2036-40	2041-45	2046-50
c_1: Relax the family planning policy (TFR could raise to 1.6, 1.77 or 1.94)							
TFR=1.6	-0.049	-0.140	-0.190	-0.091	0.078	0.393	0.789
TFR=1.77	-0.103	-0.291	-0.391	-0.168	0.154	0.544	0.948
TFR=1.94	-0.156	-0.476	-0.660	-0.287	0.275	0.761	1.147
c_2: Postpone the retirement age							
5 year direct	0.117	0.065	0.023	0.004	0.005	0.024	0.028
Step by step 5	0.032	0.124	0.028	0.008	0.007	0.026	0.029
Step by step 8	0.032	0.124	0.227	0.050	0.016	0.062	0.055
c_3: Increase the training time to 1.2 month per year							
1.2 month/year	0.383	0.407	0.404	0.406	0.382	0.294	0.292
c_4: Increase the average years of schooling							
Extend 0.5 year	0.348	0.066	0.053	0.046	0.039	0.028	0.020
Extend 1 year	0.805	0.138	0.102	0.081	0.062	0.044	0.029
Extend 2 year	1.766	0.286	0.203	0.152	0.111	0.075	0.048
c_5: Tax cut: production tax will cut back by 1/3, 1/4 and 1/5							
Cut back 1/5	0.759	1.089	0.982	0.830	0.757	0.816	0.971
Cut back 1/4	0.946	1.345	1.199	1.005	0.910	0.973	1.148
Cut back 1/3	1.255	1.757	1.542	1.273	1.140	1.205	1.405
c_6: Improve TFP							
0.2 points	0.224	0.265	0.291	0.307	0.311	0.300	0.282
0.5 points	0.559	0.664	0.731	0.771	0.780	0.753	0.709
1 points	1.119	1.331	1.468	1.551	1.571	1.517	1.428

Resources: Author's calculation based on Table 4. The reform dividend equals to the difference between high potential growth rate and middle potential growth rate.

1. Reform Measures for the Continuation of Demographic Dividend

Reform measures can be further classified into two categories. The first kind of reform measures focus on the continuation of demographic dividend. That means China's demographic dividend could be prolonged, if some policy is changed, e.g., relax family planning policy and postpone the retirement age are conductive to labor supply; and increase the average years of schooling and training are conductive to labor quality, by which a country's window of the demographic dividend can be prolonged. The second kind of reform measures focus on the improvement of productivity. It need emphasize that long-term economic growth is determined by the

growth rate of TFP, when a slowdown in a country's factor inputs.

1.1 Relaxed Family Planning Policy

The population prediction depends on the value of the total fertility rate (TFR). TFR is the average number of children a woman could expect to have in her life time. A country's TFR is the simplest way to determine whether population is naturally growing or shrinking in the future. Some demographers believe that the fertility rate in China is now 1.4 children per woman, close to the global warning line of 1.3, which is commonly considered as the "low fertility trap". Once it slips into the trap, no country has ever returned to the replacement level of 2.1. That means women give birth to insufficient babies to sustain population levels and population will surely shrinking in future.

Although China's TFR theoretically not be more than two under family planning policy, unlike 30 years ago, with its economic development and higher education, China's fertility willingness has been changed a lot. Theoretically, TFR can be boost by relaxing the family planning policy, but the newly relaxed family planning policy in China—a family in which either parent is an only child is permitted to have a second child, has limited effect on TFR. This situation is far beyond any one's expectation. Considering the limited response to the new family planning policy, many survey data reveal that the total fertility rate would be boosted less than 0.2 and, then based on this assumption, we has simulate the effect of relax family planning policy on potential growth by assume that China's total fertility rate would be increased form 1.4 to 1.6.
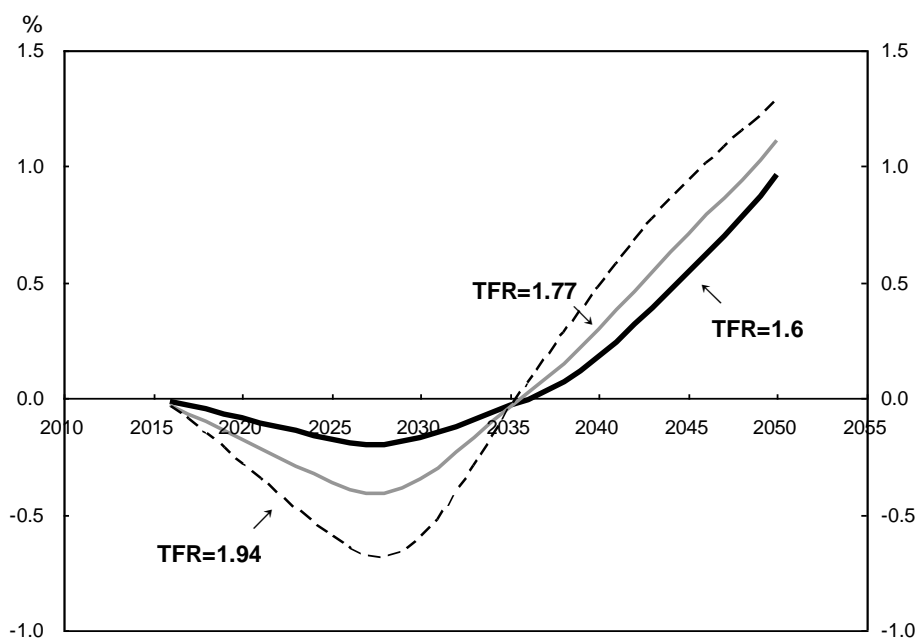

