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ABSTRACT

China's 40 Years Demographic Dividend and Labor Supply: The Quantity Myth*

In the past forty years the Chinese economy achieved miracle growth and many attributed a significant part of this to China's favourable labour supply flowing from the "demographic dividend": a larger share of working age population (WAPS). Currently, this dividend is slipping away and many in China are very concerned. Against this background I set out to examine the contributions of various dimensions of China's changing WAPS and its impact on economic growth. I show that between 1982-2015 the increase in the WAPS was offset by a decline in the labour force participation rate, resulting in a very limited increase in the quantity of labour supply. I then estimate the association between regional variations in economic growth and changes in factors such as population size, WAPS, migration, education. The results lend little support to the view that increasing WAPS played a major role in China's economic growth over this period.

JEL Classification: J10, J11, J21
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1 Introduction

During the People's Republic of China (PRC)'s 70 years' history, debates about population policy have never stopped. In August 1949, just two months before Mao declared the establishment of the PRC, the US State Department published 'The China White Paper' that listed 'over-population' and lack of food to feed Chinese people as a major problem facing every Chinese government up until then and concluded that all Chinese governments had failed to resolve the problem. As a response to the 'White Paper', Mao in 1949 stated 'The most precious thing in this world is people. As long as we have people we can achieve any miracle we desire' (Mao, 1991). This belief in large population underpinned China's 1950s' population policy and initiated China's baby-booming era, which in the 1960s brought China's dependency ratio — the ratio of 0-15 and above 65 population over the total population — to a very high level. According to the World Bank Development index China's dependency ratio hovered around high 70% during that period(The World Bank, 2021).

At the end of the 1950s, however, the Great Famine hit China and tens of millions people were estimated to have died from it(Yao, 1999; Li and Yang, 2005). 'How China can feed its people' again became an urgent question for government. Soon after, the government established family planning commissions at both the central and provincial levels (Zhang, 2017). The following decades saw an ever-increasing degree of fertility control policies, from 'Later, Longer, and Fewer' to 'One is not too few, two are just fine, and three are too many', to 'One Couple, One Child'. Between the early 1960s and the introduction of the more relaxed two-children policy in 2015, China's total fertility rate dropped from over 6 to just 1.64 (The World Bank, 2021).

From the beginning of the twenty-first century discussions of the disadvantages of the One-Child Policy (OCP) started to appear regularly and gained momentum: issues raised varied from the increasing cost of old age support, to behaviour of the children of the single-child generation, to the losing of the demographic dividend (dd), and to general concerns as to future labour shortages. Eventually, in 2015, policy changed direction and the two-children policy was introduced. Despite this, the total fertility rate in the next five years only increased marginally from 1.64 to 1.69, and since the publication of the 2020 population census results, policy makers, academics, and large sections of society appear to have become increasingly concerned. Many believed that China's miracle economic

growth, over the last 40 years, was in part driven by its favourable population structure, the 'demographic dividend' (see, for example, Cai and Wang, 2005; Golley and Tyers, 2012). And, as this demographic dividend is disappearing soon, many believe that this will adversely affect China's economic development momentum. Discussions as to how to avoid 'growing old before growing rich' and the 'low fertility trap' became widespread among academics, policy makers, and main stream and social media. In May 2021, the central government announced further relaxation of the fertility policy: One couple can now have three-children. In addition, the government vowed to introduce a series of policies to encourage more births, including incentives for maternity leave, childcare, tax, and housing.

Ever since Malthus (1798), demographers and economists have been discussing the relationship between population and economic growth and, in the second half of the 20th century, the focus has been on demographic transition and economic growth. Originally, the discussions, be it views of 'pessimism' or 'optimism', focused more on the population quantity effect (see, for example, Coale and Hoovern, 1958; Ehrlich, 1958; Kuznets, 1976; Simon, 1981), later the 'neutralists' started to examine the differential impact of the type of population growth, namely the change in fertility, mortality or immigration on labour supply and hence economic growth (Bloom and Freeman, 1986; Kelley, 1988). The idea of a 'demographic dividend' grew out of the 'neutralist' branch and was more systematically discussed in Bloom and Williamson (1998). Their study highlighted the importance of the increase in the working age population share of the total population (WAPS) through an increase in labour supply and saving/investment on economic growth. They labeled such an impact as the 'demographic gift'. Subsequent studies followed this line of inquiry, linking the WAPS with labour supply and economic growth (see, for example, Bloom and Williamson, 1998; Bloom and Canning, 2005; Bloom and Finlay, 2009; Hajamini, 2015). More recently Cuaresma et al. (2014); Lutz et al. (2019) have questioned whether it is the favourable demographic condition generated increase in quantity of labour or education (quality of labour) that contributed mostly to the economic growth, while Kotschya et al. (2020) argue that both age structure and education contributed.

The recent concern in China about the ineffectiveness of increasing fertility through the consecutive relaxation of the family planning policy may have been related to a wide range of areas, including social, political, and economic. In this paper, however, I will

focus on the merit of the argument that the 'demographic dividend' has been a driving force for China's economic growth and, as it disappears, this process will hinder China's future economic growth. Thus, if the government does not boost fertility to suppress the declining trend of the 'dd' China's economic growth would be seriously constrained.

The main channel of the relationship between the WAPS and economic growth is through the quantity of labour supply: the argument is that a larger share of the working age population to support less non-working dependents is good for an economy.[1] I argue in this paper, though, while it is true that in the past 35 years, China has had an increase in the share of the working age population, many other factors that affect labour supply have also changed and establishing the importance of the link between economic growth and the demographic dividend is not straightforward. Whether an increase in WAPS can be translated into an increase in quantity of labour supply depends on the labour force participation rate. More importantly, the increase in the quality of the labour force and the change in the structure of workforce allocation across different sectors of the economy may be more relevant to economic growth, past or future. Hence, understanding the extent to which the contribution of each aspect of labour supply to China's growth is the key to understanding how much 'dd' contributed to China's growth and now that it is disappearing should China be overly concerned from the point of view of the quantity of labour supply.

Using population census and population survey data from 1982 to 2015, I first examine how the labour supply has changed in China as a whole during this period. I then compile a panel data set at the prefecture level, combining census, population survey data together with prefecture level economic variables, to estimate how the variation of economic growth is correlated with the variation of the 'demographic dividend' and other important variables, following the ideas formulated in Bloom and Canning (2005) and Cuaresma et al. (2014).

A detailed analysis of the past 35 years of economic growth seems to suggest that quantity of labour supply is very weakly related to the WAPS. Given the WAPS there is considerable room for government policy to encourage labour force participation, efficient labour force allocation and to improve the quality of labour. Once these factors are taken

[1]Another important economic channel is through saving based on the life-cycle hypothesis, it is argued that the younger age group is more likely to save relative to the old age group, and that this will be good for growth. However, the life-cycle hypothesis does not seem to be at work in China over the past 30-40 years, (see, for example, Chamon and Prasad, 2010).

into account, WAPS per se does not seem to play much of a role in China's economic growth during this period. If appropriate economic policies can be implemented to change these factors, China should not face serious labour supply constraints. In other words, the 'demographic dividend' is a relatively static view of the relationship between population changes and economic development, but economic growth is a dynamic process.

The paper is structured as follows. The next section discusses the data; Section 3 provides an historical overview of China's detailed labour supply. I examine the change in labour force participation, the size of the labour force, its education composition, and rural-urban migration by gender, rural and urban, and age group. Section 4 discusses the model specification of the relationship between economic growth and 'demographic dividend'. Section 5 presents the results, while Section 6 offers concluding comments.

2 The data

China does not have regular labour force surveys. Previous labour supply studies either use household surveys or census data. The inadequacies of household surveys are twofold. First, China's publicly available and nationally representative household surveys only started in the last decade and hence it is not possible to use these data to examine long time trends. Second, the sample size of these household surveys is often limited and at the sub-national level they lose representativeness. Censuses are much better in terms of a long-time horizon and sub-national representativeness. However, the census was only conducted every 10 years. To study the impact of population and 'demographic dividend' on China's economic growth researchers have mostly used aggregated data at the provincial level from the statistical yearbooks (see, for example Cai and Wang, 2005; Golley and Tyers, 2012; Yao, 2013). The drawback of using yearbook data is the lack of information on education levels per worker, rural-urban migration, and labour force participation rates.

In this study I use the Population Census and Population survey data. Since 1949 China has conducted seven population censuses. Apart from the 1970s, during the Cultural Revolution, the census was conducted approximately every ten years (1953, 1964, 1982, 1990, 2000, 2010, and 2020) (Wu, 2014; National Bureau of Statistics of China, 2021a). In between two consecutive censuses, from the fourth Population Census (1990)

onwards, the National Bureau of Statistics has conducted intercensal One-Percent Population Surveys in 1995, 2005, and 2015. To date, the 1% sample of the 1982-2015 census, together with some proportion of most of the intercensal population survey unit record data has been made available to some researchers. These should be the most representative data to study the quantity, structure, and quality of the population and labour supply in China.

Further, to examine the relationship between demographic features and economic development, I combine variables extracted from the censuses/intercensal population surveys with economic data from China's City Statistical Yearbook data for the years 1990, 2000, 2005, 2010 and 2015. The variables I extracted include GDP per capita, capital stock, population density, and the sectoral distribution of the labor force.[2]

In the sections below I will detail the sample, the variable definitions, and summary statistics when the data are employed.

3 China's labour supply, 1982-2015

In 1982, China was at the start of economic reform and there was a strict population control policy with a total population of just over 1 billion. Almost 40 years later in 2020, China's total population has reached 1.4 billion, an 0.88% increase per annum. China's working age population increased from 600 million in 1982 to just over 1 billion in 2020, an increase of 1.3% per annum. Over the same period, China achieved an unprecedented fast and continuing economic growth that lifted its per capita GDP from just over US$431 in 1980 to US$10,370 in 2020 in constant 2015 US$ (The World Bank, 2021).

Is there a relationship between this fast economic growth and a growing share of the working age population and its contribution to labour supply? Population, and the changing share of the working age population affect economic growth mainly through its impact on labour supply. 'Labour' as one of the important inputs in the production process can contribute to economic growth through many channels: the quantity, the composition, and the quality. In this section, I discuss each of these channels.

[2]I am unable to find the 1982 City Statistical Yearbook data. Thus, in the regression analysis of economic growth I exclude the year 1982.

