Demographic Transition, Economic Growth and Labor Market Dynamics

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Groningen, The Netherlands

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Chapter 1

Introduction and Summary of Findings

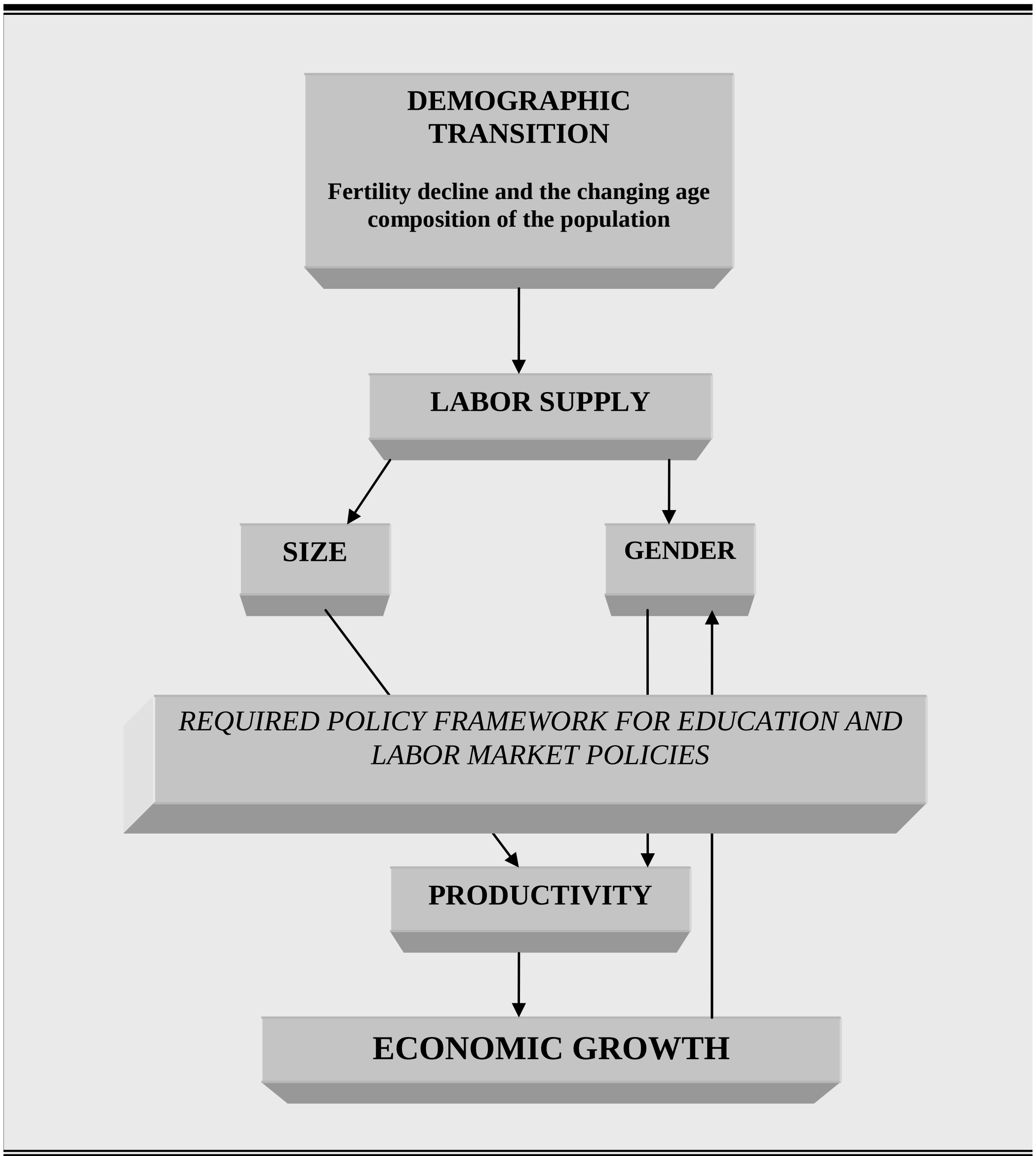
1.1 Motivation

The change in the distribution of the population across different age groups is an important explanatory factor for economic and productivity growth (Bloom and Williamson, 1998; Mason, 2005). As a consequence of demographic transition, the number of working-age adults grows larger over time relative to the dependent population. This increase of the working age population share leads to a potential opportunity of rapid economic growth, known as the *Demographic Dividend* (Bloom *et al.*, 2002). In this thesis demographic transition is defined as the process of change from a situation of both high birth and death rates (at or near equilibrium) to a situation in which both birth and death rates are low (at or near equilibrium). The demographic dividend may lead to faster economic growth as different population age groups have specific economic characteristics. Young people (0-14 years) require investment in education and health, prime-age adults (15-64 years) provide labor and savings, while the aged (65+) need health care and retirement income. If the number of working-age adults grows larger relative to the dependent population, less expenditure are needed to meet the needs of the youngest and the oldest age groups, as a result of which resources become available for investment in human development and general economic welfare. However, an optimal utilization of the demographic dividend requires a careful assessment of the changing population age structure and the accompanying policy framework. The demographic dividend is not an automatic phenomenon, but requires an integrated policy framework (health, education, labor markets policies) to transform the potential opportunity of high economic growth in reality. In absence of such required changes in the policy framework and proper planning, the potential demographic dividend can turn into a demographic burden in the form of an army of unskilled, uneducated and unemployed youth.

The potential opportunity to utilize the demographic dividend well is currently quite strong for emerging market economies. The process of demographic transition for developed countries took far longer than it will take for emerging economies. Bloom *et al.* (2003) show that the demographic transition process in Western Europe started in the middle of the eighteenth century and took nearly 150 years, whereas it will take only 50-75 years in East Asia. Consequently, the share of the population in productive age groups is also expected to be higher. The World Population Prospects Report of the United Nations (2008) reveals that the share of prime-age adults in developed countries peaked in 2005 and started to decline afterwards, but it will continue to rise in less developed economies up to 2040.

Although differences in the pace of demographic transition are important, we need to point out that other country-specific determinants may affect economic growth too. In his Nobel Prize memorial lecture in 1971, Simon Kuznets already discussed the wide disparity of growth patterns between pre-industrialized developed and current developing countries. Referring specifically to China, India and Pakistan, he mentioned that *…no country that entered modern economic growth (except Russia) approached the size of India or China, or even of Pakistan and Indonesia; and no currently developed country had to adjust to the very high rates of natural increase of population that have characterized many less developed countries over the last two or three decades.* In the same lecture Kuznets also pointed out that, while the stock of material and social technology that can be tapped by less developed countries today is much larger than that in the nineteenth and even early twentieth century, the technological backwardness is also much greater now. In spite of these observations back in 1971, the emerging economies of China and India managed to achieve extra-ordinary growth rates of which a significant part can be attributed to the demographic dividend, as we will show in this thesis.

Figure 1.1 : Demographic transition and economic growth



1.1 Research questions and analytical framework

The main research question of this thesis is: *What are the mechanisms behind the relationship between demographic transition and economic growth?* To answer this question, this thesis focuses on the distribution of the population across different age groups and its implication for economic growth and productivity. There are various channels through which demographic transition can affect these key economic targets, of which an increase in labor supply, labor productivity, investment in human and physical capital, and saving are the most important.

Figure 1 provides a graphical description of the mechanisms behind the relationship between demographic transition and economic growth that will be investigated in this thesis. Mason (2005) divides demographic dividend as a result of demographic transition into two parts: one that occurs as a result of a changing age structure and one that occurs due to a higher saving rate and more investment in human capital as a result of lower mortality and longer life spans. This thesis focuses primarily on the impact of a changing age structure, although we will not ignore the investment component of the growth story.[1] Figure 1.1 shows that the age structure effect consists of two elements. First, a higher concentration of population in productive ages may lead to an increase in labor supply, provided that labor market can absorb the large number of workers in a productive way. Second, due to a decline in family size and saving of childcare time, relatively more women are likely to enter the labor market, both in terms of higher participation and in a larger number of working hours. Consequently, our four sub-questions are:

(i) What is the impact of demographic transition, i.e., a change of the distribution of the population across different age groups, on economic growth? (chapter 2)

(ii) How does female labor force participation behavior change with fertility decline and economic development? (chapter 3)

(iii) What is the impact of an increase in labor force participation of different age groups and by gender on labor productivity growth? (chapter 4)

(iv) How does the effect of different determinants of labor productivity vary at different levels of age dependency? (chapter 5)

By answering these questions we should be better able to find out whether the expected demographic changes can accelerate economic growth, or pose a threat that can hinder economic growth.

[1] The impact of a changing age structure on savings and investment is beyond the scope of the current thesis but will be the topic of future research in the near future (Choudhry, 2010).

1.2 Thesis outline and value addition

The thesis consists of five chapters addressing the impact of demographic transition on economic growth through labor market dynamics in developing and emerging economies.