Figure 4 The Reform Dividend Generated by Relaxing Family Planning Policy

Relaxing family planning policy will generate different short-term and long-term growth effects. In the short run (15 years), relax fertility policy will boost TFR, however, the newborn babies affected by new policy couldn't enter into labor market at once and, then the increased population dependency ratio, instead, will cause negative effect on economic growth. In the long run, however, newborn babies grow into adults (at least 15 years to reach working age) and, then enter into the labor market, which cause the working-age population rises and dependency ratio declines, all of which produce positive effects on economic growth. This mechanism describes the impact of the 'baby boom' on the potential growth rate.

The simulation shows that China's average annual potential growth rate would down less than 0.05 percentage points during the 13th Five-Year Plan period, but would up more than 0.7 percentage points during 2046-50, if TFR can be increased by additional 0.2 percentage points (that means TFR increased from 1.4 to 1.6).

1.2 Postponed the Retirement Age

The legal retirement age in China currently is 60 for male, 55 for female high educated, and 50 for female worker. Human Resource Development Report (2012) argued that the average actual retirement age of urban citizen is 56.1, in which 58.3 for man and 52.4 for woman. In order to simplify the model, we assume that the actual retirement age for man is 58 and 52 for woman. Therefore, under the current policy, a 58-year-old man and a 52-year-old woman has out of labor market and, then there may be a threshold in labor participation rate around the retirement age. If the retirement age prolong by one year, the 58-year-old man under the new policy will keep the same participation rate with that of 57-year-old man under the old policy and, then the participation rate in other ages remain the same. Female has a similar simulation, that is, the 52-year-old woman under the new policy will keep the same participation rate with that of 51-year-old woman under the old policy. It is implied that the slowdown of labor force participation rate, on the 'threshold', completely attributed to retirement regulation.[2]

There are three scenarios for postpone the retirement age. Fist, raise the retirement age directly by 5 years fro man and woman from the beginning of the 13th Five-Year Plan Period. Second, postpone the retirement age in progressive steps—rises 1 year in 2 years (postpone one year every other year), and postpone the retirement age by 5 years. Third, postpone the retirement age in progressive steps—rises 1 year in 2 years, and postpone the retirement age by 8 years.

If raise the retirement age by 5 years and in progressive steps, China's potential

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[2] If the retirement age prolong by five years, the man aged between 58-62 years old under the new policy will keep the same participation rate with that of 57-year-old man under the old policy and, then the participation rate in other ages remain the same.

growth rate only increased by 0.03 percentage points during 13th Five-Year Plan Period, and 0.12 during 14th Five-Year Plan Period (2021-2025). The reform dividend would be fading fast. It is indeed a very limited effect on the increase of the potential growth rate, if Chinese government increase the participation rate only from the point of view of postponed the retirement age (see Table 6).

1.3 Prolonged the Years of Schooling and Training

Human capital is the stock of knowledge by certain education or training etc embodied in the ability to perform labor so as to produce economic value, which is a proxy variable of labor quality. The demographic dividend will turn from positive to negative due to the decline in labor supply and the rises in population dependency ratio. However, labor quality can be improved by increase the average years of schooling and training and, then to prevent the slowdown of demographic dividend.