3.1 Quantity of labour supply

The quantity of labour supply not only depends on the size of the population and the age structure of the population, but also on the labour force participation. Table 1 reports the working age population, the participation rate, the total labour force, the labour force as the share of the total population, and the labour force annual growth rate. The table shows that although the working age population (aged 16-65) has increased its share of the population and grown by 1.6 per annum over the period, the labour force participation rate has decreased from around 85% in 1982 to just over 70% in 2015, a 15 percentage point decline.[3] This leads to a much slower labour force growth than the growth of the working age population. Between 1982 and 2015, when China's GDP per capita increased on average by 9% per annum, the annual average labour force growth was only at 1% per annum. If we consider the most recent period, 2000-2015, the labour supply only increased by 0.06% per annum. This table clearly shows that the growth of the quantity of labour supply could not have played much of a role in China's economic growth era. The decline of the labour force participation largely eroded whatever the labour quantity aspect of the 'demographic dividend' was supposed to deliver. In fact, although the WAPS increased significantly during this period, a 21% increase in the WAPS (dividend ratio) from 60% to 73%, its labour quantity effect was largely offset by the decline in the labour force participation rate of 17% from 84% to 71%. As a result, China's labour force as a share of the total population only increased slightly from 51% in 1982 to 52% in 2015.

Figure 1 presents the labour force participation change across different age groups and the labour force age composition change between 1982 and 2015. Panel A documents the difference in the labour force participation rate for each age group between the two years. It shows that a drop of labour force participation rate occurs in all age groups between 16 and 50 years of age. The most dramatic drop is among the youth. For people aged 16-22 participation rate dropped as much as 40-60 percentage points. Even among the primary aged population (25-45 years old) the drop of participation is prominent at over 10 percentage points. For those over 50 years of age, their participation rate increased, but the increase is below 10 percentage points. Thus, for the country as a whole the labour force participation rate dropped on average 15 percentage points over the period,

[3]The definition of 'working age population' varies from study to study. In this paper I define it as those aged 16-65 because in 1986 China implemented the Compulsory Schooling Law, which stipulates that children must stay in school before turning age 16.

and the decline mainly occurred among the young and primary aged workforce.

If we compare the age distribution of the workforce in 1982 with that in 2015, we observe in Panel B that there was considerably more 16-35 years old in the China's labour market in 1982 than that in 2015. Whereas for the 2015 labour market there were more over 35 yeas olds than that in the 1982 labour market, the larger increase in share is for the 40-53 age group. The facts presented thus far suggest that on balance the increase in the quantity of labour supply per se, especially the primary aged labour supply, cannot be an important contributing factor for the fast economic growth during this period.

So, whose labour force participation rate declined the most? While gender is a common dimension in labour supply analysis, hukou status is important for China. As is well-known, China has had largely separate rural and urban economies/societies since the 1950s. Citizens are labelled as having an agricultural (rural) or non-agricultural household (urban) registration (hukou in Chinese). The two groups have different access to social services and social welfare and, as a result, there has been large gaps in income, quality of education, and types of job held. Ever since the 1950s, the majority of the Chinese population holds a rural hukou, with the proportion in 1982 still at over 85%. The change over the past 30-40 years was slow and by 2010 there was still 72% of the total population holding a rural hukou.[4] Over the past forty years, the government has made many attempts to reduce the rural-urban economic gap, but the rural-urban divide relates to China's entire public finance system and requires much more fundamental changes to substantially reduce the gap between the two groups. Despite the large scale rural-to-urban migration occurring since the late 1990s and hundreds of millions of rural hukou population coming to the city to work, migrants are not able to enjoy urban social services and social insurances because of their hukou status. Thus, understanding labour supply changes as they relate to hukou status has real meanings not only in relation to the quantity but more importantly the average education level of the workforce. However, it is important to stress here that not all rural hukou workers are working in rural areas.

[4]Appendix Figure (A.1) presents the details of the total labour force rural-urban composition by age and gender over the period 1982-2010. The reason the data end in 2010 is because the 2015 intercensal population survey did not ask individuals about their hukou status. Later in the paper, whenever I present data based on hukou status, for the year 2015, it is based on the question "do you have the right to own land in rural hometown". This will inevitably overstate the urban hukou and understate the rural hukou population as after the city expansion and re-classification of rural-urban administratively, many rural areas lost their land, hence do not have land rights anymore. But their hukou status is still 'rural'.

Since the late 1990s many young rural workers find jobs in cities. By 2015 the number reached around 170 million, which accounted for more than a third of total rural hukou workforce.

Table (2) presents the participation rates by gender and hukou status. It shows that over the 35 year period, the LFP rate dropped for all four groups, but the largest decline was among the urban hukou population; a 22 percentage points decline in labour force participation rate. In particular, among urban females the participation rate dropped by 24 percentage points from 77% in 1982 to 52% on 2015. Both rural male and female participation rates reduced by 8-9 percentage points over the same period, less than half of that of the urban hukou population.

To understand where the drop in the labour force participation rate occurred, Panel A of Figure (2) examines the change in labour force participation across different age groups by gender and hukou status between 1982 and 2015. The figure shows that for all four groups the most significant drop in participation rate occurs among the youth, which is primarily related to education expansion. In 1986, China introduced the compulsory schooling law which stipulated that children must stay in school for 9 years. Then in 1999, a large tertiary education expansion took place, resulting in a enrolment rate increase from 9.8% in 1998 to 22% in 2006 (Ou and Zhao, 2022). These education expansions greatly reduced the quantity of labour supply for the young, but at the same time increased the quality of labour supply. Panel B of Figure (2) excludes the student population from the 16-65 age population. A comparison of Panel A and Panel B makes it clear that education played a major role in the reduction in LFP rate of those below 25 years of age.

The second important fact revealed from Figure (2) is that the labour force participation rate for the urban over 50 age group, both male and female, are much lower than their rural hukou counterparts. On average, the participation rate for the urban population age 50 to 65 group was 51% in 1982, and reduced to 37% in 2015, a decline of about 30%. Whereas for the rural hukou same age group the participation rate was 57% in 1982 and increased to over 70% in 2015, a 23% increase. The large contrast between urban and rural hukou holders is mainly related to the differential retirement rules by hukou status. The compulsory retirement rule requires females to retire at age 50-55 and males at age 60-65 depending on the type of jobs one holds. These rules, however, are only applicable to the urban hukou population. Agriculture workers had no pension access previously and

the New Rural Pension Scheme introduced only from 2009, had only a limited impact, as the pension entitlement amount was still very low by 2015. Rural hukou migrant workers can only receive a pension if they have paid pension insurance for over 15 years, but the majority of them were unable to reach this threshold due to the temporary nature of the rural-urban migration, thus limiting the number of years individual could contribute.

Finally, Figure (2) also shows that female primary age groups are more likely to have a much lower participation in 2015 than in 1982. The reason for this decline is related to the fact that during the Mao era, China's female labour force participation rates were exceptionally high. The participation rate for both rural and urban hukou primary aged population are very high in 1982 (males of both rural and urban hukou population had 99% participation rate, while urban females participation rate was 88% and rural females was 84%). The market-oriented economic reform gave individuals more choice as to whether to participate in the labour market or not and, at the same time, the privatisation of the childcare system significantly increased childcare costs leading to more labour force withdrawal. Figure (3) presents, for the urban hukou population, the female labour force participation rate and the proportion of childcare cost in earnings over the period of 1988-2009 using Urban Household Survey (UHS) data. It shows a very clear negative relationship. Childcare cost as share of average female earnings increased from less than 10% in 1988 to over 40% in 2009.[5] Thus, such an important increase in childcare cost may have acted as a significant deterrent for female labour force participation among the primary age female population.

The description presented in this section indicates that over the past 35 years, while China had an exceptionally high economic growth, the share of working aged population has increased considerably. However, this did not translate into a meaningful increase in the quantity of labour supply as a share of the population. The main reason is that the increase in the WAPS has been largely offset by the reduction in labour force participation rate. As such the share of labour force in the total population has barely increased. Furthermore, the drop in the LFPR is largely policy induced, from the very low compulsory retirement age, to the increase in childcare cost, to the significant expansion of education. Looking forward, it seems reasonable to conjecture that the rate of decline

[5]It can be observed that the urban hukou female labout force participation rate revealed from the UHS is much higher than that revealed from the censuses. This is mainly due to the sampling representative of the household surveys.

in participation of the young will substantially reduce, as will the decline in male and female participation rates in urban areas. Finally we might well expect an increase in participation of those over 50 years of age. The key is to set right policies. In this way, it seems reasonable to expect that a decline in the WAPS may not be associated with any significant labour force reduction. As a result a demographic dividend loss is unlikely to have a major influence on China's per capita income growth.

3.2 Quality of labour supply

While the quantity of labour supplied over the past 35 years has only increased marginally, its quality has improved substantially. Table (3) presents the share of labour force with different levels of education between 1982 and 2015 for the total sample, as well as the rural and urban hukou groups separately. The table shows that at the beginning of the period over 60% of the Chinese workforce had primary school or below education and by 2015 this share had fallen to 20%. In 1982, less than 1% of the workforce had college or above education. By 2015, the workforce with college and above education had increased to 14%, and those with 12 or more years of education had increased from 12% in 1982 to 30% in 2015. The most significant increase occurred among the urban hukou population (also see Appendix Figure (A.2)). In 1982 over a third of urban hukou workforce had primary or below education, and just 3.6% with college or above education. By 2010, the primary and below group had dropped to 4.4% while college and above educated increased to 37.5%.

Education has also increased for the rural hukou population. But here the main change occurred in the sharp reduction in the illiterate workforce and a significant increase in the share of workforce with junior high-school (9 years) qualification. As mentioned above, in 1986 China implemented the 9-years compulsory schooling law and that perhaps played an important role in increasing the population share of junior high school completion rate. However, as urban job opportunities increase the opportunity cost of obtaining higher education substantially increased and many rural hukou youth gave up further education to move to the cities to work. Thus, we observe a decline in senior high school qualification in the first 25 years of our data period and it was not until 2010, that a slight increase is observed. Some increases are also observed in the share of degree holders. But as getting a university degree often allows one to obtain an urban hukou, it is not clear

how large this change has been.

Figure (4) presents by year, gender and age the average years of schooling of the total workforce. The figure indicates that over the 35 years the workforce average years of schooling for each age group has increased substantially for both males and females. Females made the most progress and almost at every age the average years of schooling has doubled.