Chapter 2 determines the contribution of demographic variables to economic growth. For this purpose, we use an augmented Solow-Swan neoclassical growth model extended to include demographic variables. The demographic variables that will be included are the growth differential between the working-age population and the total population, child dependency and old-age dependency ratios. These variables are motivated by a transition of the augmented Solow-Swan neoclassical growth model formulated in output per worker growth into a comparable model formulated in output per capita growth. To estimate this model we use data for seventy countries over the period 1961-2003. Modern panel data techniques are employed in the empirical estimation. A comparison with the traditional cross-section approach shows that the panel data approach performs better due to the dynamic nature of the population age distribution.

The added value of the second chapter is twofold. First, we extend the theoretical framework for economic growth by incorporating the demographic variables in the model. Our results show that change in age composition of population and age dependency matters for economic growth. Second, we calculate the role of demographic variables in explaining the economic growth in China, India and Pakistan. Although the main objective of this chapter is to analyze the overall effect of demographic transition on economic growth, we focus on the impact of demographic variables on economic growth in China, India and Pakistan over the last four decades. In addition, we forecast their role in coming decades and provide policy suggestions to properly utilize their potential. From a policy viewpoint, our results underline the strong need to better understand the pace and timing of the demographic transition process and the transformation process of “demographic dividend” into economic growth. Most of the developing and emerging market economies are passing through or are about to enter a stage where they can actually get the benefits from the demographic transition. But there is no guarantee that the true quantum of these benefits will be realized. Reasons are unpreparedness and lack of an adequate policy framework to utilize the demographic dividend.

Chapter 3 focuses on the change in female labor force participation as a result of fertility decline and economic development. This chapter determines the impact of demographic transition on female labor supply behavior for different age groups and investigates the relationship between women's labor force participation and per capita income levels. Several behavioral changes may occur along the demographic transition process. Long life expectancy can lead to changes in investment in human capital, saving behavior, the retirement decision and the attitude towards women in society. If the fertility rate declines and child care responsibilities diminish, women also have more time to participate in the labor market (Bruno and Rodrigo, 2007). Goldin (1995) and Mammen and Paxson (2000) show that the relationship between female labor force participation rates and per capita income around the world is U-shaped. To analyze the role of demographic dynamics on women's labor force participation and to investigate the existence of a U-shaped female labor supply behavior, we use a panel of 40 countries over the period 1960-2005. As the fertility rate may not be exogenous, since several studies found that those who participate in the labor force tend to have fewer children (Lesthaeghe, 1995; Sundström, 2000), we overcome the problem of reverse causation by treating the fertility rate as an endogenous variable and use an instrumental variable approach to estimate the parameters of our model.

The added value of the analysis in chapter 3 is threefold. First, it evaluates the impact of fertility decline on female labor supply behavior of ten different age groups over the period 1960-2000. It is found that fertility decline has a positive effect on female labor force participation but that the impact varies across different age groups. As was to be expected, we find that the positive effect of fertility decline is higher in the child-bearing age group of women aged 15-44. Nevertheless, the impact on other age groups also appears to be significant, which implies that studies that restrict the analysis to certain (prime) age groups will underestimate the overall impact of fertility decline on female labor supply. Second, the impact of fertility decline depends on the level of economic development of a particular country. In low income countries the impact of fertility decline is different than in high-income countries. A model with interaction effects is used to capture the impact of various determinants of female participation at different levels of the capital stock per worker (as a proxy for economic development). Previous studies of Pampel and Tanaka (1986), Tansel (2002) and Fatima and Sultana (2009) already considered the square of the level of income per worker. In these three studies the coefficient of the level of income per worker is found to be negative and significant and that of its square to be positive and significant. However, since we find that the coefficients of other interaction effects are significant too, we conclude that only one interaction effect is not sufficient to uncover the supposed U-shaped relationship. Third, this chapter not only finds that the impact of fertility transition differs between age groups, but it also calculates the turning points of the explanatory variables for different age groups, the income level at which the impact of the explanatory variables changes sign.

The theory of demographic transition predicts that as a result of fertility decline there will be a change in the age composition of the population. The increase of the relative size of the working-age population may lead to more labor supply. Chapter 4 focuses on the impact of increasing labor force participation rates on labor productivity. One would assume that one of the factors affecting labor productivity is the availability of productive and decent employment. However, in developing countries, where there is already a substantial level of unemployment and underemployment, a rise in labor supply often results in further underemployment and unemployment, since these economies do not have the capacity to produce employment opportunities for the new entrants on the labor market. To evaluate the impact of increased labor supply, the relationship between labor force participation and productivity growth needs to be investigated (McGuckin and van Ark, 2005; Broersma, 2008). This chapter contains an empirical analysis of this relationship for 45 countries in different regions of the world over the period 1980-2005, with a particular focus on transition and developing economies.

The added value of the fourth chapter is threefold. First, our results show that there exists a tradeoff between productivity and labor force participation in the short term. Second, this tradeoff tends to fade away after several years, revealing that the increase in labor force participation has a positive effect on economic growth in the medium to long term. However, due to this short-term tradeoff effect, largely related to the pro-cyclicality of productivity, previous findings that an increase in working-age population share opens a window of opportunity should be taken with care (Bloom *et al.*, 2002; Kelley and Schmidt, 2005; Mason, 2005). Third, although a number of studies already identified a tradeoff between productivity and labor force participation (Beaudry and Collard 2002; McGuckin and van Ark, 2005; Becker and Gordon, 2008; Broersma, 2008), most of these studies are restricted to high income countries. This chapter investigates the nature of this relationship for developing and emerging economies and finds that the intensity of this tradeoff varies across countries and is related to the income level. The tradeoff is weakest in developed high income economies, where it fades away in less than five years. By contrast, in developing and transition countries the tradeoff is stronger and weakens more slowly after multiple years.

Chapter 5 provides further insights on the divergence of labor productivity across different regions and income groups around the world. The purpose of this chapter is to test whether the age composition of population affects the impact of different determinants on labor productivity across countries. The empirical analysis is based on a panel of up to 110 countries over the period 1980-2005. Using a model with interaction effects, among which the age dependency ratio and social, economic and infrastructural determinants of labor productivity, we find that at higher levels of age dependency, the impact of certain productivity determinants becomes insignificant.

The added value of this final chapter is twofold. First, we find that the main determinants of labor productivity not only have a direct impact on labor productivity but that their impact is also conditional on the age composition of total population. Previous studies have investigated the effect of various determinants on labor productivity, among which gross capital formation, ICT investment, inflation and financial development (Islam, 2008; Belorgey *et al.*, 2006), as well as the effect of labor force participation rates (Feyrer, 2007; Choudhry and Van Ark, Chapter 4 of this thesis). However, to the best of our knowledge, no study before has considered interaction effects. Second, in this chapter, we investigate the effect of different determinants of productivity in OECD and non-OECD countries separately[2]. Our results indicate that higher age dependency has a negative effect on labor productivity, not only directly but also via other social, economic and infrastructural determinants of labor productivity. This finding implies that if the working-age population grows larger during the process of demographic transition, productivity growth will boost, not only because of the direct effect of age dependency but also because of its interaction effects on other socio-economic determinants of labor productivity. Up to now, these interactive impacts have not been taken into account in the literature. Moreover, our findings also help to explain labor productivity differentials across high-income OECD countries, which are affected by an aging population, and low-income non-OECD countries.

1.3 Main findings of the thesis

This thesis finds strong empirical evidence in favor of the hypothesis that changes in the distribution of the population across different age groups affects economic growth along the process of demographic transition. However, it is also clear that an increase of the relative size of the working-age population does not necessarily transform itself into a demographic dividend unless an adequate policy framework is adopted to realize this potential opportunity.

In relation to the research questions formulated in section 1.2, we draw five main conclusions from this thesis: (i) The distribution of the population across different age groups may boost economic growth temporarily (when working age population share dominates in total population share), (ii) Fertility decline has a positive effect on female labor force supply behavior, (iii) The relationship between women's labor force participation and per capita income around the world is U-shaped because women's labor force participation rates first fall during the process of economic development and then start to increase again, (iv) There exists a tradeoff between productivity and labor force participation in the short term, which fades away in the medium term providing opportunities for catch-up growth for emerging and developing economies , and (v) Age dependency has a negative effect on labor

[2] In contrast to all those studies explaining GDP per capita, most studies analyzing productivity determinants focused on OECD countries only. One exception is Islam (2008).

productivity growth, as well as a negative effect on the impact of other social and economic variables on labor productivity growth.

Age structure and economic growth

The impact of the distribution of the population across different age groups on economic growth is discussed in chapters 2 and 5 of this study. In chapter 2, we find that GDP per capita growth is positively related to the growth differential between the working-age population and the total population, and negatively related to child and old-age dependency ratios. Based on this model, we find that together these effects explain 46 per cent of growth in per capita GDP in China over the period 1961-2003, 39 per cent in India, and 25 per cent in Pakistan. All three economies show up a positive demographic dividend effect and they will continue to do so in the next decade.

In chapter 5, we also investigate the impact of age dependency on labor productivity. To better understand growth differentials across countries, more and more studies focus on productivity rather than just aggregate GDP effects (Hall and Jones, 1999; Kogel, 2005; Islam, 2008). We find that age dependency has a direct negative effect on labor productivity growth, as well as an indirect negative effect via other determinants of labor productivity. In addition, we find that child dependency is more harmful for economic and labor productivity growth in developing and emerging economies than old age dependency. It implies that declining child dependency in developing and emerging economies will boost labor productivity growth in these economies.