Our simulations assume that the average years of schooling remain unchanged for those aged over twenty-five. In other words, human capital, which is estimated by years of schooling, will no longer increase steadily with age when an individual steps out its education phase. We further assume that the average years of schooling in future could be increased by 0.5 year, 1 year and 1.5 year, respectively. For example, we projects China's potential growth rate will rises from 6.6 per cent to 7.5 per cent in the 13th Five-Year Plan Period if the average years of schooling could be boost by additional one year. This reform dividend will reach to nearly 0.8 percentage points in the short-term. However, it shows a decreasing trend of this reform dividend and, at the end of 2050, this reform dividend would slowdown to 0.03 percentage points (see Table 6). In fact, education is the best way for a nation to invest in the future. The limited reform dividend in our simulation can attribute to taking no account of education quality.

The quality of human capital can be improved by way of training then an increase in human capital will be more significant and sustainable. The present paper give a simplified assumption—that is, we assume, as a baseline, that a typical worker in the labor market can access training opportunities of 1.2 months every year. That means for a typical worker, in each 10 years their years of schooling will rise by one year due to training. Based on this hypothesis, this reform dividend could reach to 0.3-0.4 percentage points on average (see Table 6). It worth noting that old workers are always relatively less educated, training could solve the problem of skills deficit, especially when Government decide postpone the retirement age.

2. Reform Measures for Economic Sustainability

2.1 Tax Cut

Social return on capital (gross return on capital) has two components, that is, firm's

real return on capital, and return on capital in the form of tax. A country's gross return on capital will ultimately be distributed between 'government' ('tax') and 'firm'. Therefore, a rise in production-tax rates would crowd out private investment and vice versa. Capital formation rate rises when governments reduce the rate of tax and, then an increase in capital stock will cause an increase in potential growth rate.

The present study projects the trends of potential growth rate by assuming the production tax could be cut by 1/5, 1/4, and 1/3, respectively, e.g., China's current value added tax (VAT) is 17%, if the VAT could be cut by 1/5 from the 13th Five-Year Plan Period, VAT will be down to 13.6%. If so, the return on capital in terms of tax could also be cut by one fifth, and which will add to the real return on capital for enterprises, therefore, the potential growth rate could be boosted by tax abatement.

The simulation results are consistent with our institution. Reform measure of tax abatement is significant, by which it will generate a 0.76 percentage points reform dividends during the 13th Five-Year Plan Period. It worth noting that reform dividend increase gradually with the increases of tax cut (see Table 6). We concern not only the effectiveness, but also the duration and trends of reform dividend. In fact, according to short-term and long-term growth effects, the Government should select reform measures and priority of reform.
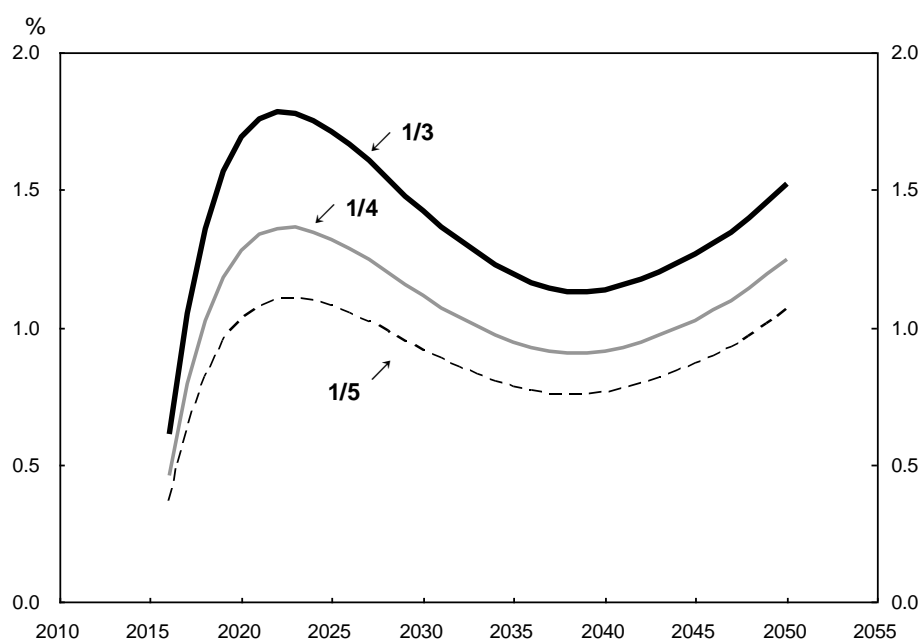

Figure 5 The Reform Dividend Generated by Tax Cut

Figure 5 shows the net effect generated by tax abatement—the gap between high and middle potential rate. There exists a nonlinear tendency in this reform dividend. The most significant reform dividend bring by tax cut appears in 2020-25, e.g., tax abatement by one fifth could produce more than one percentage points growth during

that period.