To take account of the change in population size, participation rate, and the level of schooling acquired, I follow the literature on economic growth (see, for example, Barro, 1991; Cohen and Soto, 2007; Lee and Lee, 2016; Hana and Lee, 2020) to calculate the total years of schooling for China's workforce as a measure of its human capital stock or quality adjusted labour supply.[6] Table (4) presents this figure in 100,000 education years. Panel A shows the data for the total labour force aged 16-65, while Panel B depicts the figures for labour force aged 21-65. Panel B is presented because many 16-20 years old are still at school in these years and hence their LFP rate over the years has dropped significantly. The data in the table show that over the 35 years, China's quality adjusted labour supply has increased by 120%, while the unadjusted labour supply only increased by 40%. If 16-20 year olds are excluded, the increase is even higher at 180% with an annual average growth rate of 3.2%. Recall that the unadjusted labour supply grew at 1% per annum, less than a third of the quality adjusted labour supply annual growth rate. Figure (5) compares the quality adjusted labour supply by age and gender between 1982 and 2015. It clearly indicates that apart from the 16-20 years old for every other age-gender group, the increase in labour quality is substantial. Thus, what has missed by the low growth of the quantity of labour may have been compensated for by the faster growth in the quality.

3.3 Structural change of labour supply

Perhaps an equally important change in the labour supply in China, over the past 30-40 years, is the large movement of the workforce from from agriculture to the non-agriculture sector. All countries in their economic development process experience a transition from an economy which focuses mainly on the agriculture sector to a one that is dominated by

[6]The calculation uses aggregated population size for those aged 16-65, by gender by age, times each age/gender group labour force participation rate, and then times the age-gender group average years of schooling for each of the census and intercensal years.

non-agriculture sectors. This process switches a country's workforce from low productivity activities to high productivity activities to reap more benefit from a given quantity of labour. This is precisely what happened in China. Panel A of Table (5) presents the remarkable shift which occurred between 1982 and 2015. Over 35 years, the share of China's labour force that identified themselves as working in the agriculture, forestry, and or animal husbandry sector more than halved, from 72% in 1982 to just over 30% in 2015. Table (5) also shows that in later years there are more women than men working in the agriculture sector.

Panel B of Table (5) presents another important trend in the change in rural to urban migration. Here I define a rural-to-urban migrant as an individual who is currently living in a county which is different from their hukou registration county/district (both at the six digit regional code) and that he/she holds an agriculture hukou. In 1982 hardly any of the labour force lived in a location outside of their hukou location. By 2010, the share of this group increased to 13%.[7]

Figure (6) presents the share of the total labour force in the agriculture sector (Panel A) and the share of the rural labour force migrated to the city to work (Panel B) by age and gender. Panel A of the figure shows that in 1982, among the total labour force in China, for almost all the age groups and for both genders there was over 65% being employed in the agriculture sector. The trough between age 21 and 25 for both genders is the effect of the Great Famine, which substantially reduced the rural hukou population and artificially created an increase in the non-agriculture share of the workforce. By 2015 the agriculture share of the workforce reduced in all the ages and for both genders, but the reduction was most profound among the young and middle-aged. The old, especially old women stayed predominately in the agriculture sector. If we compare this figure with Figure (2), where we show that the only important age and hukou group that increased

[7]Note that these figures are lower than those reported by the NBS each year. For example in 2000 and 2010 NBS reported that 61 and 153 million rural hukou workers, respectively, left their home to work in regions other than counties of their hukou location based on their household survey data (National Bureau of Statistics of China, 2001, 2011). These numbers should amount to 11% and 26.9% of total rural hukou workforce, respectively, for 2000 and 2010, which are twice as large as what are reported in this table. The precise reasons for such a large discrepancy are unclear. However, here are some potential reasons. First, the census data mostly included those who left hukou county for six months or more, while NBS survey includes people who left hukou registration location for any length of time. Second, in the table I only included those who moved to another county/district as migrants, while NBS data could include within county migration. Third, the census data are observed from the receiving locations, while NBS surveys were conducted at both sending and receiving locations. Thus, the rural-to-urban migration reported here should be a lower bound numbers.

their labour force participation was the rural older women, the picture seems to be that as more and more of the rural workforce moved to work in the non-agriculture sector, the older rural women stepped up to take over the jobs in the agriculture sector.

Rural-to-urban migration is an important part of the story of how China switched from a predominantly agriculture society to one that is dominated by non-agriculture activities. The groups that were most likely to move to cities were the young and males at the beginning of the migration movement. Later when migration became widespread, all gender and age groups gained momentum to move, but still the younger age groups moved the most.

The analyses conducted in this section suggest that during China's fast economic growth era, although its share of working aged population increased quite significantly, the mapping of this change into changes in the labour force was not straight forward. First, the decline in labour force participation largely offset the gain from the 'demographic dividend' from the point of view of the quantity of labour supply. Second, during the same period, the quality of labour supply in terms of human capital increased substantially. Third, the structure of labour supply changed towards the urban sector and away from agricultural activities. Both of the last two points indicate that it was the quality of labour and the structure of labour supply that changed in a direction most suitable for economic growth.

4 Increase in the share of working age population and economic growth

The 'demographic dividend' is formally defined as potential economic gains arising from the higher share of the working-age population (15 to 64) to the dependent population (14 and younger, and 65 and older), that is the inverse of the dependency ratio (DR). In the literature the share of working aged population is most often used.

In the last section, I discussed how, in China over the past 35 years, the increase in the share of the working age population did not map well into the changes in the quantity of labour supply and discussed the reasons for this disconnection. In this section I will consider the relationship between the change in share of working aged population and economic growth, conditional on the change in quality and structure of labour supply.

Before I do so, Figure (7) presents the unconditional relationship, at the aggregated level, between China's WAPS and its per capita GDP for the period 1960-2020 using data from both the World Bank and National Bureau of Statistics (NBS) sources (The World Bank, 2021; National Bureau of Statistics of China, 2021b). In the 1960s and early 70s, China had a low WAPS that hovered around 55%.[8] This low share, to some extent, contributed to the move to introduce the family planning policies of the 1970s. Over the next decade, the WAPS increased from 0.56 in 1974 to 0.65 in 1986, an annual growth of 1.1 percent. However, this period did not see significant economic growth relative to subsequent years (with a 4.9% per capita GDP annual growth rate). In the next 24 years the WAPS increased slowly to 0.73 in 2010, an annual growth of 0.48%, but the GDP per capita grew at a stunning 9% per annum. Then, the WAPS started to drop for the next 10 years at the rate of -0.42%. Economic growth, on the other hand, continued to increase at the rate of 6.3% per annum. Figure (7), thus, does not seem to support the idea that the 'demographic dividend' was an important driving forces for China's fast economic growth.[9]

The analysis of the aggregated data, however, has limitations. Other variables relevant to GDP growth are not available for the whole period. More importantly, variables related to the education level of the workforce and the rural-urban migrant workforce are also not available. In this section, I use compiled panel data at the prefecture level that combines the regional statistical yearbook data for prefectures with that of the census and intercensal population survey data to examine the relationship between the variations of change in the share of working age population and economic growth across different prefectures in China.

Before I embark on the analysis, two issues need to be discussed. First, the objective of the paper is not to identify the causal impact of the change of WAPS on China's economic growth, but to simply understand if there is a clear correlation between changes in the

[8]NBS data seem to have a slightly lower dependency ratio. NBS website did not have data before 1982. The 1964 data point is the author's own calculation based on aggregated data from the 1964 Chinese Population Census (Population Division, NBS and Third Division, Ministry of Public Security, 1988).

[9]The NBS data presented in Figure (7) although largely consistent with World Bank data, in each of the census- and intercensal-years the number deviates from the trend significantly. This makes me wonder whether this is related to the issue of under-reporting of babies during the census- or intercensal-years to avoid fines imposed on households who violated the family planning policies. This becomes more obvious when we observe that after the relaxation of the OCP, in 2020 the inverse dependency ratio measured by the Population Census jumped downwards instead of upwards as it was during the OCP period.

WAPS and that of the economic growth, controlling for other potential factors which are considered to importantly contribute to economic growth.

Second, the existing literature, relating to the relationship between the change in the WAPS and economic growth, have taken an international focus and used panel data at the country level. This study investigate the issue within one country. Early studies on the 'demographic dividend' from the point of view of the relationship between the change in the WAPS and China's economic growth have used across province variation (Cai and Wang, 2005) using aggregated statistical yearbook data. As the detailed labour force participation rate, rural-to-urban migration, and education level of workforce data are not easily obtained from statistical yearbooks, these studies do not examine the impact of the quality and the structure of labour supply. To increase the sample size, and to respond to the deficiency of the aggregated provincial yearbook data, I use prefecture level data. Thus, the research question here becomes "do cities with a higher increase in the share of the working age population also have higher economic growth, conditional on other factors that affect economic growth?".[10]

4.1 Model specification

The literature begins the analysis by noting the relationship between economic development and the working age population share of the total population from the identities,

$$\frac{Y}{N} = \frac{Y}{L} * \frac{L}{WA} * \frac{WA}{N}, \ and, \ \ ln\frac{Y}{N} = ln\frac{Y}{L} + ln\frac{L}{WA} + ln\frac{WA}{N} \tag{1}$$

where Y is total GDP, N is population, L is the labour force, and WA is the working age population (Bloom and Canning, 2005; Cuaresma et al., 2014). Thus, GDP per capita is identically equal to the product of GDP per worker, the labour force participation rate, and the WAPS of the total population. The last term is related to the 'demographic div-

[10]Inevitably, the issues now become whether one can investigate the variation of the change in the WAPS within a country and how it affect regional growth, and what it is meant of this variation in 'dividend' across regions of one country. These issues are related to whether local governments or central government are responsible for looking after dependent populations: for example, which level of government is responsible for childcare, education, health, and aged care. From early 1990s, China, in general, has a federation system in terms of public finance, while the contract between the local and central government are signed every five years. The local governments are allowed many means of collecting income and pay for local public expenditure, though, the central government, at the margin, plays a role of redistribution. Thus, in essence, each local region can be regarded as independent, but with a relatively soft budget constraint.

idend'. In an attempt to avoid the problem posed by the identity, studies often omit the labour force participation term, and transform/augment this identity in different ways to formulate an empirical estimation equation. In general, the final equation includes an augmented production function (adding elements that could affect total factor productivity or enhance labour) and demographic related variables. In this paper I take the Cobb-Douglas production function augmented to include human capital and, given the importance of structural change of labour supply in China's economic development, I include in the equation rural-to-urban migration. Hence, the first item in equation 1, $ln(\frac{Y}{L})_{jt}$, can be written as:

$$ln(\frac{Y}{L})_{jt} = ln(A_{jt}) + \alpha_1 ln(\frac{K}{L})_{jt} + \alpha_2 ln(\frac{YSCH}{L})_{jt} + \alpha_3 ln(\frac{MigR}{L}), \tag{2}$$

where subscript j and t refers to prefecture and year, and A is often referred to as Total Factor Productivity (TFP) in the economic growth model.