Fertility decline and female labor supply behavior

In chapter 3, we investigate the relationship between fertility and female labor force participation. Fertility appears to have a large negative and significant effect on the participation rate of females in different age groups (15-19, 20-24, …, 60-64), whereas the interaction effect between fertility and the capital-labor ratio (a proxy for economic development) appears to have a positive effect. This positive effect, however, is only significant for females aged between 15-19 and 20-24. The fact that the coefficient of the fertility variable is negative and that of the product term with the capital-labor ratio is positive indicates that fertility has a negative effect on the female labor force participation rate in lower income economies and a positive effect in higher income economies. The turning point for the total female working-age population amounts to US $69,410 available capital stock per worker. In other words, in countries located in Africa, South Asia, the Middle East, North Africa and South America, fertility affects participation negatively, while in countries located in Europe, North America and Oceania, fertility affects participation positively. The explanation is that the latter countries not only provide more child care facilities but also provide more financial support to families with young children, among which paid parental leave and childcare subsidies (Jaumotte, 2003). First, paid parental leaves help mothers of young children reconcile work and family life, and may strengthen labor market attainment through a job guarantee. Second, childcare subsidies reduce the relative price of childcare, thereby increasing the return of market work relative to home production (in addition to increasing effective income). The turning points in terms of capital stock per worker for females in the prime-age groups are higher than those for the younger and older age groups. It implies that teenagers and elderly women are the first who will enter the labor market as a result of fertility decline when income levels rise, then women in the younger age groups 20-24 and 25-29 and, finally, women in the age groups 30-34, 35-39 and 40-44.

Our results also point out that when fertility declines by four births per woman, which represents the difference between fertility rates in low-income and high-income economies, the total female labor force participation rate will rise by about 19 percentage points.

Economic development and female economic participation

Chapter 3 of this thesis finds strong empirical evidence in favor of the hypothesis that the relationship between women's labor force participation and per capita income around the world is U-shaped. A microeconomic framework of the labor force participation decision is aggregated across individuals to show that fertility, the share of employment in agriculture, education and the income level (measured by the capital-labor ratio) are the key variables explaining the female labor force participation rate in countries at different levels of economic development. A quadratic functional form in the capital-labor ratio is estimated for females in ten different age groups using data for 40 countries in different income classes over the period 1960-2000. For every age group and for every explanatory variable in the model we find a particular point where the regime of falling participation rates change into a regime of rising participation rates. The policy implication is that every country can eventually narrow the gap in labor force participation rate between men and women.

Tradeoff between participation and labor productivity

In chapter 4, we study the relationship between productivity and participation in different regions of the world for the period 1980-2005. There generally is a strong tradeoff between productivity growth and participation, as the former tends to save jobs. However, the causes of this tradeoff as well as their intensity may differ between countries. By analyzing patterns of the participation-productivity tradeoff across regions and different income groups, we find that the intensity of the tradeoff varies across countries and is related to the income level of the country. The tradeoff is weakest in developed high income economies, where it fades away in less than five years. However, the tradeoff is stronger in developing and transition countries and weakens more slowly after multiple years. We also find that the tradeoff has become weaker after 1995 for all regions and income groups except for transition economies. The results show that Africa is a victim of low productivity trap because of unproductive employment growth, whereas the Southeast Asian region shows positive growth both in employment and productivity. Along with pro-cyclical nature of labor productivity, this diversity in the pattern of tradeoffs may be explained by differences in structural transformation phases and dissimilar labor market institutions between transition and developed countries. For example, developing and low income economies still mainly depend on agriculture for employment generation and this sector is less productive compared to other sectors because of high underemployment. The productivity-participation tradeoff is therefore the worst for most of the African and South Asian countries where the agricultural sector in many cases still accounts for half to more than two thirds of total employment.

In chapter 4 we also investigate the extent of this tradeoff for female workers and young and aged workers, and find that the impact of female and young workers (15-24 years) participation on labor productivity growth is negative and significant.

Age dependency and labor productivity

In chapter 5, we find that higher age dependency impacts labor productivity negatively not only directly but also modifies the effect of other social, economic and institutional determinants of labor productivity. These findings imply that the performance of these determinants is conditional on different levels of age dependency. At higher levels of age dependency, the impact of certain productivity determinants becomes insignificant. Separate analyses for 27 high income OECD countries and 83 other countries provide very similar kind of marginal impacts of gross capital formation (GCF), information and communication technology (ICT) and labor market reforms (LMR). However, the marginal impact of financial development slightly differs among OECD and other countries, We find that in high income OECD countries, financial development marginal effect on labor productivity curve is more steeper as compared to developing economies which implies that financial development will promote labor productivity at high level of age dependency This may be due to the different nature of age dependency in high income developed and developing economies.

Chapter 2

Demographic Transition and Economic Growth in China, India and Pakistan[1]

2.1 Introduction

The world population tripled over the past half-century and much of this increase was accounted for by developing and emerging economies. One question that has attracted a lot of attention in the literature concerns the economic consequences of rapid population growth. In most neoclassical modeling it is assumed that the labor force growth rate is equal to the population growth rate (Kelley and Schmidt, 2005). This assumption is relevant in the longer run when both population size and the distribution of the population across different age groups stabilize, but it is less relevant in periods of demographic transition when mortality and fertility rates change from high to low levels. Economic growth may boost temporarily when during the process of demographic transition the number of working-age adults grows large relative to the dependent population, and slow down when a population ages rapidly (Bloom and Williamson, 1998; Kelley and Schmidt, 2005).

The objective of this chapter is to determine the effect of demographic transition on economic growth in China, India and Pakistan, not only in the past but also in the future. Although demographic transition will only boost economic growth

[1] This Chapter is based on the paper "Demographic transition and economic growth in China, India and Pakistan" written with Paul Elhorst. The paper is accepted for publication in Economic Systems.
We are grateful to Bart van Ark for constructive comments on previous versions of this chapter. We also thank participants of the conferences of the European Society of Population Economics in 2008 and of the European Association for Comparative Economic Studies in 2009 for useful comments and critical remarks.

in countries that are passing through the middle phase of the demographic transition process, developed countries that have reached the last phase of the demographic transition process in which the population ages will be included too. This is because sufficient variation in the data is a prerequisite for obtaining significant effects and these countries offer additional information about the types of effects that occur not only if the number of working-age adults grows large, but also if the number of working-age adults starts decreasing again. In total, we use data from seventy countries located in different regions of the world and being in different phases of the demographic transition process. The data set covers the period 1961-2003. Only when computing the contribution of demographic changes to economic growth and when forecasting the growth potential of demographic changes, we will restrict the data set to China, India and Pakistan.

To evaluate the impact of demographic transition on economic growth, we use an augmented Solow-Swan neoclassical growth model extended to include demographic variables (Mankiw *et al.*, 1992; Barro and Sala-i-Martin, 1995; Asian Development Bank, 1997; Bloom and Williamson, 1998; Kelley and Schmidt, 2005). The type of demographic variables that will be included is motivated by a transition of this model formulated in output per worker growth into a comparable model formulated in output per capita growth. This transition extends the framework proposed by Bloom and Williamson (1998).

One relevant question asks to what extent differences found in the contribution of demographic variables are attributable to the way in which applied econometricians analyze a given body of data. One part of the literature uses data in a cross-section, while another part combines time-series and cross-sectional data. Mankiw *et al.* (1992) and Barro and Sala-i-Martin (1995) are classic references of the first approach, while Islam (1995) is the most prominent example of the second. Within the literature that combines time-series and cross-sectional data, considerable discussion also arises about two concerns: the appropriate time length to use when a total sample period is divided into several shorter periods, and the inclusion of fixed effects. For example, whereas Bloom and Williamson (1998) adopt a cross-section model, Kelley and Schmidt (2005) adopt a panel data model including country and time-period fixed effects. In this chapter we apply the cross-section as well as the panel data approach and test for endogeneity for some of the explanatory variables to find out which econometric model best describes the data.

Our particular interest in Pakistan, India and China is mainly due to three reasons. First, all three countries are emerging economies with impressive economic growth rates in the recent past. Second, they are in the top ten worlds ranking of countries based on population size. In this respect, it should be noted that these three economies account for nearly forty percent of world population. Third, all three countries are passing through the process of demographic transition but at a different pace and over a different time period. Therefore, it is pertinent to explore the impact of demographic transition on their economic performance both in the past and in the future.

This chapter is structured as follows. In section 2.2, we present a detailed comparative analysis of the process of demographic transition in China, India and Pakistan. In section 2.3, we describe the augmented Solow-Swan model extended to include demographic variables that is used for testing the empirical relationship between the demographic transition process and economic growth and, in section 2.4, we present and discuss the empirical findings. Based on this model, we calculate the relative contribution of demographic variables to economic growth in China, India and Pakistan over the period 1961-2003 in section 2.5. In section 2.6, we map the future prospects of the demographic transition process on economic growth in China, India and Pakistan over the period 2005-2050. In the concluding section we summarize our main findings.