2.2 Improvement on TFP

When a country enters into a new classical economic growth model, the main source of economic growth will depend on the improvement of TFP. Therefore, an increased technical progress and relevant sectors' reform can substantially increase the TFP and, then provide a big boost to China's potential growth.

In fact, the net effects of the reform dividend produced by TFP are obvious and sustainable, e.g., China's average potential growth rate will rise from 6.65 per cent to 6.87 per cent during the 13th Five-Year Plan Period if TFP can be increased by additional 0.2 percentage points every year, and such kind of reform dividend will reach to 0.22 percentage points during corresponding period. Noting that the net effect generated by TFP is an incremental curve, this kind of reform dividend would still remain 0.28 percentage points, even if at the end of our simulation period. It worth noting that reform dividend increase gradually with the increases of TFP (see Figure 6).
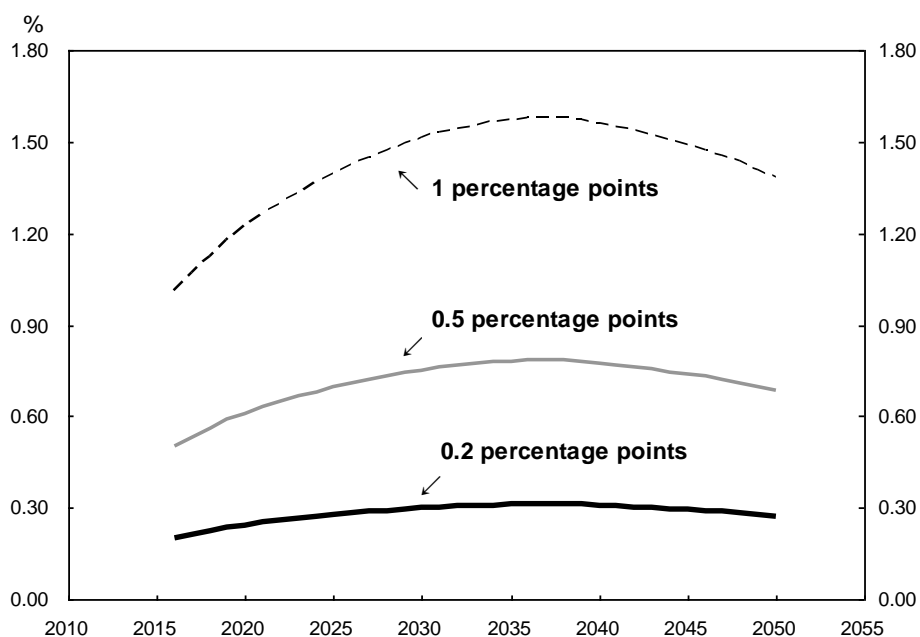

Figure 6 The Reform Dividend Generated by Increase of TFP

The sources of TFP are mainly including technology progress and institutional reform to improve productivity. First, there is still a big gap between China and developed countries in technology, China can continue to enjoy the advantage of backwardness before closing the gap and further promote the progress of TFP. Second, there is still important potential to improve productivity—that is, given the large disparities in productivity among firms within the sector, the mobility of factors of production from low-productivity firms to high-productivity firms—which allows for more efficient

enterprises to survive, expand and develop, while long-term inefficient enterprises are eliminated—could improve the industry as well as national productivity. In this process, government needs to remove the presence of institutional barriers, build on a market mechanism for freely enter and exit. Viewed from this perspective, there is room for the development of China's total factor productivity.

3. High-Speed Potential Rate Scenario based on Mixed Reform Measures

The above simulation results show that one single reform measure could produce different short-term and long-term reform dividend, and may have a limited effect on potential growth. However, a basket of reform measure produced a so-called *superposition effect* of policy, will lead to potential economic growth significantly. The *superposition effect* is not equal to the sum up of individual effect produced by single reform measure. The relationship between the two group can be described in $1+1>2$.

Table 7 shows the *superposition effect* of the basket of reform. The fist basket contains three kind of individual reform measure, including tax cut, relax family planning policy, and postpone the retirement age. Specifically, we projects the trends of potential growth rate by assuming the production tax could be cut by 1/5, TFR could be increased from 1.4 to 1.6, and postpone the retirement age by 5 years during the 13th Five-Year Plan Period. We take these three reform measure as a basket due to its adjustable feature in policy operation. The *superposition effect* could reach to nearly 0.8 percentage points during the 13th Five-Year Plan Period, and the potential growth rate will rise from 6.65% to 7.39%.