Substitute Equation 2 into Equation 1 (omitting the participation rate term) and take the difference on both sides, the model becomes:

$$\Delta ln\tilde{y}_{jt} = \Delta a_{jt} + \beta_1 \Delta lnk_{jt} + \beta_2 \Delta lnysch_{jt} + \beta_3 \Delta lnmigr_{jt} + \beta_4 \Delta lnwa + \varepsilon_{jt}, \tag{3}$$

where $\Delta ln\tilde{y}_{jt}$ is the change in $ln(GDP$ ***per capita****)* for prefecture j in year t; Δa_{jt} is the change in $ln(A_{jt})$; Δlnk_{jt} is the change in log capital ***per worker***; $\Delta lnysch_{jk}$ is the change in log years of schooling ***per worker***; $\Delta lnmigr_{jt}$ is the change in log rural migrant share in the total workforce; while $\Delta lnwa$ is the change in the log share of the working aged in the population. ε_{jt} is the random error term.

With regard to the change in TFP, Δa_{jt}, the economic growth literature often treates it as being associated with many factors related to institutions, endowments and initial conditions. The lagged GDP per capita, $ln\tilde{y}_{j,t-1}$, is included to capture a catching up effect. In addition, following Cuaresma et al. (2014) I also include the lagged share of the working age population, $lnwa_{j,(t-1)}$ and lagged average years of schooling, $lnysch_{j,t-1}$. Finally, I also include the lagged share of rural-to-urban migrants in the city's total labour supply, $lnmigr_{j,t-1}$.

Thus, the empirical model can be written as the following:

$$\begin{aligned}\Delta ln\tilde{y}_{jt} = \beta_1 \Delta lnk_{jt} + \beta_2 \Delta lnysch_{jt} + \beta_3 \Delta lnmigr_{jt} + \beta_4 \Delta lnwa_{jt} \\ + \gamma_1 ln\tilde{y}_{j,t-1} + \gamma_2 lnwa_{j,t-1} + \gamma_3 lnmigr_{j,t-1} + \gamma_4 lnysch_{j,t-1} + \varepsilon_{jt},\end{aligned} \tag{4}$$

In addition to the above controls, city and year fixed effects are also included. Adding city fixed effects allows me to reduce the impact of potential omitted time invariant variables, while adding year fixed effects mitigates the problem which arises from the unequal time intervals pf the data.

Before moving on to estimation it is important to discuss the fact that the above regression equation omits the potential contribution of variation of the labour force participation rate (LFPR). As discussed earlier, equation 1 is an identity. To avoid the estimation problem brought about by the identity, the literature normally omits the participation rate in the estimation equation. However, the importance of the LFPR in transforming the WAPS into actual workforce, an important production input, demands for some consideration of LFPR in the regression. Further the last section also raised an important policy question in relation to China's very low compulsory retirement age. In the estimation I will include an additional specification that add the participation rate for the 50 and above age group into equation 4. This enables me to include an important demographic share variable without giving rise to the identity problem at the same time allows me to test whether adjusting compulsory retirement age would influence economic growth.

The summary statistics of the variables used in the regression are reported, by year, in Table 6. As I use lagged variables to control for the initial conditions, the estimation uses data from the years 2000-2015.[11] The top panel of Table 6 presents variables as log-levels and ratios, while the bottom panel includes the average annual growth rate of each variable. Real GDP per capita increased significantly over the period as a whole, but the growth rate dropped between 2010 and 2015. This change correspond quite well with the change in real capital per worker, which also dropped in the last five years. Also, the gap between the growth rate of GDP per capita and that of capital per worker in the last five years reduced significantly, suggesting a reduction in the rate of capital intensity growth in the economy. An important trend among other variables is that the share of

[11] As discussed in the data section, the prefecture level data are not available for the year 1982.

migrants in the workforce has increased sharply.[12]

4.2 Results

To understand the relationship between the WAPS and economic development through time and across prefectures, I first present in Figure 8 unconditional relationships between the change in real GDP per capita and the change in the share of the working age population in the total population for the total sample (left Panel) and by year (right Panel). These scatter diagrams indicate, disregarding the cross year variation, that there is a clear association between the two variables. However, when we plot the relationship by year we can see that in the early periods (1990-2000, and 2000-2005) there is a positive correlation between the two variables, but not for the later periods (2005-2010 and 2010-2015). These are the unconditional relationships, and the regression results presented below will show how controlling for other important economic growth contributors changes the correlation between the share of working age population and economic growth.

Table 7 presents results obtained from estimation of equation (4). The first column reports the results from regressing the change in real log GDP per capita against the change in the share of working aged population, measured as the initial condition (lagged variable) and the change. The results show that both variables are positively and statistically significantly associated with economic growth. Adding the change in log capital per worker and a lagged dependent variable to the equation substantially reduces the magnitude of the coefficients attached to the lagged and the difference of the WAPS variables but they remain statistically significant (column 2). The size of the coefficient for the $\Delta lnwa$ variable, 0.465, implies that a 1% increase in the share of working aged population is associated with a 0.465% increase in the log of the change in per capita GDP between two periods.

To examine how the magnitude and significance level for the variable 'share of working age population' changes as the structure of labour supply and the quality of labour supply are controlled for, I first include the variables related to 'the share of workforce who are rural-to-urban migrants', both the stock (the lagged variable) and the change (column 3). Both variables are positively and statistically significantly correlated to the change in log per capita GDP. The inclusion of these variables further reduce the magnitudes of the

[12]Most other variables related to population and labour supply have been discussed in Section 3.

coefficients related to the share of working aged population. The statistical significance of the in particular for the $\Delta lnwa$ variable is also reduced to the 10% level. However, we cannot directly compare the magnitudes of the correlations, with the log of the per capita GDP change, between the $\Delta lnwa$ and $\Delta lnmigr$ directly using the coefficients. This is because the coefficients here implies a 1% change in the independent variables on the percentage change in dependent variable, whereas 1% change of the two variables with very different means and standard deviations are very different. Thus, I translate them into a one percentage point change in the two variables. Based on the mean values of the two variables presented in Table 6 I find that a one percentage point increase in rural migrant ratio is associated with a 0.62% increase in per capita GDP, whereas a one percentage point increase in the working aged population is associated with a much smaller increase, 0.48%, in the per capita GDP.

Why should including the workforce share of rural-to-urban migrants reduce the correlation of the share of the working aged population with economic growth? This is related to two factors. First, moving more workers into higher productivity activities has a direct impact on economic growth. Second, rural-to-urban migration mainly occurs among the young working-aged group, and therefore increases WAPS. Hence, there is a correlation between the WAPS and migration, and it is the share of migrants in the labour force, not the share of working age population per se, that is closely related to the economic growth. In addition as more young workers move to cities, migration can play a role of equalising the variation of the share of working aged population across cities. This process has actually occurred in China. Figure 9 presents the relationship between the share of the working aged population and the rural migrant share of total labour force by year. It clearly shows that as rural-to-urban migration increases over time, the variation of the share of working aged population across cities reduces.

Turning to column 4 of Table 7, when the variables that capture the stock of human capital ($lnysch_{j,t-1}$) and its change ($\Delta lnysch_{jt}$) are included in the estimation, coefficients on both variables are positive and statistically significantly correlated with the change in log real GDP per capita. The estimated elasticities are similar and greater than 1, suggesting that a 1% increase in education per worker is associated with a 1.5% increase in GDP per capita. What is more interesting is that once human capital variables are included, both the lagged and the change in log share of the working age population

become statistically insignificant. In general, the literature provides considerable evidence that increasing in the education level of the workforce directly enhances productivity (quality of labour supply), whereas the potential impact of demographic dividend (DD) on economic growth is said to be indirectly through having more workers to support the dependents, i.e. the quantity of labour supply. In the discussion of the contribution of the dd on economic growth, the potential substitution of quality for quantity seems to be missing. The regression results presented in column 4 of Table 7 clearly indicate such a substitution exist and that the quality plays a dominate role. The results that once the education stock and growth are included the effect of demographic dividend association with economic growth disappears has also been found using cross-country studies (see, for example, Cuaresma et al., 2014; Lutz et al., 2019).

The last column of Table 7 includes the participation rate for the over 50 years aged population, both lagged and the change. Because of the identity presented in Equation 1, the aggregated labour force participation rate (15-65 years of age), cannot be included in the regression directly. However, participation rate change in mitigating the impact of WAPS in quality of labour supply is established in the last section. Further, whether China's compulsory retirement age is too low has been a topic of considerable interest. Thus, adding the over 50's participation rate may shed some light on both the discussion of older age labour supply impact of economic growth, and the potential omitted variable bias generated by omitting an important channel of the WAPS on economic growth. The results show that adding the older workforce participation rate does not change the correlations between other control variables and the change in GDP per capita. We also find that the higher the increase in over 50's participation rate is associated with an increase in GDP per capita, while the lagged over 50's participation rate is also positive, but not statistically significant.[13]

5 Discussions and Conclusions

The idea of the 'demographic dividend' has attracted significant attention in China in recent years, especially since the realisation that a sudden reversal of the family planning policy may not instantly increase fertility and the decline in the WAPS is likely to con-

[13]Of course, I cannot rule out the possibility of reverse causality, that is cities with higher growth rate attract more over 50s to work.

tinue for some decades. In this paper I examined the extent to which the 'demographic dividend', over the past forty years, acted as one of the driving forces for China's economic growth.