2.2 Demographic transition and demographic dividend in Pakistan, India and China

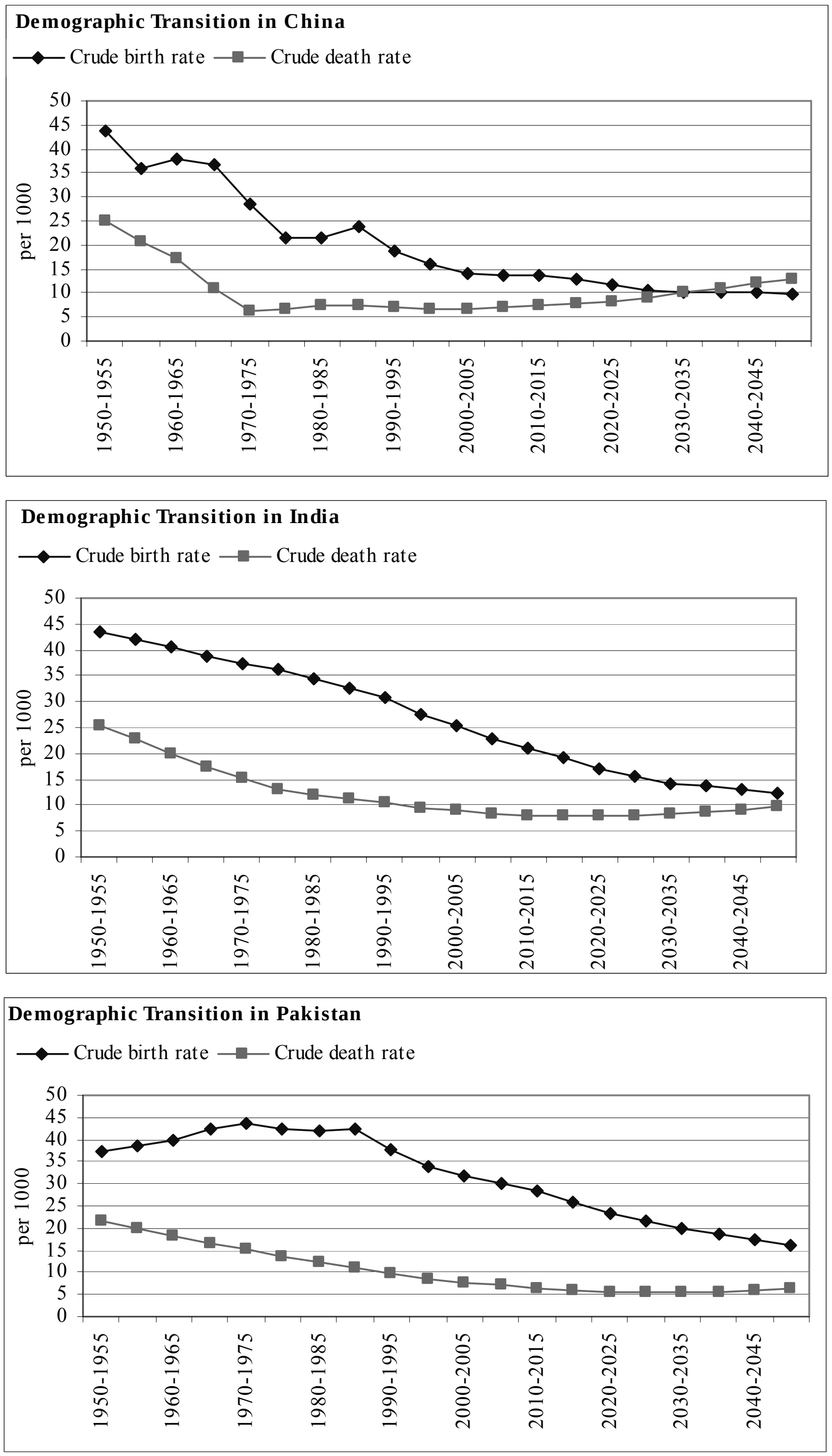
Since we are particularly interested in the effect of demographic transition on the economies of Pakistan, India and China, we briefly describe the process of demographic transition and the main factors behind this process in these three countries.

Figure 2.1 shows that the demographic transition process started with a decline of the Crude Death Rate (CDR) in the early 1950s. This decline proceeded most rapidly in China, followed by India and Pakistan. Over the period 1950-2000, the decline of the CDR was the lowest for Pakistan. The decline in mortality was accompanied by an increase in life expectancy. Over the period 1950-2000, life expectancy at birth rose by 28.9 years for China, 26.2 years for India, and 19.5 years for Pakistan. Although not shown, the Infant Mortality Rate (IMR) also declined. This decline ran analogously to the decline of the crude death rate and the increase in life expectancy.

The fall in infant mortality induced parents to reduce fertility, the second phase of the demographic transition process, although they did not adjust immediately. Except for Pakistan, the Total Fertility Rate (TFR) started to decline in the late 1960s (Figure 2.2). One explanation for the sharp decline in China after 1970 is the introduction of the so-called *wan xi shao* birth control campaign (later marriages, longer interval between births, and fewer children). This policy was followed by the family planning program of "one child policy" in 1979. One of the effects was that the Contraceptive Prevalence Rate (CPR) — the percentage of women between 15-49 years who are practicing, or whose sexual partners are practicing, any form of contraception — increased. For example, it rose from 64.4 percent in 1981 to 77.3 percent in 1987. It should be stressed that India was actually the first country to adopt a family planning program (1951) with full government support. Initially, it was a clinic-based program but in the 1960s this program was extended to include efforts by media and health workers to motivate couples to accept contraception.

The CPR, however, was and still is lower than that in China. It rose from 4.4 percent in 1967 to only 52 percent in 2004. A similar pattern occurred in Pakistan. In 1952, the Family Planning Association of Pakistan initiated efforts to control rapid population growth. Three years later the government began to fund the association and emphasized the need to reduce population growth in its First Five-Year Plan (1955-60). However, population policy was suspended during the 1960s for political and religious reasons. In 1980 the Population Division was renamed the Population Welfare Division and transferred to the Ministry of Planning and Economic Development. This agency was charged with the delivery of both family planning services and maternal and child health care. Pakistan's CPR rose from 3.3 percent in 1979 to 27.6 percent in 2000.

Figure 2.1: Demographic transition in China, India and Pakistan



Source: United Nation Population Division

Due to the sharp decline in fertility, China was and still is the first of these three countries that saw its fertility rate fall below replacement level, namely in 1995. According to projections of the United Nations (2008), India will not be able to achieve this level before 2025 and Pakistan not before 2050.

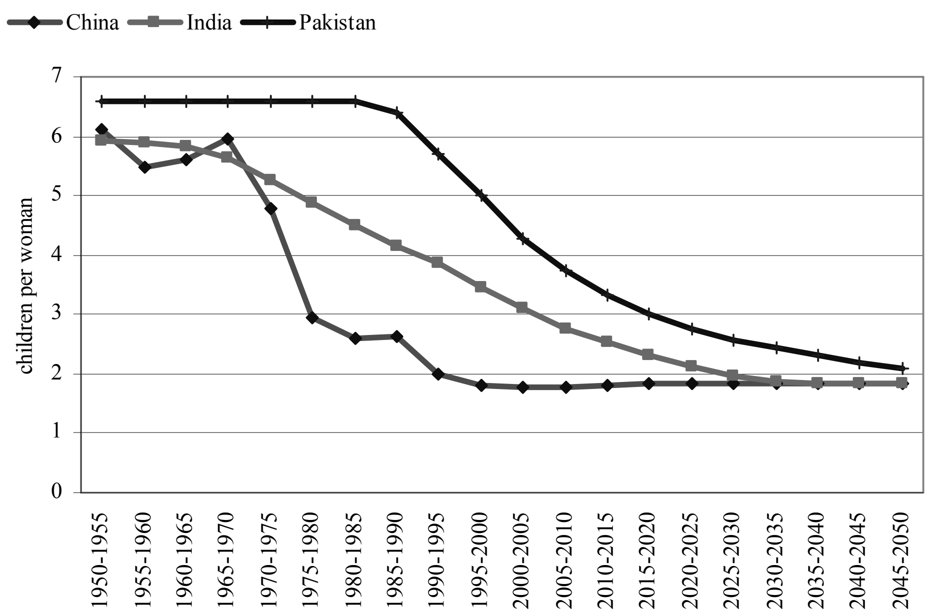
The pace and timing of the demographic transition process in these three countries cause(d) divergent trends in population growth and the distribution of the population across different age groups. Figure 2.3 graphs the share of the working-age population (15-64), of children (0-14), and of people aged 65 and over (65+) to the total population. Since 1975 the share of the working-age population increased for all three economies, while the share of children decreased. Up until now, the share of elderly people is below or around 10 percent and therefore not a serious problem for these countries.