Table 7: Superposition Effect Generated by a Basket of Reform

Period　　　　　Simulation	2016　—2020	2021　—2025	2026　—2030	2031　—2035	2036　—2040	2041　—2045	2046　—2050
1. Basic	0.744	1.088	0.854	0.792	0.882	1.221	1.674
2. Contain TFP	0.971	1.362	1.155	1.109	1.205	1.545	1.996

From the perspective of historical empirical in developed countries, after a stage of dual economy, new economic model depending on improvement of TFP will not be easy. Therefore, we further projects the trends of potential growth rate by assuming the production tax could be cut by 1/5, TFR could be increased from 1.4 to 1.6, postpone the retirement age by 5 years, and TFP could be improved by additional 0.2 percentage points during the 13th Five-Year Plan Period. The potential growth rate will rise from 6.65%—the middle-speed scenario—to 7.62%. The reform dividend will reach an average 1-2 percentage points in 2016-50.
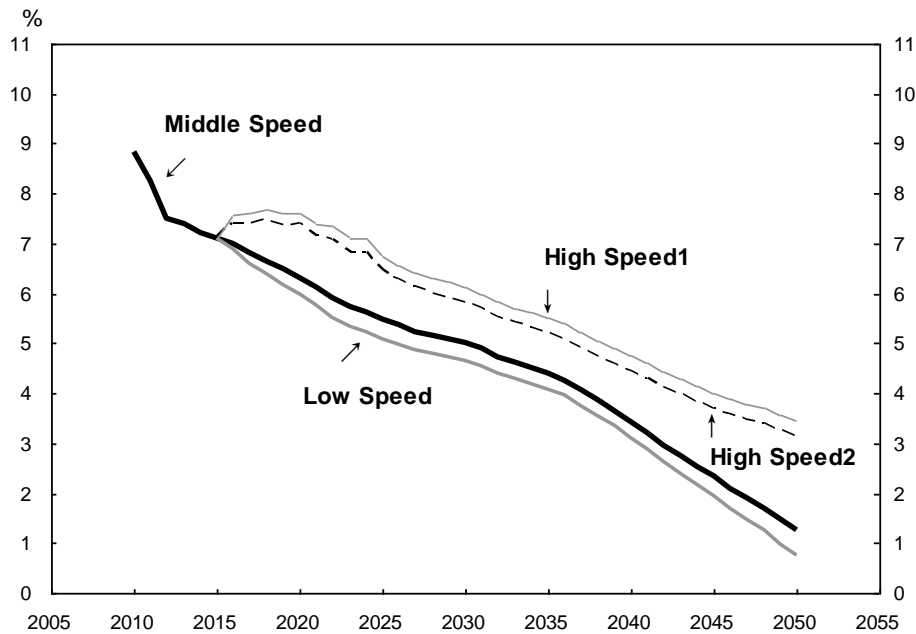
Figure 7 The interval of China's Potential Growth Rare

According to the middle-speed (baseline), low-speed and high-speed potential growth rate, the range of China's potential growth rate during 2011-2050 can be obtained. The interval of potential growth rate is shown in Figure 7. It need emphasize that China's potential growth rate will slowdown in the next decades, which has turn to a new normal. But the real worry is what's behind the slowdown. According to the story of demographic dividend, the end of demographic dividend is the main driving force to the slowdown of economics, however, reform measures for improving productivity and diminishing institutional barriers determines the sustainability of China's long-term economic growth.

V. Conclusion and Implication

China's economy has been growing at an annual average rate of 9.8 per cent for 30 years running. The high economic growth that followed was so long and significant it became known as the economic miracle. Our results suggest that demographic dividend contributed to nearly one forth of the economic growth in China in the past three decades, however, the contribution of demographic dividend open ignored in literatures. China's population control policy generated a significant demographic dividend in a very short time, which is unique and different with any other country's experience.

This paper has demonstrated the necessity to estimate China's potential growth rates according to production factors and TFP growth potentials, adopt such potential growth rates as growth targets, and evaluate the increase of potential growth rates or

reform dividends that can be brought about by the comprehensive deepening of reform in the context of China's "new normal" of economic development. These measures will present reasonable expectations of economic growth and help the government identify appropriate policy measures to ensure sustained and healthy economic growth. That is to say, demand-centric stimulus policies should be abandoned to give way to top level design and comprehensive coordination for the advancement and guidance of reform in key areas.