The findings suggest that during the fast growing years there was an increasing share of working age population, but this increase was largely offset by the decline in the labour force participation rate, resulting in a limited increase in quantity of labour supply. Most of the reduction of the labour force participation rate occurred among the younger age groups and the reason for the reduction was the substantial increase in education levels. In addition, an important structural change in sector of employment saw a large proportion of rural workers moving from the low productivity agriculture sector to higher productivity jobs in the cities. Thus, the more important change in China's labour supply is ***not*** the increase in the ***quantity*** of the workforce in response to the increase in the WAPS, but the ***structural change*** of labour supply and its ***quality*** improvement. The regression analysis showed that, indeed, once the structural change of labour supply and the quality of workforce are included in the economic growth regression, the WAPS is not associated with economic growth across prefectures and over time.

The paper also discussed whether the reduction in labour force participation over the past 35 years was largely policy induced. The extremely low participation rate among the urban over 50 age group (over 60 for men) is due to compulsory retirement. This can be seen in the sharp contrast between the rural- and urban-hukou aging population participation rates. The reduction in primary age female participation rate may, to large extent, related to the increase in childcare costs, whereas the significant reduction in the participation of the younger age group is due mainly to the deliberate policy of increasing the education level of future labour supply. Thus, looking ahead, as China's WAPS reduces, some of these policies can be reversed to encourage higher labour force participation rate, such as increasing the compulsory retirement age and reduction in childcare cost. The policy of educating the future workforce should continue to act as an important economic growth enhancing measure to compensate for the reduction in the quantity of labour supply.

Any country, as it proceeds along its development path, will experience a demographic transition. As people become richer, technologies develop, infant mortality reduces and life-expectancy increases, inevitably there will be a drop in fertility. China, due to the

introduction of the OCP, might have had a faster demographic transition than usual, but it is still one of the most populous countries in the world. Recent fertility policy changes may have not generated the immediate response as some expected. This could be due to the fact that behavioural change normally takes time. After almost 40 years of being told that having less children was good for the country and good for oneself, the sudden reverse in propaganda may not generate an immediate response.

The findings from this study suggests, at least from economic development point of view, that there is not much reason to be concerned about the demographic transition and population decline and that having a larger share of the working age population does not necessarily guarantee faster economic growth. Instead, the change in the quality of labour is probably more important than the increase in the quantity of working age population.

The current paper discusses the past economic growth. In the future, an important issue will be changes in labour demand and how labour supply will adjust to meet that demand. As Chinese economic development progresses, more and more labour intensive production will be exit from China or undergo a significant automation transformation. As such, the future demand for labour would be even more biased towards quality rather quantity. The development of AI and that of the automation indicates that the future demand for physical work may reduce significantly. Thus, how to prepare the workforce to meet the future quality requirement should be the priority rather than an excessive focus on the working age population alone.

Figure 1: The change of labour force participation rate and age composition of labour force: 1982-2015

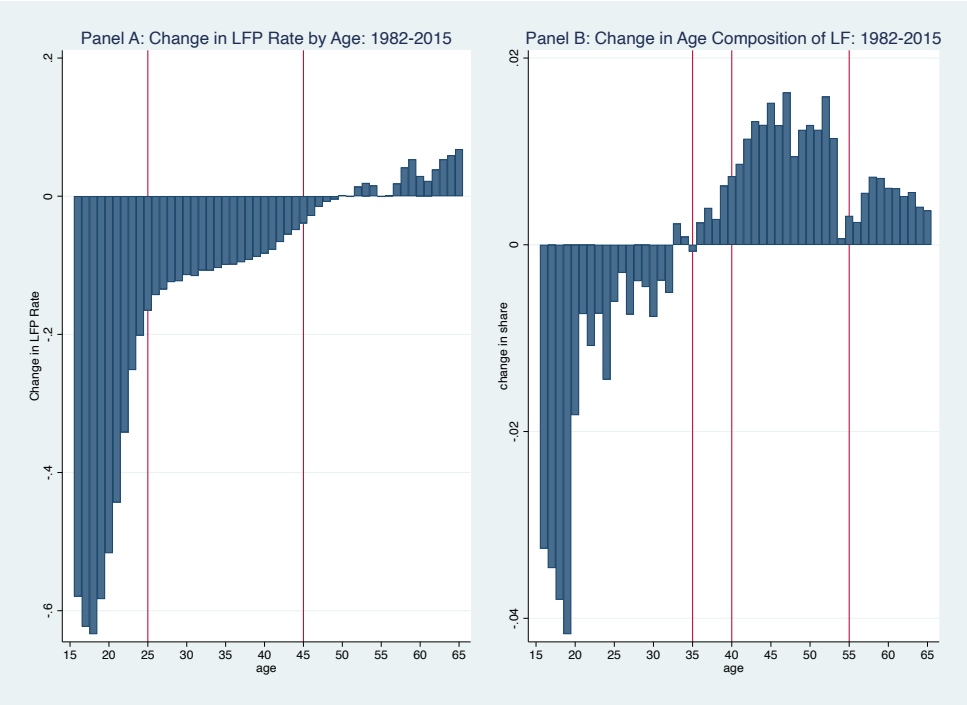


Figure 2: The change of labour force participation rate by gender and hukou status: 1982-2015

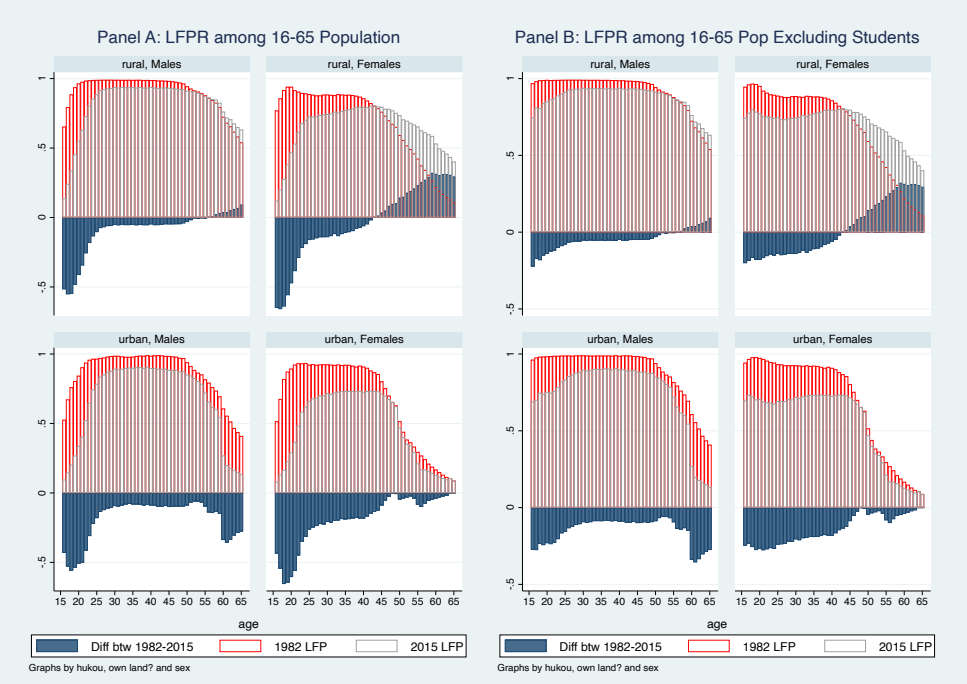


Figure 3: The change of female labour force participation rate and childcare cost: 1988-2009

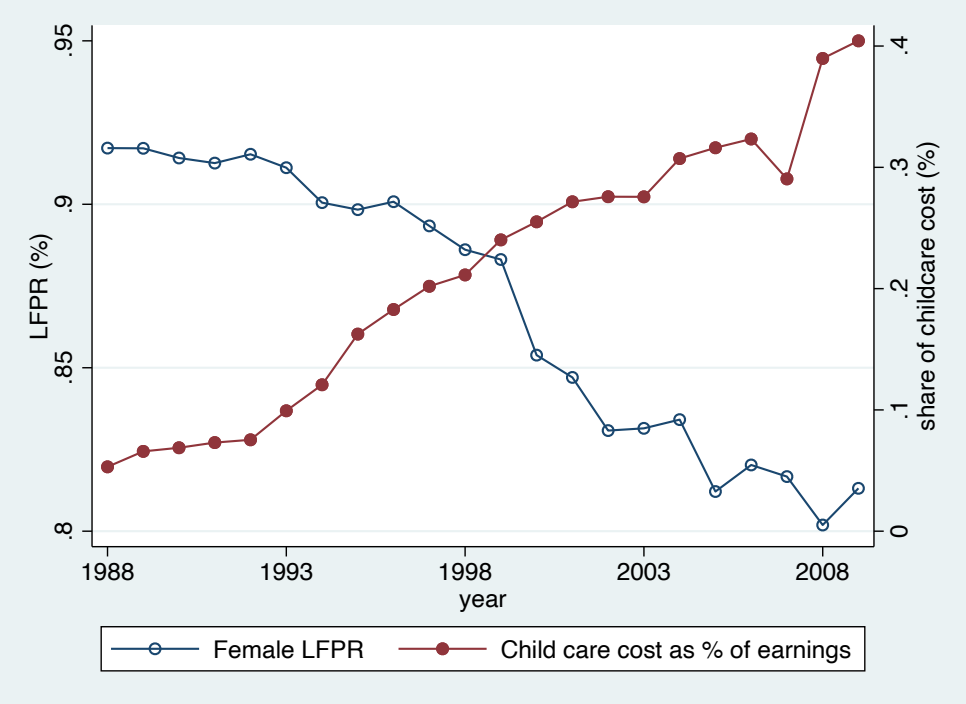


Figure 4: Average Years of Schooling by Gender and Age: 1982-2015

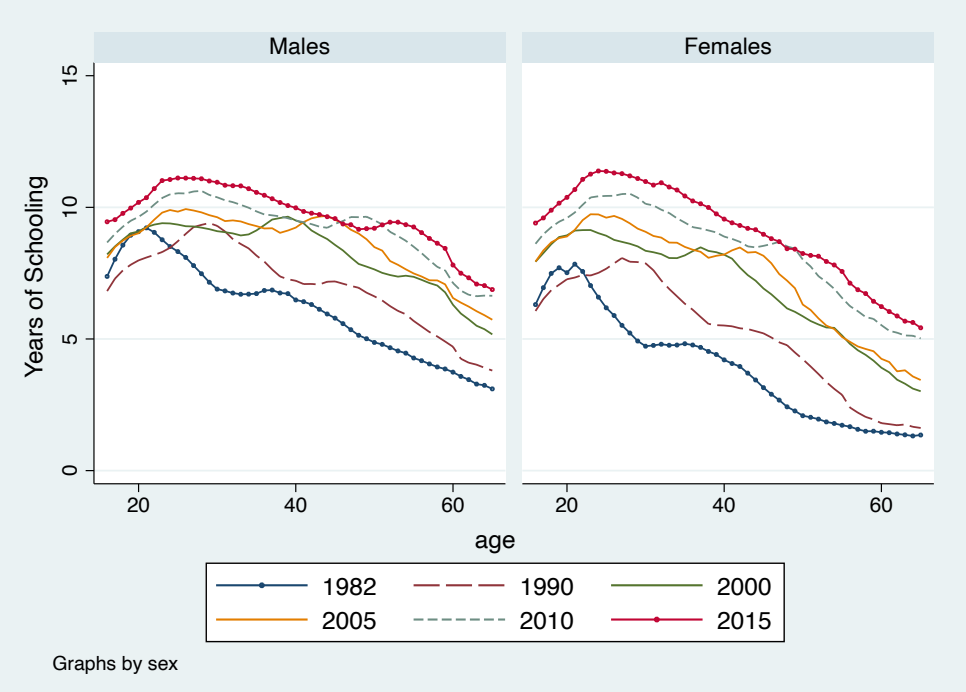


Figure 5: Change in quality adjusted labour supply (by Gender and Age): 1982-2015