Due to concentration of population in productive ages, opportunities for economic growth tend to rise. First, a higher concentration of population in productive ages may lead to an increase in labor supply, provided that labor market can absorb the large number of workers in a productive way. Second, since fertility decline can free up time from child care, relatively more women are likely to enter the labor market, both in terms of participation and in number of hours (Bloom et al., 2009; Choudhry and Elhorst, 2010). Third, because of lower mortality and longer life spans, the willingness to invest in human capital and to save increases, as a result of which the labor force becomes more productive (Cervellati and Sunde, 2009) and prospects for investment improve (Mason, 2001; Schultz, 2004; Fang and Wang, 2005). Taken together, these effects are known as the Demographic Dividend effect (Bloom et al., 2002). The period in which these positive effects are expected to occur is called the potential window of opportunity (WOP). The WOP for China, India and Pakistan is presented in Figure 2.3 and depends on the (expected) distribution of population across different age groups over the period of 1950-2050.[2] This figure shows that the share of the working-age population in China will reach its peak in 2010 (72%). Although the share of children will still be declining, the share of older people will already increase at that time. The WOP will remain open till 2020. In India and Pakistan, the share of the working-age population will reach its peak in 2040 (69%)

[2] Expected values are based on United Nations (2008).

and 2045 (67%), respectively. The WOP, which opened in the 1990s in these two countries, is expected to remain open until the middle of this century.

Figure 2.2: Comparative analysis of total fertility rate



Source: United Nation Population Division

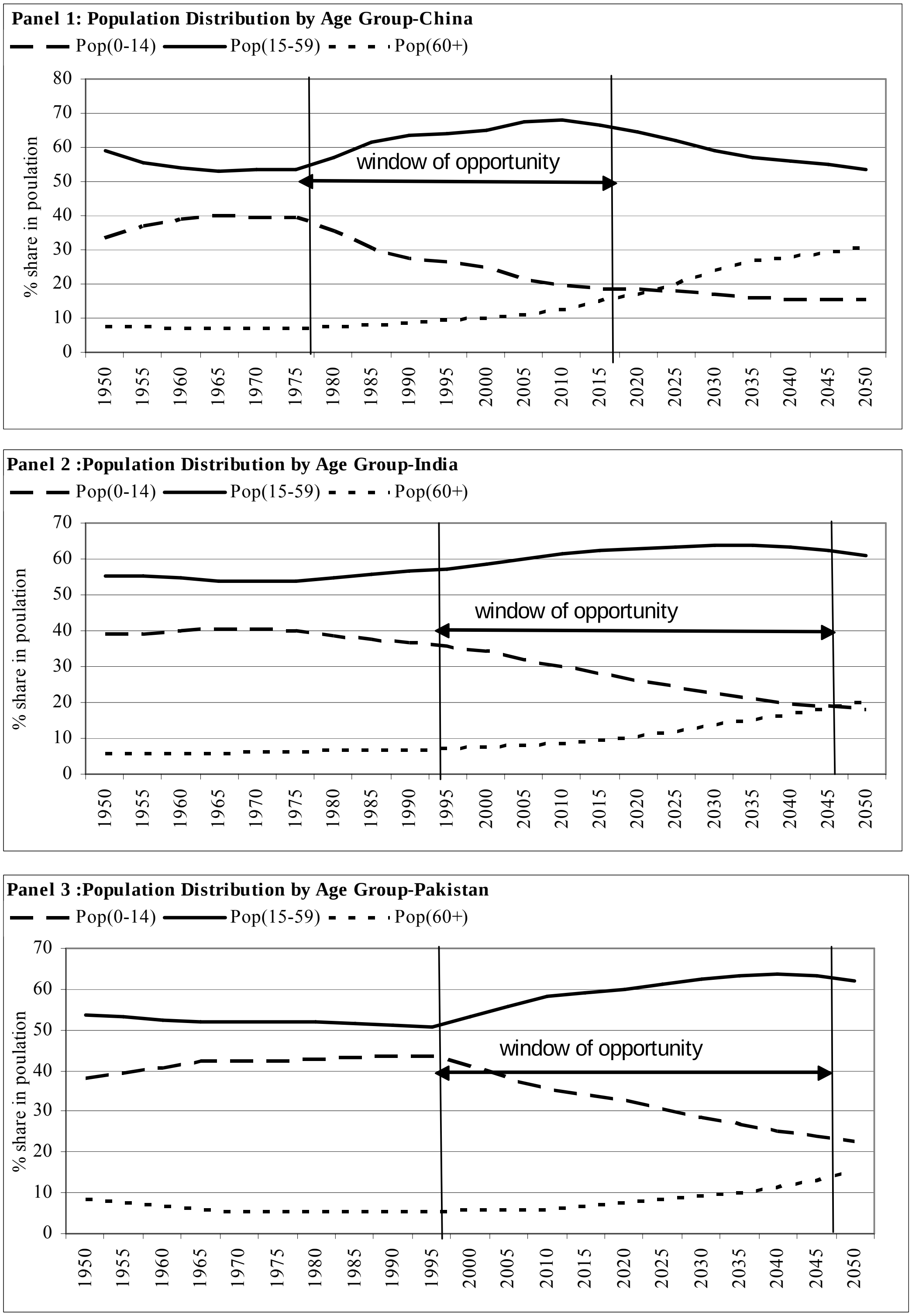
2.3 Demographic transition and economic growth: Theory

To explain economic growth we adopt the augmented Solow-Swan model (Mankiw et al., 1992), which is characterized by the following expression for the steady-state output per worker y_t at time t

$$\ln(y_t) = \ln(A_{t-T}) + gT + \frac{\alpha}{1-\alpha-\beta}\ln(s_t) + \frac{\beta}{1-\alpha-\beta}\ln(h_{t-T}) - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(\tau_t + g + \delta) \quad (2.1)$$

where T denotes the time span of the growth period considered, A_{t-T} is the state of technology at the beginning of the observation period, α is the cost share of physical capital and β of human capital in production under a Cobb-Douglas technology, s is the fraction of income invested in physical capital (the saving rate) and h invested in human capital, τ is the labor force growth rate, g is the rate of technological progress, and δ is the depreciation rate.

Figure 2.3: Population dynamics by age groups



Source: World Population Prospects: The 2007 Revision Population Database

The convenient growth-initial income-level regression equation is a linear approximation to the growth rate of output per worker, which is derived from a linear approximation to the dynamics around the steady state in (2.1) using a Taylor expansion (see Mankiw *et al.*, 1992, pp. 422-423). This yield

$$\frac{\ln(y_t/y_{t-T})}{T} = \gamma_0 + \gamma_1 \ln(y_{t-T}) + \gamma_2 \ln(s_t) + \gamma_3 \ln(h_{t-T}) + \gamma_4 \ln(\tau_t + g + \delta) + \varepsilon_t, \qquad (2.2)$$

where $\gamma_0 = (1-e^{-\lambda T})[\ln(A_{t-T}) + gT]/T$, $\gamma_1 = -(1-e^{-\lambda T})/T$, $\gamma_2 = \frac{\alpha}{1-\alpha-\beta}(1-e^{-\lambda T})/T$, $\gamma_3 = \frac{\beta}{1-\alpha-\beta}(1-e^{-\lambda T})/T$, and $\gamma_4 = -\frac{\alpha+\beta}{1-\alpha-\beta}(1-e^{-\lambda T})/T$ (see Barro and Sala-i-Martin, 1995; Islam, 1995). In its simplest version, ε represents a normally distributed and independent error term, as a result of which (2.2) can be estimated by Ordinary Least Squares (OLS). This model implies that economies tend toward the same equilibrium growth path for capital, and hence output per worker, except for differences in s, h, τ, g and δ. The annual speed of convergence implied by the parameter estimate of γ_1 is $\lambda = -\ln(1+\gamma_1 T)/T$, although it is important to note here that absolute (or unconditional) convergence, i.e. the idea that a country grows faster the further it is from its own steady state, may change if we allow for explanatory variables that have different values across countries. This is because differences among the explanatory variables of economic growth correspond to different steady-state positions. A poor country may still grow faster than a rich country, but only conditional upon the variables determining its steady-state position. This is true for all explanatory variables that are considered in addition to the initial income level.

According to Bloom *et al.* (2001), the neoclassical Solow-Swan model ignores a critical dimension of population dynamics: populations' evolving age structure. Since each age group in a population behaves differently, and the distribution across age groups changes, economic growth may be boosted or slow down temporarily. Whereas prime-age adults supply labor and savings, the young require education and the aged health care and retirement income. Consequently, economic growth may boost when the number of working-age adults grows large relative to the dependent population, and slow down when a population rapidly ages. Estimates by Bloom and Williamson (1998) and Kelley and Schmidt (2005) indicate that successively one-third of East Asia's economic growth over the period 1965-1990 and 44 percent of Asia's economic growth over the period 1960-1995 can be attributed to population dynamics. At the same time, Bloom and Williamson (1998) warn that the demographic gift when the number of working-age adults grows large merely represents a growth potential. Whether this potential is used properly or not depends upon the policy environment as reflected by quality of institutions, labor policies, openness to trade, macroeconomic management, and education policies.