First, the Chinese Government should continue to stick to and improve its current family-planning policy. Although relaxation of the family-planning policy will not have an immediate growth effect, in the long run, however, relaxing the family-planning policy could be conducive to a reasonable demographic structure and an increase in the working-age population, thus generating a positive impact on China's potential growth rate. Adjusting the family-planning policy sooner rather than later will generate obvious effects. Therefore, the Chinese Government should make the transition from the 'selective two-child policy' to a 'two-child policy' as soon as possible, and ought to further adjust the family-planning policy according to the reality of population development.

First, improving the market mechanism that plays an essential role in the allocation of resources creates an equal, competitive environment for the entry and exit of firms. There is still important potential to improve productivity—that is, given the large disparities in productivity among firms within the sector, the mobility of factors of production from low-productivity firms to high-productivity firms—which allows for more efficient enterprises to survive, expand and develop, while long-term inefficient enterprises are eliminated—could improve the industry as well as national productivity. Second, allocative efficiency could be improved by financial system reform, which should focus on the promotion of interest rate liberalisation. It is clear that only market-based interest rates can achieve the allocative efficiency of capital. It is not possible for the interest rate to float, reflecting the rate of return to capital, under the conditions of non-market or controlled interest rates. Third, the Chinese Government should help migrant workers by reforming the household registration system. The task can be achieved through public policy reforms, which either enhance the potential growth rate by increasing the labor supply or eliminate institutional obstacles to dredge the channel of labor mobility and continue to create resource reallocation efficiency, and then maintain the increasing rate of TFP.

Entering into a "new normal" of economic development, China remains in a period of strategic opportunities. Nevertheless, the key to confronting the challenges and seizing the opportunities lies in an appropriate understanding of, and adaptation to, the "new normal." Setting growth targets based on potential growth rates will present us with a better understanding of China's changing development stages and the "new

normal." The understanding that reform can bring about new dividends from enhanced potential growth rates will help China's policymakers better adapt to the "new normal" and ensure sustained economic growth.

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Appendix 1: Model

1-1 Estimation for Potential Growth Rate[3]

We use a standard Cobb-Douglas production function, adding the variable of human capital, to project the potential growth rate (Equation 1).

$$Y = AK^{\alpha}(hL)^{1-\alpha} \tag{1}$$

In Equation 1, Y is real GDP, A is total factor productivity (*TFP*), K stands for capital stock (in constant prices), L is employment, and h stands for human capital. We deduce Y/hL by dividing hL on both sides of Equation 1 (Equation 2).

$$Y/hL = A(K/hL)^{\alpha} \tag{2}$$

In Equation 2, *Y/hL*, represented by y, is a function of the *TFP* and capital–labour ratio, *K/hL*, represented by k. That is, $y = Ak^{\alpha}$. Differentiate it totally with respect to time and divide by y and one obtains Equation 3.

$$\frac{\dot{y}}{y} = \frac{\dot{A}}{A} + \hat{\alpha}\frac{\dot{k}}{k} + \varepsilon_t \tag{3}$$

Where dots indicate time derivatives. Based on Equation 3, we could calculate the estimated value of return to capital, $\hat{\alpha}$, and return to labour, $(1-\hat{\alpha})$, by using $\dot{y}/y$ as the dependant variable and $\dot{k}/k$ as the independent variable. And one could obtain $\hat{\dot{A}}/A + \varepsilon_t = \dot{y}/y - \hat{\alpha}\dot{k}/k$, and $\dot{A}/A$ could then be estimated by using Hodrick–Prescott filter method to diminish error term ε_t.

It is necessary to use potential employment, L_t^*, to forecast the future potential GDP growth rate. Where $L_t^* = population_{15+,t} \times Tr_{15+,t} \times (1 - NAIRU_{15+,t})$, $population_{15+,t}$ is the population aged fifteen years and above; $Tr_{15+,t}$ is the trend of the labour participation rate; and $NAIRU_{15+,t}$ is the natural rate of unemployment.