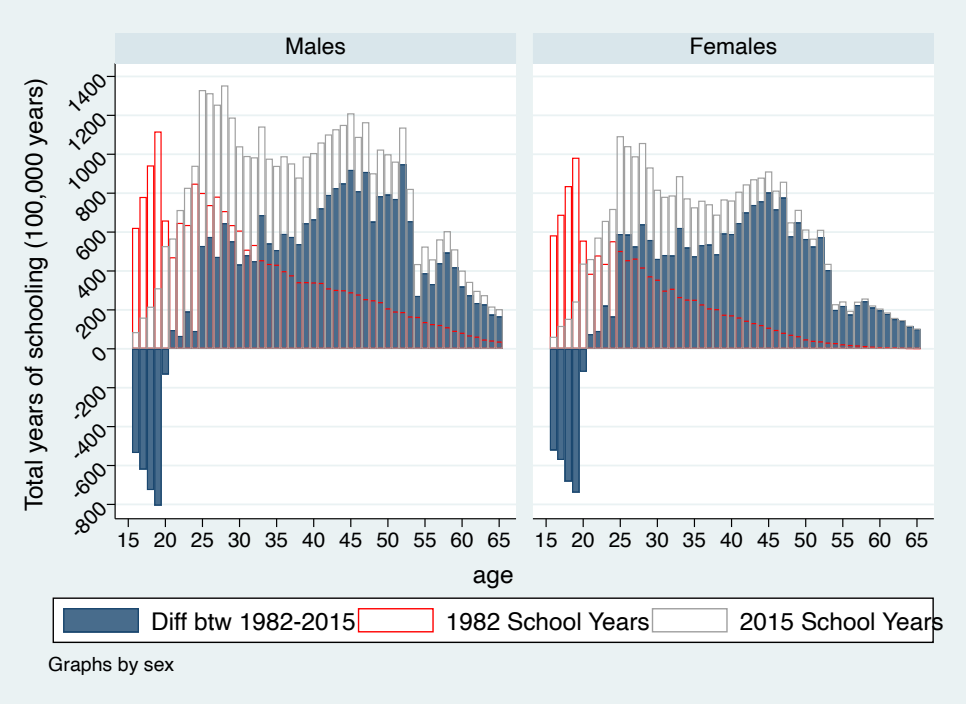


Figure 6: Change structure of labour supply (Sector, Hukou, Gender and Age): 1982-2015

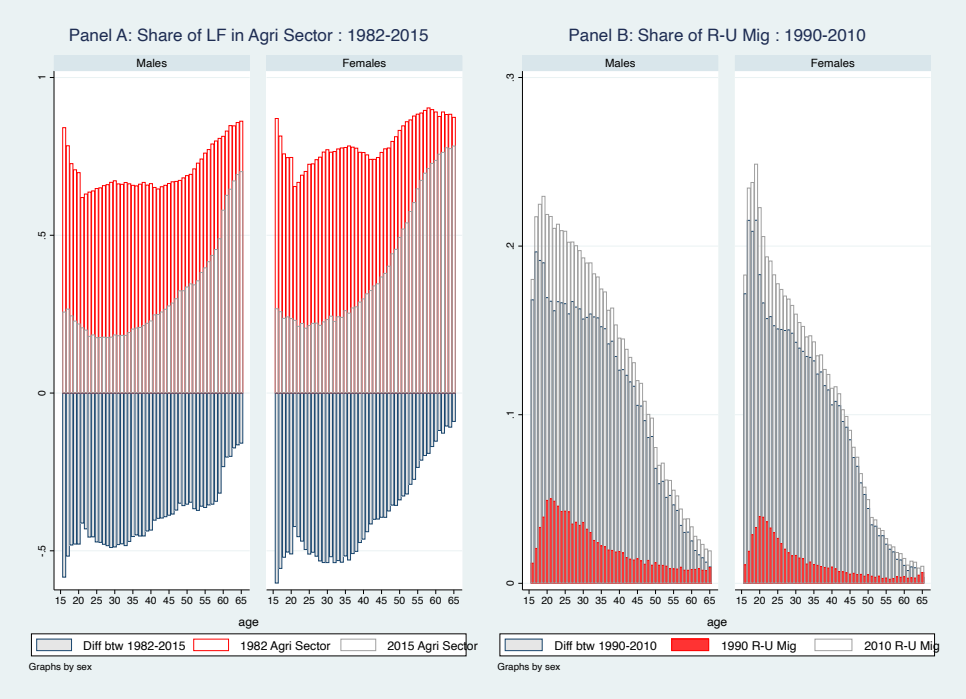
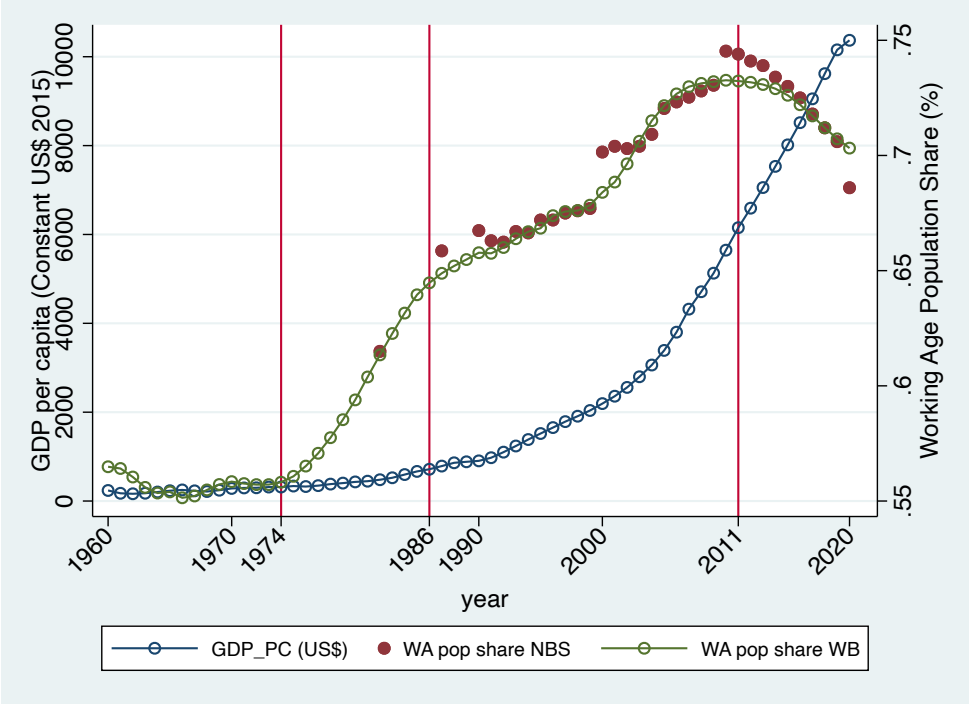


Figure 7: China's GDP per capita and working age population share: 1960-2020



Source: The World Bank, 2021

Figure 8: Unconditional Relationship between Change in GDP pc and WA Population

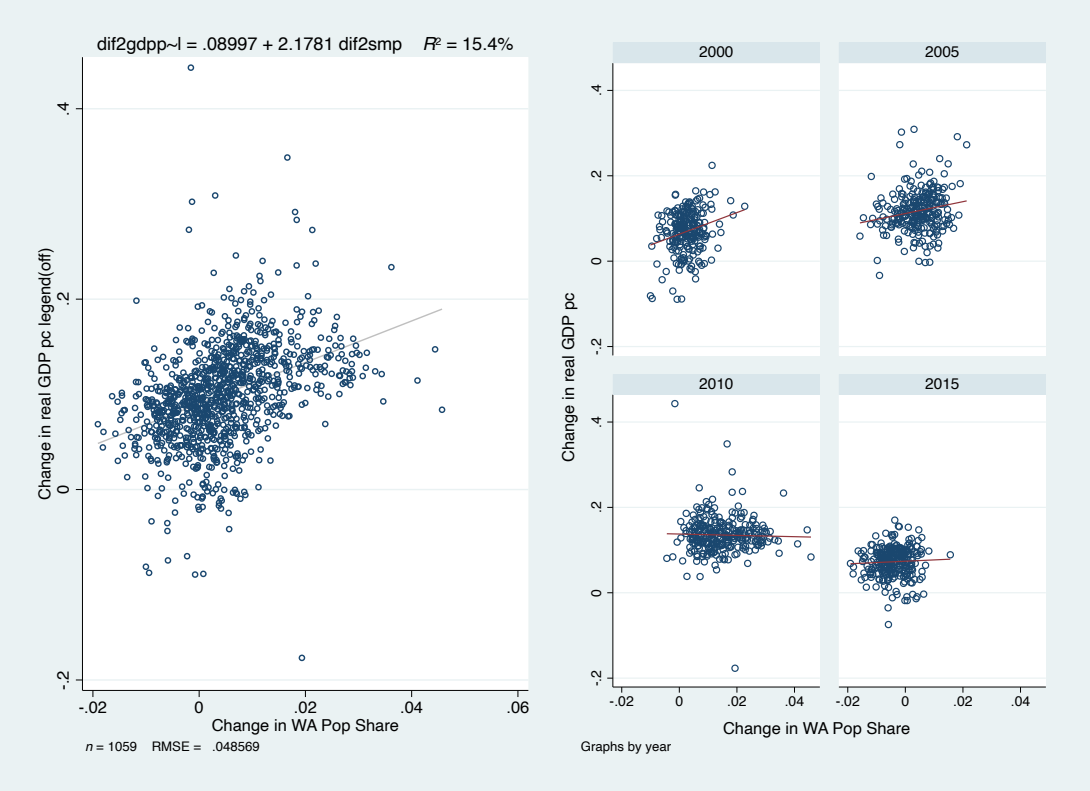


Figure 9: Unconditional Relationship between Demographic Dividend and Rural-urban Migration