In many studies on economic growth, output per capita rather than output per worker is the main focus of analysis (Barro and Sala-i-Martin, 1995). Bloom and Williamson (1998) show that output per capita is identical to

$$y = \frac{Y}{N} \equiv \frac{Y}{L}\frac{L}{N}, \tag{2.3}$$

where N is the total population and L is the labor force. When taking natural logs and converting this expression to growth rates, one obtains

$$\ln\left(\frac{Y}{N}\right)_t - \ln\left(\frac{Y}{N}\right)_{t-T} = \ln\left(\frac{Y}{L}\right)_t - \ln\left(\frac{Y}{L}\right)_{t-T} + \ln\left(\frac{L}{N}\right)_t - \ln\left(\frac{L}{N}\right)_{t-T}. \tag{2.4}$$

This equation splits per capita output growth into two components: a component measuring productivity per worker and a component that transforms output growth per worker to output growth per capita. The first component is the dependent variable of the augmented Solow-Swan model when it is divided by the time span T (since $y_t = Y_t/L_t$), while the second component can be rewritten as

$$\ln\left(\frac{L}{N}\right)_t - \ln\left(\frac{L}{N}\right)_{t-T} = \ln\left(\frac{L_t}{L_{t-T}}\right) - \ln\left(\frac{N_t}{N_{t-T}}\right) \equiv \tau - n\ . \tag{2.5}$$

According to Kelley and Schmidt (2005), this component can take three different forms:

- The labor force growth rate is equal to the population growth rate, τ-n=0.
- τ-n $\approx$ wa–n, where the variable "wa" represents the growth rate of the working-age population, i.e., the population aged 15 to 64.
- τ-n = [τ-lf] + [lf-wa] + [wa-n]. This decomposition is different from (4) in that it assumes that L represents the number of labor hours and τ the growth rate in

the number of labor hours, and "lf" the labor force growth rate. This transformation takes full advantage of the components of labor change.

The first assumption is employed in most neoclassical theoretical modeling and most relevant in the longer run when both population size and the age distribution stabilize. It is less relevant when studying the impact of demographic transition, because this process marks a period within which the age distribution changes tremendously. Bloom and Williamson (1998) adopt the second transformation, because the growth rate of the working-age population is seen as a simple but useful proxy for the labor market effects that occur over the period of demographic transition, and because this proxy can be treated as an exogenous variable to the model. The third transformation also requires data on the number of labor hours and the labor force participation rate of the working-age population, which in addition may not be treated exogenous to the model.

Kelley and Schmidt (2005) argue that the modeling framework proposed by Bloom and Williamson (1998) to address imbalanced age-structure changes over the demographic transition process is not sufficient to capture the multi-faceted role of demography in economic growth. In addition to the population growth and the working-age population growth variables, they also propose demographic variables such as the population shares of younger and of older people, as well as population size and density. However, a theoretical framework to justify these variables is lacking.

Some studies have debating the question whether more factors should be included to explain economic growth. Sala-i-Martin et al. (2004), Cuaresma and Doppelhofer (2006), and Islam (2008) argue that mono-causal theories of economic performance (productivity measured as economic growth per worker), although valid, are less useful as it appears, because they find, using advanced econometric techniques, that a good number of variables have robust partial correlation with economic growth. In an overview paper, Durlauf and Quah (1999, p. 276) count 36 different categories and 87 specific examples of variables that have been included in previous studies. At the same time, Durlauf and Quah argue that the lessons that can be drawn from these models are unpersuasive. First, many studies fail to clarify whether the additional variables they consider can be interpreted in the light of some economic theory. Second, even if they can and appear to be statistically significant, it is not always clear what exercise a researcher conducts by adding particular control variables. Since growth explanations are so broad, it is often difficult to identify a particular economic theory. Brock and Durlauff (2001) refer to this problem as the "open-endedness" of theories of economic growth. To justify additional variables, such as the demographic variables in Kelley and Schmidt (2005), we therefore extend the transition model of Bloom and Williamson (1998), while control variables that cannot be justified theoretically will be left aside in this study.

The population growth rate, n, can be rewritten as a weighted average of the population growth rates of different age groups

$$n = s_{0-14}n_{0-14} + s_{15-64}n_{15-64} + s_{65+}n_{65+}, \tag{2.6}$$

where s denotes the population share of a particular age group and n the growth rate of that age group. Note that the three age groups, 0-14, 15-64 and 65+, may be considered as the main age groups representing the demographic transition process and that n_{15-64} represents the population of working-age.

Collecting terms from (2.2), (2.5) and (2.6), the annual GDP per capita growth rate can be written as a function f of the following demographic variables

$$\frac{1}{T}[\ln\left(\frac{Y}{N}\right)_t - \ln\left(\frac{Y}{N}\right)_{t-T}] = f[\ln(\tau_t + g + \delta), \tau - (s_{0-14}n_{0-14} + s_{15-64}n_{15-64} + s_{65+}n_{65+})]. \tag{2.7}$$

Table 2.1 gives an overview of demographic variables used in a selection of previous studies, which are representative for the kind of variables that have been considered over the last fifteen years.[3] Brander and Dowrick (1994) consider the birth rate and the population growth rate. They find that high birth rates reduce economic growth because both investment and labor supply will fall. Since the birth rate and the population share of people aged 0-14 are closely related to each other, this variable fits within (2.7). Barro (1996, 2008) and De Gregorio and Lee (2003) use the total fertility rate to capture the impact of population change on economic growth. On the short-term, a higher fertility rate means that increased resources must be devoted to childrearing, rather than production of goods. Just as the birth rate, this variable fits within (2.7). On the long-term, a portion of the economy's investment must be used to provide capital for new workers (after children have grown up), rather than to raise

[3] Dependent on the key words and the software being used, up to 300 journal articles could be found dealing with demographic transition and economic growth.

capital per worker. This effect is reflected by the variable $\ln(\tau+g+\delta)$ since its coefficient γ_4 is expected to be negative.

Table 2.1: Demographic variables included in previous studies

Study	Demographic Variables
Brander and Dowrick (1994)	Birth rate and population growth rate
Barro (1996, 2008)	Total fertility rate
Kelley and Schmidt (1995)	Population growth rate, population density, crude birth rate, lagged crude birth rate and crude death rate
Bloom and Williamson (1998)	Population growth rate, working-age population growth rate
Kelley and Schmidt (2005)	Child dependency, old-age dependency, population density, population size
Crenshaw et al. (1997)	Population growth rate, population (15+), population (0-14)
De Gregorio and Lee (2003)	Total fertility rate
Fang and Wang (2005)	Total dependency ratio
Hongbin and Zhang (2007)	Birth rate, youth dependency ratio, growth of labor force share, migration rate
Azomahou and Mishra (2008)	Population growth rate, population (15-64), population (0-14), population (65+)
Bloom et al. (2008)	Youth-age and old-age population shares

Kelley and Schmidt (1995) augments the growth model with population growth, population density and components of population growth (crude death rate, crude birth rate and the crude birth rate lagged fifteen years in time). The inclusion of the current and the lagged birth rate is meant to distinguish between the supposed negative resource-using effects of births from the positive labor supply effects of past births. Population density is included to cover land stock per capita to signify positive inducements to technical change caused by pressure on resources created by population growth. The last variable, however, does not follow from (2.7).

Bloom and Williamson (1998) consider the growth rate of both the working-age population and the total population to translate a traditional neoclassical model formulated in output per worker growth into a comparable model formulated in output per capita growth. This means that they replace τ by $n_{15\text{-}64}$ and do not decompose n into different age group. In a follow-up study (Bloom et al., 2008), they also consider the youth-age and old-age population shares. Kelley and Schmidt (2005) consider the child and old-age dependency ratios. Since these variables are defined as $s_{0\text{-}14}$ and s_{65+} and as $s_{0\text{-}14}/s_{15\text{-}64}$ and $s_{65+}/s_{15\text{-}64}$, respectively, they perfectly fit within (2.7).

Other studies reported in Table 2.1 use variables describing the size of different age groups or dependency ratios and confirm the observation that the focus has been shifted from population growth rates towards its distribution across different age groups. The inclusion of these variables is often justified by the distinct economic behavior of different age groups.

Although the decision which variables to use is partly a matter of taste, statistical considerations may be important too. Following Bloom and Williamson (1998), we approach τ-n by wa–n=$n_{15\text{-}64}$-n, the growth differential between the working-age population and the total population. The advantage of $n_{15\text{-}64}$ over τ is that the first variable may be treated exogenous to the model. If τ were to be measured by either the number of labor hours or the number of people participating in the labor market, it will partly depend on the rate of economic growth, and thus be endogenous to the system. At the same time, it should be realized that τ will also depend on child dependency (or the birth/fertility rate) and old-age dependency. A reduction of child dependency can free up time from child care and can increase female labor supply, both in terms of participation and in number of hours (Choudhry and Elhorst, 2010). A reduction of old-age dependency may reduce tax and social security contributions paid by employed people needed to finance retirement income and health care of the elderly and therefore also increase labor supply (Elhorst and Zeilstra, 2007). For this reason, we follow Kelley and Schmidt (2005) and also consider child and old-age dependency ratios.[4] Except that they determine the population growth rate, as pointed out in (2.7), they also affect labor supply, which is important since the replacement of labor force growth rate τ by the working-age population growth rate $n_{15\text{-}65}$ has the side effect that τ is no longer part of the model. The variables $s_{0\text{-}14}/s_{15\text{-}64}$ and $s_{65+}/s_{15\text{-}64}$ not only compensate for this but also perfectly fit within (2.7). The coefficients of these two dependency ratios are expected to be negative.