Building on $\Delta A_t \hat{/} A_{t-1}$, $h_t L_t^*$, $\hat{\alpha}$ and $\Delta k_t^*/k_{t-1}^*$, the potential labour productivity growth rate, $\Delta y_t^*/y_{t-1}^*$, could be estimated, where $\Delta y_t^*/y_{t-1}^* = \Delta A_t \hat{/} A_{t-1} + \hat{\alpha}\Delta k_t^*/k_{t-1}^*$, which stands for the growth rate of potential labour productivity; $k_t^* = K_t/h_t L_t^*$; $y_t^* = Y_t^*/h_t L_t^*$, and Y_t^* is just the potential GDP in year t. Building on $\Delta y_t^*/y_{t-1}^*$ and $h_t L_t^*$, Equation 4 can be deduced.

$$\Delta Y_t^*/Y_{t-1}^* = (\Delta y_t^*/y_{t-1}^* + 1) \times (h_t L_t^*/h_{t-1}L_{t-1}^*) - 1 \tag{4}$$

$\Delta Y_t^*/Y_{t-1}^*$ is the potential growth rate in year t. In Equation 4, four factors would influence the potential growth rate—that is, the potential growth rate of the capital–labour ratio, the potential growth rate of employment, the growth rate of human capital and the TFP growth rate. That means demographics will affect the first three factors directly or indirectly. The TFP growth rate is, however, more related to institutional factors—for example, migration, the *hukou* system, technical progress,

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3 The methodology we adopted is very similar to the one we used in Lu and Cai (2014).

and so on. Therefore, we assume TFP remained unchanged in the 'medium-speed' simulation.

1-2 Decompose China's Output Growth into Factor Contribution

Following the pioneering work of Solow (1957) and predecessors discussed in Griliches (1994), the objective of growth accounting is to break down the growth rate of aggregate output into contributions from the growth of inputs, usually capital and labor, and the growth of technology (Barro, 1995, p.346). Factor's contribution on economic growth between 1978 and 2010 could be decomposed by Cobb-Douglas production function. Based on Equation 1, one obtains Equation 5.

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + \alpha\frac{\dot{K}}{K} + (1-\alpha)\frac{\dot{h}}{h} + (1-\alpha)\frac{\dot{L}}{L} \tag{5}$$

The growth rate of aggregate output equals $\dot{A}/A$, the growth rate of TFP, plus a weighted average of the growth rates of the two inputs, where the weights are the corresponding input shares (Barro, 1995, p.347), e.g. the contribution of capital to economic growth is equals to the increasing rate of capital multiplied by the return to capital, $\alpha\dot{K}/K$, and then divide by the economic growth rate, $\dot{Y}/Y$.

Appendix 2: Data

2-1 Data during 1980-2010

The data for real GDP (at constant 2005 national prices) and real capital stock (at constant 2005 national prices) were obtained from the Penn World Table (*PWT 8.0*). The data for human capital were cited from the index of *hc* in the Penn World Table (*PWT 8.0*). The data for population and employment were obtained from the *China Statistical Yearbook* (NBS various years).

2-2 Population predictions during the period 2011-2050

Demographic predictions are based on a country's total fertility rate (TFR). The forecast data for population by age and sex were provided by Guo (2013). In terms of different fertility scenarios—TFR equals to 1.4, 1.6, 1.77 and 1.94[4], the working-age

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[4] The first three scenarios keep TFR remain 1.6, 1.77 and 1.94 between the year 2010 and 2050. The forth scenario assume that TFR could remain 1.4 before year 2035, after that TFR dramatically increase to 1.94. It worth noting that if we pay close attention to the accuracy of the potential growth rate in the short term and the reform dividend before the year 2035, the forth scenario is more appropriate. However, for the simulation results after 2035, the reform dividend will be overestimated because we assume a jump in TFR at the year 2035—TFR rise from 1.4 to 1.94. Of course, the benefits of the forth scenario is that we can observe reform dividend drastically affected by relaxing of family planning policy after 2035. The reality is that the 'selective second-child' policy—introduced in 2014 has limited positive effect on TFR—aggregate effect no more than 0.2, and theoretically, the economic development and education improvement may also produce a negative effect on TFR, therefore, if government choose a modest mode to adjust to the family planning policy before 2035, China's TFR will keep 1.4 for a long time; if government substantial adjust to the family planning policy or even cancel it after 2035, a dramatically increase in the TFR is not impossible. It worth noting that China's current TFR more closed to 1.4, if we assume TFR remain 1.6 over the forecast period, reform dividend can be identified and comparable in the all time period, but the potential growth rate in the short term will be underestimated.

population and population dependency ratio can be obtained.

2-3 China's capital stock during the period 2011-2050

It was necessary to forecast China's capital stock by the well-known 'perpetual inventory method'—that is, $K_t = I_t + (1 - \delta_t)K_{t-1}$, where K_t and K_{t-1} are the measures of real capital stock at year t and $t-1$; I_t is the real capital formation of GDP in year t; and δ_t (= 5 per cent) is the rate of depreciation, noting that K_t is a weighted sum of all past levels of investment and depreciated value of the initial real capital stock. It's necessary to build up an empirical relationship between fixed capital formation rate and population dependency ratio. We note that once the forecast data of population dependency ratio identified, China's fix capital formation rate (investment) during the next 40 years can be obtained.