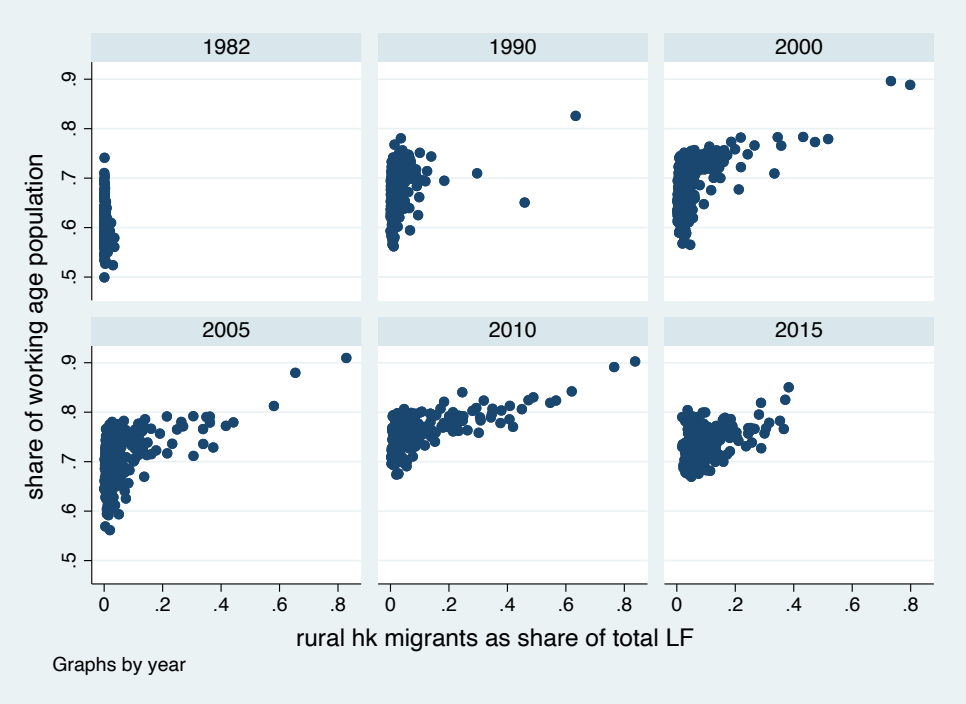


Table 1: Labour Force Participation and Total Labour Force: 1982-2015

	1982	1990	2000	2005	2010	2015
Total population (10,000)	100391.39	113051.06	124261.22	130399.41	133281.09	138240.82
Share of 15-65 in pop (%)	59.72	65.39	68.95	70.08	73.81	72.98
16-65 population (10,000)	59953.74	73924.09	85678.11	91383.90	98374.77	100888.15
LF participation rate (%)	84.71	85.28	82.46	76.57	75.28	70.65
Total labour force (10,000)	50788.53	63043.71	70652.43	69971.34	74057.66	71275.23
LF as share of population(%)	50.59	55.77	56.85	53.66	55.56	51.56
16-65 pop annual growth (%)		2.64	1.49	1.30	1.49	0.51
LF annual growth (%)		2.74	1.15	-0.19	1.14	-0.76
GDP pc (WB, US$,Constant price)	480.31	905.03	2193.89	3390.71	5647.06	8016.43
GDP pc annual growth (%)		8.24	9.26	9.10	10.74	7.26

Sources: Data on total population, share of 15-65 in population are from Population Division, NBS and Third Division, Ministry of Public Security (1988); Population Census Office, State Council and Population Division, NBS (1993, 2002, 2012); China 1% Population Survey Office, State Council (2007, 2016). Labour force participation rate data are author's own calculation using unit record census- and intercensal survey files, the GDP per capita data are from the World Bank Data Online, while the remaining variables are authors' own calculation based on the data presented in the table.

Table 2: Labour Force Participation Rate by Gender and Hukou Status: 1982-2015

	Rural			Urban		
	Males	Females	Total	Males	Females	Total
1982	0.93	0.77	0.85	0.89	0.77	0.83
1990	0.93	0.82	0.88	0.82	0.71	0.77
2000	0.93	0.83	0.88	0.76	0.60	0.68
2005	0.88	0.76	0.82	0.74	0.55	0.65
2010	0.87	0.74	0.81	0.70	0.52	0.61
2015	0.85	0.68	0.70	0.70	0.52	0.61

Sources: Data presented in this table are author's own calculation using unit record census- and intercensal survey files.

Table 3: Labour Force Educational Attainment: 1982-2015

	illiterate	primary	junior H	senior H	College+
Total	(3)	(2)	(3)	(4)	(5)
1982	27.62	33.82	26.41	11.25	0.89
1990	15.90	37.32	33.22	11.63	1.92
2000	6.70	31.86	43.06	13.65	4.74
2005	6.72	27.62	43.90	13.96	7.80
2010	2.41	21.42	51.25	14.51	10.40
2015	2.27	17.69	48.36	17.62	14.06
Rural	illiterate	primary	junior H	senior H	College+
1982	30.99	35.44	24.19	9.01	0.37
1990	19.55	43.62	31.00	5.78	0.04
2000	8.47	39.27	45.65	6.41	0.20
2005	8.76	35.06	48.38	7.25	0.55
2010	3.06	26.60	58.02	10.02	2.29
Urban	illiterate	primary	junior H	senior H	College+
1982	10.26	25.50	37.84	22.83	3.57
1990	2.07	13.44	41.60	33.82	9.06
2000	0.63	6.40	34.18	38.48	20.31
2005	0.61	5.39	30.51	34.01	29.48
2010	0.26	4.10	28.61	29.49	37.53

Sources: Data presented in this table are author's own calculation using unit record census- and intercensal survey files.
Note: Because the 2015 Intercensal Population Survey did not ask hukou status, the divide here is based on hukou location, which overstates urban hukou population and understates rural hukou population. This probably is why the high education proportions dropped for the urban hukou population in 2015 relative to 2010, whereas for the rural group there is a significant increase in high education group.

Table 4: Total Human Capital Stock: 1982-2015 (Years of Schooling, 100,000 years)

	Panel A: Labour Force Aged 16-65			Panel B: Labour Force Aged 21-65		
	Total	Males	Females	Total	Males	Females
1982	31344.46	19600.01	11744.46	23573.36	15477.38	8095.979
1990	44527.31	26405.21	18122.1	38066.81	23052.44	15014.37
2000	58622.06	33804.17	24817.89	53375.75	31138.82	22236.93
2005	59417.4	34032.74	25384.66	55863.84	32257.72	23606.13
2010	68426.97	39167.87	29259.1	64649.04	37160.64	27488.4
2015	69246.7	40296.34	28950.36	66927.22	38993.17	27934.05
Mean ann. growth (%)	2.43	2.21	2.77	3.21	2.84	3.82

Sources: Data presented in this table are author's own calculation using unit record census- and intercensal survey files and NBS Aggregated Population by Age Data.

Table 5: Structure Change of China's Labour Force: 1982-2015

	Panel A: % total LF in Agri-Sector			Panel B: % Rural HK LF Mig. to Cities		
	Total	Males	Females	Total	Males	Females
1982	72	69	77	0.4	0.04	0.05
1990	70	67	74	0.2	0.2	0.2
2000	61	58	66	0.6	0.6	0.6
2005	54	50	59	0.8	0.9	0.8
2010	41	37	47	12.0	13.0	11.0
2015	31	28	36			

Sources: Data presented in this table are author's own calculation using unit record census- and intercensal survey files.

Table 6: Summary Statistics

	1990		2000		2005		2010		2015	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
log(real gdp pc)	3.56	0.54	4.21	0.66	4.72	0.70	5.30	0.73	5.65	0.68
log(pop density)	5.96	0.85	5.78	0.79	5.83	0.79	5.73	0.92	5.74	0.92
log(labour force)	14.35	0.82	14.46	0.73	14.32	0.74	14.44	0.79	14.48	0.57
Share of working age pop	0.68	0.04	0.69	0.05	0.71	0.05	0.76	0.03	0.74	0.03
Participation rate	0.84	0.06	0.81	0.08	0.76	0.07	0.75	0.07	0.70	0.07
log(real capital per worker)	2.91	1.35	3.91	0.90	4.51	0.94	5.23	0.97	5.59	0.75
Years of schooling	7.44	1.14	8.49	0.80	8.65	0.91	9.26	0.79	9.73	0.83
Rural mig share of workforce	0.03	0.06	0.06	0.10	0.06	0.10	0.08	0.12	0.09	0.07
					Average annual growth rate					
Real GDP pc			0.070	0.049	0.118	0.049	0.135	0.045	0.073	0.034
Labour force			0.017	0.049	-0.022	0.113	0.031	0.116	0.017	0.151
Working age pop			0.003	0.005	0.004	0.007	0.015	0.009	-0.004	0.005
Participation rate			-0.003	0.010	-0.013	0.021	-0.005	0.010	-0.014	0.013
Real capital per worker			0.107	0.092	0.156	0.158	0.194	0.220	0.082	0.139
Rural migrant share			0.078	0.102	0.009	0.102	0.108	0.120	0.145	0.192
Years of schooling			0.014	0.008	0.005	0.006	0.017	0.009	0.010	0.005
Number of cities	218		239		259		279		280	

Sources: Data presented in this table are author's own calculation using unit record census- and intercensal survey files.