Bloom and Williamson (1998), among others, split the variable τ-n into τ and n to test whether their coefficients are different. However, since the correlation coefficient between the growth rates of the working-age population and of the total population is rather high (in our sample 0.92), their evaluation might be undermined by multicollinearity issues. Including variables in a regression that are highly correlated may cause the coefficients to have the wrong sign or implausible magnitudes and to have high standard errors and low significance levels even if they are jointly significant and

[4] Kelley and Schmidt (2005) include the child and old-age dependency ratios because they might affect the saving rate, a variable they do not include. However, we believe that the impact of these dependency ratios on labor supply is more important, because changes in labor supply affect the transition of the Solow-Swan model formulated in output per worker growth into a comparable model formulated in output per capita growth. Moreover, we control for the saving rate.

the R^2 for the regression is high (Greene, 2008, p. 59). The coefficient of the variable τ-n is expected to be positive. If the growth rate of the working-age population exceeds the growth rate of the population, economic growth may be boosted temporarily, and vice versa. Most likely, its coefficient is also smaller than 1.[5]

2.4 Demographic transition and economic growth: Empirics

For our empirical analysis we use data from 70 countries over the period 1961-2003. The data set consists of developing as well as developed countries at different phases of the demographic transition process. Table 2.1A in the appendix gives an overview of the countries included arranged by continent.

Data on GDP per capita are taken from the Groningen Growth and Development Centre (http://www.ggdc.net) and expressed in constant price purchasing power parities (PPP). Demographic variables are taken from World Development Indicators (World Bank, 2007). The working-age population is defined as the population 15-64 years of age, while the child and old-age dependency ratios are obtained by dividing the population aged 0 to 14 and aged 65 and over by the working-age population, respectively. The saving rate is measured as gross domestic saving in percentage of GDP and taken from World Development Indicators (World Bank, 2007), while human capital is measured as the tertiary gross enrolment rate and taken from World Bank (2000).

The first column of Table 2.2 reports the estimation results when using the data in one single cross-section, i.e., if T=42 and the number of observations equals the number of countries in the sample (70). The average annual growth rate over the entire period 1961-2003 (multiplied by 100) is explained by both the initial level of per capita GDP and the tertiary gross enrolment rate in 1963 and the averages of the growth differential between the population of working-age and the total population, the child and old-age dependency ratios, and the saving rate for the period 1961-2003. Employing the single cross-section approach has three potential drawbacks. First, it only utilizes data at the beginning and the end of the sample period. Second, it erroneously assumes that variables like the growth differential between the population of working-age and the total population, and the child and old-age dependency ratios

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[5] Usually, $(g+\delta)$ is assumed to be the same for all economies and to be equal to 0.05 (Mankiw et al. 1992; Islam 1995). Replacing $\gamma_4\ln(\tau+0.05)+\tau$ by $\gamma^*\ln(\tau)$ will have the effect that $\gamma^*<1$ since $\gamma_4<0$, unless the approximation of τ by $n_{15\text{-}64}$ is not adequate and the restriction that the coefficients of τ and -n are the same does not hold.

are constant over the sample period. Third, it overlooks the possibility that different growth paths may lead to similar results in terms of convergence.

Table 2.2: Effect of demographic transition on economic growth

Dependent variable is growth rate of GDP per capita in constant PPP terms (1961-2003) multiplied by 100

	1	2	3	4
Independent Variables	**Cross Section**	**TSCS**	**Fixed Effects**	**Fixed Effects Instrumental Variable Approach**
Log initial GDP per capita	-0.83	-0.55	-1.69	-2.72
	(-4.32)	(-2.79)	(-3.91)	(4.60)
Growth differential between working-age	3.56	1.32	0.55	0.60
population and total population	(5.99)	(5.51)	(2.06)	(1.59)
Log of child dependency ratio	-2.71	-3.54	-1.76	-3.32
	(-3.46)	(6.15)	(1.98)	(-1.96)
Log of old-age dependency ratio	0.45	-0.77	-0.47	-3.68
	(0.80)	(1.74)	(-0.50)	(1.18)
Log of tertiary gross enrolment rate	-0.003	-0.013	-0.005	0.014
	(-0.15)	(-1.44)	(-0.40)	(0.82)
Log of saving rate	0.54	0.92	1.20	1.06
	(1.63)	(4.77)	(5.12)	(4.08)
Constant	5.51	1.39	10.87	10.77
	(2.38)	(2.07)	(2.68)	(1.14)
Number of cross sectional units	70	70	70	70
Observations(unbalanced panel)	-	540	540	463
$\mathbf{R^2}$	0.65	0.28	0.48	0.42
LR-test, significance country FE			232.70	
p-value (Chi-square statistic)			0.00	
Hausman test (FE vs. RE) Chi-square (14)			34.24	
p-value			0.00	
Significance of time FE F statistic/ chi-2 statistic in IV model		12.11	6.33	43.16
p-value		0.00	0.00	0.00
Sargan-Hansen test over identifying restrictions Chi-square (1)				1.24
p-value				0.31
Davidson-MacKinnon test of exogeneity F(2,378)				1.22
p-value				0.29

t values in parentheses.
The coefficient of tertiary gross enrolment rate is multiplied with 100 to make results presentable.
In column 4, the child and old-age dependency ratios are instrumented by lagged values of the population growth rate, the working-age population growth rate and life expectancy.

Results in the second column of Table 2.2 are obtained by moving to cross-sections for shorter periods. In such a pooled regression, the average annual growth rate over each period is explained by the initial level of per capita GDP and the tertiary gross enrolment rate for that particular period, as well as the averages of the growth differential between the population of working-age and the total population, the child and old-age dependency ratios, and the saving rate for that particular period. The question that arises what the appropriate length of such periods is. A time span of just one year is possible since the underlying data set provides annual information. However, often yearly time spans are said to be too short for studying growth convergence because short-term disturbances may loom large in such brief time spans (Islam, 1995). Therefore, we consider five-year time spans, T=5, just as in Islam (1995). Since our data set is not balanced, the number of observations in this regression is smaller than 630, namely 540 (growth periods considered are 1961-65, 1966-70, 1971-75, 1975-80, 1981-85, 1986-90, 1991-95, 1996-2000, 2001-2003).

A possible objection to pooling time-series cross-section data is that this approach does not control for fixed effects. Islam (1995) argues that fixed effects should be included, since the strategy of replacing the term $(1-e^{-\lambda T})[\ln(A_{t-T})+gT]$ in the growth-initial income-level regression with just a constant and a normally distributed error term, $\gamma_0 + \varepsilon$, is flawed. Since A_{t-T} not only reflects technology but also such factors as resource endowments, climate and institutions, A_{t-T} is anything but constant among different countries, and could probably be correlated with one or more of the explanatory variables in the regression model. Replacing this variable with a normally distributed error term and then estimating the model by OLS thus violates the condition that the explanatory variables are independent of the error term. A better solution is to replace A_{t-T} by a conventional error term as well as a dummy variable for each country in the sample, since the latter does not need to be uncorrelated with the other explanatory variables in the model. Since the rate of technological process, gT, may also change over time, this variable is replaced by time-period fixed effects. The results of this model are reported in the third column of Table 2.2. For reasons of space, the country and time-period fixed effects are not reported.

A necessary and sufficient condition for convergence is that the coefficient of the initial GDP per capita level is negative. For all regression results summarized in Table 2.2, this condition is satisfied. The coefficient of the variable measuring the growth differential between the working-age population and the total population is positive and significant for all of regressions whose results are reported in Table 2.2. The coefficient appears to be greater than one for the first two regression specifications (single cross-section model and TSCS model) and smaller than one for the third regression specification (fixed effects model). Overall, these results imply that the hypothesis that economic growth may be boosted temporarily in case the growth rate of the working-age population exceeds the growth rate of the population, and vice versa, is supported by the data.

As expected, the child dependency ratio has a negative and significant effect for all regression results summarized in Table 2.2. The coefficient of the old-age dependency ratio appears to be positive for the first regression specification (single cross-section model) and negative for the second and the third regression specifications (TSCS model and fixed effects model). However, in neither of these cases it is significant. Recently, Bloom et al. (2008) also found that the old-age population share does not have a significant effect on economic growth. One explanation is that we do not have countries in our sample that have completed the demographic transition process. Most developed countries just reached the last phase of this process, that is, the period in which the population ages, as a result of which negative effects, if present, have not yet been able to manifest themselves. Another explanation is that some studies have debated the proposition that population aging causes negative effects (Mason and Lee, 2004).

The saving rate has a positive effect for all regression results summarized in Table 2.2, although it is only significant in the TSCS model and the fixed effects model. The tertiary gross enrolment rate appears to be insignificant for all regression results summarized in Table 2.2.