It not that GDP calculated with expenditure approach that totals consumption, investment and net exports. Capital formation is a specific statistical concept used in national accounts statistics. It refers to a measure of the net addition to the physical capital stock of a country in an accounting interval. The gross capital formation is the total value of the gross fixed capital formation, plus net changes in inventories. Gross fixed capital formation rate (% of GDP) in China was 45.58% as of 2010. Its mean value over the past 30 years was 33.59%.

There exist four distinct channels through which a demographic transition can affect fixed capital formation rate (investment rate). First, with all other parameters remained unchanged, population dependency ratio affects current saving rate directly, thereby affecting the supply side of capital in the current period. Second, if population dependency ratio is the supply side factor of investment, return to capital is the demand side factor of investment, which determines the amount of investment. If a country has a relatively high rate of return to capital, the potential demand of investment will be boost. In fact, the return to capital without tax will mainly influenced by labor share and capital-output ratio, e.g., Sun (2010) argued that in the early stage of economic development, a country's labor share and the capital-output ratio always keep a low level, but with the development of economy, they will be raised. This makes the return to capital will inevitably decline. Third, the fundamental reason of a firm to decide whether or not to invest is the net profit (Zhang and Xu, 2014), return to capital contain tax well reflect social return on investment[5] (CCER, 2007). A high production tax rate will limit firm's investment rate. A country's gross return to capital will ultimately be distributed between 'government' ('tax') and 'firm'. Therefore, a rise in production-tax rates discourages investment. Forth, investment rate lags has a positive effect on the current year investment rate. Investment rate in the previous year has a positive effect on the current year investment rate.

The data for gross fixed capital formation rate (% GDP) from 1980 to 2013 were obtained by multiplying the gross capital formation rate (% GDP) by the composition

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[5] Social return on investment can also be called the gross rate of return on capital.

rate (%, Gross capital formation=100), which cited by the *China Statistical Yearbook 2014*. The data for the return to fixed capital (excluding production taxes) were cited by Bai and Zhang (2014). Where 'Return to fixed capital_tax'= 'Return to fixed capital (including production taxes)'-'Return to fixed capital (excluding production taxes)'. Based on historical empirical relationship between dependency ratio and fixed capital formation rate, and China's demographic changes in the next four decades, the forecast data for gross fixed capital formation rate and capital stock can be obtained.

2-4 Potential employment during the period 2011-2050

Three factors influence the potential employment—that is, the size of population aged fifteen years and above, labor participation rate, and natural rate of unemployment. The labor force participation rate and natural rate of unemployment are, however, a function of the population's age and sex. There exists an inverted U-shaped relationship between labor participation and age. And unemployment is also affected by demographic structure (Weithers and Sullivan, 1991). We assume that the labor participation rate and natural unemployment rate by age and sex will remain the same as it was in 2010. Even so, the gross labor participation rate will still change with the changes of demographics structure. And natural unemployment rate follows the same logic as labor participation rate. That means potential employment L_t^* during the period 2011-50 could be estimated by Equation 6.

$$L_t^* = \sum_{i=1}^{i=2} \sum_{n=16}^{n=95} population_{n,i,t} \times Part_{n,i,t} \times (1 - NAIRU_{n,i,t}) \quad (i = 1, 2; \ 16 \leq n \leq 95)$$

(6)

Where n stands for age ($16 \leq n \leq 95$), i stands for sex (i = 1 male, 2 female), t stands for year ($2011 \leq t \leq 2050$), $population_{n,i,t}$ is the population by age and sex in year t, $Part_{n,i,t}$ is the labor force participation rate by age and sex in year t, $NAIRU_{n,i,t}$ is the natural rate of unemployment by age and sex in year t, L_t^* stands for the potential employment in year t.

2-5 Human capital during the period 2011-2050

The data for human capital were cited from the index of *hc* in the Penn World Table (*PWT 8.0*). The *hc* index, in fact, is a re-estimated dataset built on the education returns estimated by Psacharopoulos (1994), and the average years of schooling provided by Barro and Lee (2012). Forecast data for the average years of schooling, by each five years, were estimated by the similar method provided by Barro and Lee (2012). The data for other years were filled in by a smoothing method, and the index of *hc* during 2011–50, ultimately, could be obtained.