Table 7: Regression Results

	(1)	(2)	(3)	(4)	(5)
$lnwa_{j,t-1}$	0.906**	0.782***	0.609**	0.232	0.301
	(0.425)	(0.237)	(0.238)	(0.240)	(0.241)
$\Delta lnwa$	1.783***	0.465**	0.353*	-0.096	-0.049
	(0.341)	(0.193)	(0.193)	(0.196)	(0.196)
Δlnk		0.024***	0.024***	0.028***	0.029***
		(0.007)	(0.007)	(0.007)	(0.007)
$ln\tilde{y}_{j,t-1}$		-0.854***	-0.843***	-0.838***	-0.839***
		(0.021)	(0.021)	(0.021)	(0.021)
$lnmigr_{j,t-1}$			0.033**	0.002	0.005
			(0.016)	(0.016)	(0.016)
$\Delta lnmigr$			0.047***	0.033***	0.037***
			(0.011)	(0.011)	(0.011)
$lnysch_{j,t-1}$				1.487***	1.645***
				(0.221)	(0.237)
$\Delta lnysch$				1.530***	1.685***
				(0.207)	(0.220)
$ln(>50\ lfpr)_{j,t-1}$					0.113
					(0.079)
$\Delta ln(>50\ lfpr)$					0.142**
					(0.055)
Observations	1059	1055	1055	1055	1055
Within R^2	0.24	0.76	0.77	0.79	0.79

Notes: All regressions include city and year fixed effects.

*, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

$(>50\ \ lfpr)$ is the participation rate for the age group >50.

References

Barro, R. J. (1991). Economic growth in a cross section of countries. *Quarterly Journal of Economics 106*(2), 407443.

Bloom, D. E. and D. Canning (2005). Global demographic change: Dimensions and economic significance. In *Global Demographic Change: Economic Impacts and Policy Challenges. A symposium sponsored by the Federal Reserve Bank of Kansas City*.

Bloom, D. E. and J. E. Finlay (2009). Demographic change and economic growth in Asia. *Asian Economic Policy Review 4*(1), 45–64.

Bloom, D. E. and R. B. Freeman (1986). The effects of rapid population frowth on labor supply and employment in developing countries. *Population and Development Reveiw 12*(3), 381–414.

Bloom, D. E. and J. G. Williamson (1998). Demographic transitions and economic miracles in emerging Asia. *World Bank Economic Review 12*(3), 419–455.

Cai, F. and D. Wang (2005). Demographic transition: implications for growth. In R. Garnaut and L. Song (Eds.), *The China Boom and Its Discontents*, pp. 34–52. Canberra: Asia-Pacific Press.

Chamon, M. D. and A. S. Prasad (2010). Why are saving rates of urban households in China rising? *American Economic Journal: Macroeconomics 2*(1), 93–130.

China 1% Population Survey Office, State Council (2007). *Tabulation on the 2005 1% Population Survey of the People's Republic of Chin*. Beijing: China Statistics Publishing House.

China 1% Population Survey Office, State Council (2016). *Tabulation on the 2015 1% Population Survey of the People's Republic of Chin*. Beijing: China Statistics Publishing House.

Coale, A. J. and E. Hoovern (1958). *Population Growth and Economic Development in Low-Income Countries*. Princeton: Princeton University Press.

Cohen, D. and M. Soto (2007). Growth and human capital: good data, good results. *Journal of Economic Growth 12*(1), 51–76.

Cuaresma, J. C., W. Lutza, and W. Sanderson (2014). Is the demographic dividend an education dividend? *Demography 51*(1), 299–315.

Ehrlich, P. R. (1958). *The Population Bomb*. New York: Ballantine.

Golley, J. and R. Tyers (2012). Demographic dividends, dependencies, and economic growth in china and india. *Asian Economic Papers 11*(3), 1–26.

Hajamini, M. (2015). The non-linear effect of population growth and linear effect of age structure on per capita income: A threshold dynamic panel structural model. *Economic Analysis and Policy 46*(1), 43–58.

Hana, J.-S. and J.-W. Lee (2020). Demographic change, human capital, and economic growth in Korea. *Japan and the World Economy 53*, 1–12.

Kelley, A. C. (1988). Economic consequences of population change in the Third World. *Journal of Economic Literature 26*(4), 1685–1728.

Kotschya, R., P.-S. Urtazaa, and U. Sundea (2020). The demographic dividend is more than an education dividend. *PNAS 117*(42), 25982–25984.

Kuznets, S. (1976). Population and eonomic growth. *Proceedings of the American Philosophical Society 111*(3), 170–193.

Lee, J.-W. and H. Lee (2016). Human capital in the long run. *Journal of Development Economics 122*, 147–169.

Li, W. and D. T. Yang (2005). The great leap forward: Anatomy of central planning disaster. *Journal of Political Economy 113*(4), 840–877.

Lutz, W., J. C. Cuaresma, E. Kebedea, A. Prskawetza, W. Sanderson, and E. Striessniga (2019). Education rather than age structure brings demographic dividendh. *PNAS 116*(26), 12798–12803.

Malthus, T. R. (1798). *An Essay on the Principle of Population As It Affects the Future Improvement of Society, with Remarks on the Speculations of Mr. Goodwin, M. Condorcet and Other Writers*. London: J. Johnson.

Mao, Z. (1991). The bankrupt of the mentalist view of history (1949). In Z. Mao (Ed.), *Selected Works of Mao Zedong, Volume 4 (in Chinese)*. Beijing: People's Publishing House.

National Bureau of Statistics of China (2001). *China Yearbook of Rural Household Survey Data*. Beijing: China Statistical Publishing House.

National Bureau of Statistics of China (2011). People's Republic of China 2010 Statistical Report on National Economic and Social Development. http://www.stats.gov.cn/xxgk/sjfb/tjgb2020/201310/P020200617516947609878.PDF.

National Bureau of Statistics of China (2021a). *Major Figures on 2020 Population Census of China*. Beijing: China Statistics Publishing House.

National Bureau of Statistics of China (2021b). National Data. https://data.stats.gov.cn/easyquery.htm?cn=C01.

Ou, D. and Z. Zhao (2022). Higher education expansion in china, 1999-2003: Impact on graduate employability. *China and World Economy 30*(2), 117–141.

Population Census Office, State Council and Population Division, NBS (1993). *Tabulation on the 1990 Population Census of the People's Republic of China*. Beijing: China Statistics Publishing House.

Population Census Office, State Council and Population Division, NBS (2002). *Tabulation on the 2000 Population Census of the People's Republic of China*. Beijing: China Statistics Publishing House.

Population Census Office, State Council and Population Division, NBS (2012). *Tabulation on the 2010 Population Census of the People's Republic of China*. Beijing: China Statistics Publishing House.

Population Division, NBS and Third Division, Ministry of Public Security (1988). *People's Republic of China's Population Statistics Data Compilation*. Beijing: China Financial and Economic Publishing House.

Simon, J. (1981). *The Ultimate Resource*. Princeton: Princeton University Press.

The World Bank (2021). World Bank World Development Indicators. https://data.worldbank.org/indicator/NY.GDP.PCAP.KD?locations=CN.

Wu, X. (2014). Census undertakings in China: 1953-2010. Population Studies Center, University of Michigan, https://www.psc.isr.umich.edu/pubs/pdf/rr14-833.pdf.

Yao, Wanjun, K. T. H. S. (2013). An empirical analysis of the relationship between economic development and population growth in China. *Applied Economics 45*(33), 4651–4661.

Yao, S. (1999). A note on the causal factors of china's famine in 1959-1961. *Journal of Political Economy 107*(6), 1365–1369.

Zhang, J. (2017). The Evolution of China's One-Child Policy and Its Effects on Family Outcomes. *The Journal of Economic Perspectives 31*(1), 141–159.

APPENDIX A Appendix Figures

Figure A.1: Total number of labour force by age, hukou and gender: 1982-2010

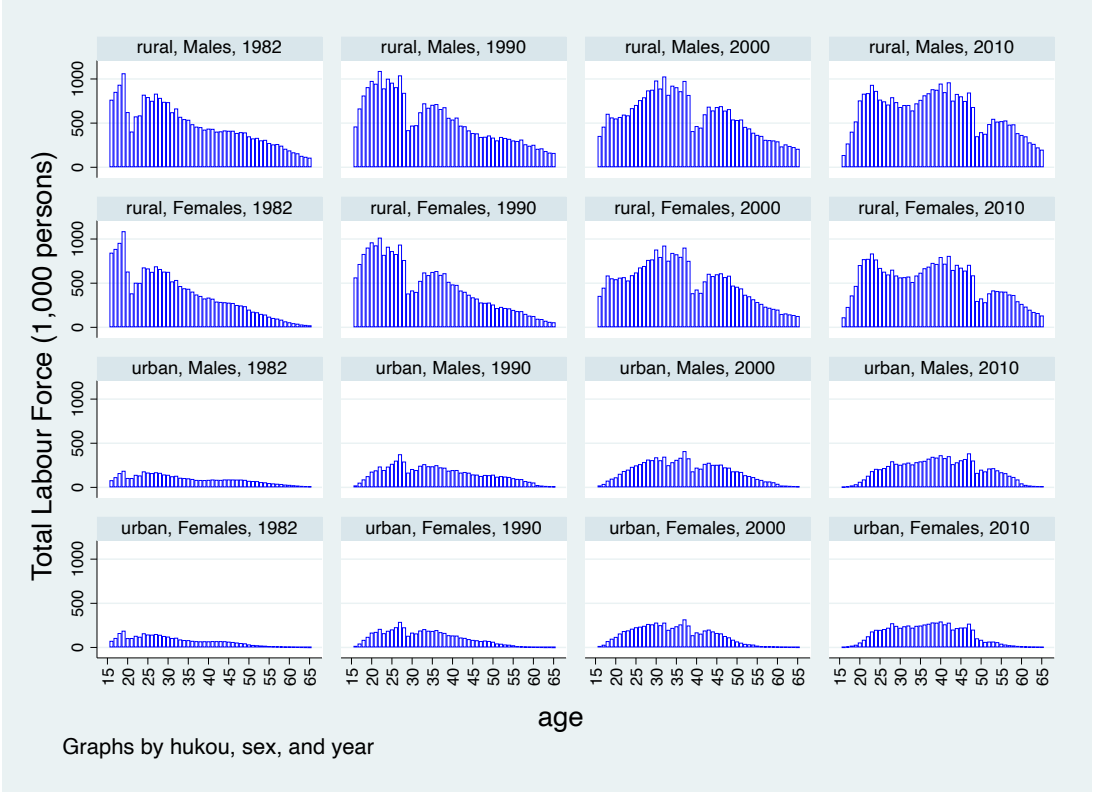


Figure A.2: Workforce Educational Composition by Hukou Status: 1982-2010