The R^2 of the TSCS approach over a five-year time span amounts to 0.28, which is considerably less than the R^2 of the single cross-section approach of 0.65. The explanation is that the increase in the number of observations also amplifies the variation in the dependent variable. The R^2 of the fixed effects model increases to 0.48, which can be explained by its only focusing on the time-series variation between observations. To investigate the hypothesis that the country fixed effects are not jointly significant, we performed a Likelihood-Ratio (LR) test. The results indicate that we must reject this hypothesis. To test whether random effects can replace these fixed effects, we performed Hausman's specification test (Baltagi, 2005). The results again are in favor of the fixed effects model. For this reason we will use this model to isolate the impact of demographic variables on economic growth. The reason to abandon the single cross-section model is that this model, just as the TSCS model, does not control for fixed effects. Another reason is that the coefficient of the demographic variable measuring the growth differential between the working-age population and the total population and the coefficient of the old-age dependency ratio take less plausible values than in the fixed effects model (greater than 1 and greater than 0, respectively). Besides, we already discussed three potential drawbacks of the single cross-section approach.

One potential objection is that the child and old-age dependency ratios are not exogenous.[6] Problems of reverse causation may bias the estimated impact on economic growth. To test for reverse causality, we re-estimated the fixed effects model by 2SLS. Child dependency and old-age dependency were instrumented with five-year lagged values of the population growth rate, the working-age population growth rate and life expectancy. The coefficient estimates are reported in the fourth column of Table 2.2, as well as the results of two specification tests.

To test the joint hypothesis that the instruments are valid and the model is correctly specified, we applied the Sargan-Hansen test of over identifying restrictions. The joint null hypothesis is that the instruments are valid instruments, that is, uncorrelated with the error terms, and that the excluded instruments are correctly excluded from the estimated equation. Under the null, the test statistic is distributed as chi-squared in the number of (I-K) over identifying restrictions, where I is the total number of instruments. A rejection casts doubt about the validity of instruments. However, we find that the joint hypothesis cannot be rejected.

To test the hypothesis that the specified endogenous regressors can actually be treated as exogenous, we ran the Davidson and MacKinnon (1993) test of exogeneity for a regression equation with fixed effects. The null hypothesis states that an ordinary least squares estimator of the same equation will yield consistent estimates: that is, any endogeneity among the regressors would not have deleterious effects on OLS estimates. Under the null, the test statistic is distributed $F(M,N_{obs}-K)$, where M is the number of regressors specified as endogenous in the original instrumental variables regression, N_{obs} is the total number of observations and K is the number of regressors. A rejection indicates that the instrumental variables fixed effects estimator should be employed. Since the five-percent critical value of this density function is 3.04, the null cannot be rejected, which implies that the child and old-age dependency ratios may be

[6] Another objection might be that the impact of child and old-age dependency cannot be evaluated using this model because it controls for the saving rate too. However, the coefficient estimates appeared to be robust against excluding the saving rate.

treated as exogenous explanatory variables. A similar result was found by Bloom and Williamson (1998) and Kelley and Schmidt (2005).

Table 2.3: Effect of demographic transition on economic growth: sensitivity analysis fixed effects model

Dependent variable is growth rate of GDP per capita in constant PPP terms (1961-2003) multiplied by 100				
	1	2	3	4
Independent variables	Deleting one percentile from each variable	Outlier treatment	Ten year time spans	Jackknifing country by country
Log initial GDP per capita	-2.23	-1.74	-2.23	-1.70
	(-5.13)	(-3.99)	(-6.83)	se=0.43
Growth differential between working-age population and total population	0.51	0.59	0.37	0.55
	(1.96)	(2.20)	(1.87)	se=0.27
Log of child dependency ratio	-2.78	-1.80	-1.74	-1.76
	(-2.90)	(-1.92)	(-2.28)	se=0.95
Log of old-age dependency ratio	-0.31	-0.38	-0.32	-0.47
	(-0.34)	(-0.40)	(-0.41)	se=0.93
Log of tertiary gross enrolment rate	-0.002	-0.006	-0.009	-.0007
	(-0.012)	(-0.402)	(-0.767)	se=0.04
Log of saving rate	1.33	1.25	0.82	1.20
	(5.52)	(5.19)	(3.96)	se=0.24
Constant	14.66	11.28	16.76	
	(3.64)	(2.78)	(5.08)	

t values in parentheses, se= standard error

To investigate whether the results are robust, Table 2.3 finally reports the results of different robustness checks of the fixed effects model. The first column gives the result when deleting one percentile on both ends of the distribution of each variable. This leads to a reduction of twelve observations. The second column gives the results when a fraction of the lowest and the highest values of each explanatory variable are set equal to a lower and an upper bound, respectively. The third column gives the results when the data are measured over time spans of ten years, which, just as time spans of five years, is common practice in the growth literature. Since the countries included in the sample are different in size and economic development, we also investigated whether the results are driven by one particular country. For that purpose, one country has been taken out of the sample at a time (jacknifing). Since the sample consists of 70 countries, we so obtained 70 observations for each coefficient estimate and its corresponding standard error (se). The last column of Table 2.3 reports the mean coefficient estimate and the mean standard error. In neither of these cases, we need to reject the null hypothesis that the estimates of one particular coefficient in the fixed effects model reported in Table 2.2 and its counterpart in one of the columns of Table 2.3 have the same expected value. This indicates that the results of the fixed effects model are robust.

Cuaresma and Doppelhofer (2006) have found that nonlinearities and threshold effects among development of economic growth may be important too. For this reason, a quadratic functional form has been estimated too, which may be considered a second-order Taylor expansion to the dynamics of the steady state [see equations (1) and (2)]. However, even though a fraction of the second-order terms was found to be significant, this approach is problematic from a forecasting point of view. In the next section, we map the future prospects of the demographic transition process on economic growth in China, India and Pakistan over the period 2005-2050, based on demographic changes over that period projected by the United Nations (2008). If the economic growth model is extended to include second-order terms between the demographic and economic variables, such as the saving rate and the tertiary gross enrolment rate, these economic variables need to be projected as well. Since these data are not available and predicted values of these explanatory variables would create new uncertainties, the analysis in the next section has been limited to results obtained for the linear fixed effects model.

2.5 The impact of demographic transition

To determine the contribution of the demographic transition process to past economic growth in China, India and Pakistan, the coefficient estimates of the demographic variables in the fixed effects model are multiplied with the country-specific growth rates of the demographic variables, averaged over the period 1963-2003. The contribution of the old-age dependency ratio is also determined, even though its coefficient in Table 2.2 turned out to be insignificant. We will come back to the implications of this in the concluding section.

The results, which are reported in Table 2.4, show that the decline in child dependency was the major contributor to GDP per capita growth in these three countries. The growth differential between the working-age population and the total population also had a positive effect on economic growth, but its contribution was much smaller. The old-age dependency ratio had a negative effect. To determine the overall contribution of the demographic variables, the individual contributions have been summed. The overall contribution appears to be positive for all three economies and the highest for China. Over the period 1963-2003, China's annual GDP per growth rate was 7.24 percent and 3.35 percentage points of this growth rate, i.e., 46 percent can be attributed to demographic variables. India grew by 2.62 percent per year of which 39 percent can be attributed to demographic variables, and Pakistan grew with 2.57 percent per year of which 25 percent can be attributed to demographic variables. The results for India and Pakistan are different from those of China because the demographic transition process in these two countries started much later (see Figure 2.1).

Bloom and Williamson (1998) found that one-third of East Asia's economic growth over the period 1965-1990 can be attributed to population dynamics. However, they did not consider demographic variables other than the growth rates of the working-age population and of the total population. Kelley and Schmidt (2005) found that 44 percent of Asia's economic growth over the period 1960-1995 can be attributed to population dynamics, of which 16 percentage points as a result of the growth differential between the working-age population and the total population and 28 percentage points as a result of other demographic variables. Our results corroborate Kelley and Schmidt's finding that other demographic variables, among which the child dependency ratio in particular, are relatively more important than the growth differential.

Table 2.2A in the appendix decomposes the results reported in Table 2.4 into four periods: 1963-70, 1971-80, 1981-90, 1991-2000. This table reconfirms that the child dependency ratio was the major contributor to GDP per capita growth in most periods, although there are notable exceptions. In addition, it shows the temporary nature of population dynamics on economic growth. For example, whereas the old-age dependency ratio was not a serious threat for China in the first three decades, the size of the negative effect obtained for the 1990s indicates that this may change soon. Furthermore, whereas the contribution of the child dependency ratio on China's GDP per capita growth rate was 6.20 percentage points and relatively important in the 1980s, it was negative and relatively unimportant in the 1960s. These figures are explained by the introduction of the *wan xi shao* birth control campaign after 1970 and the one child policy in 1979. Just as in China, the decline in child dependency in India had a positive effect on economic growth in the last three decades. However, whereas the contribution of this variable in China already started to decline in the 1990s, it still increases in India. Since the demographic transition process in Pakistan started much later than in China and India, the first positive contribution of the decline in child dependency in Pakistan is obtained for the 1990s.

Table 2.3A in the appendix shows that the child dependency ratio will continue to decline in China, India and Pakistan, but there are significant differences among these countries. In China, the child dependency ratio will stabilize after 2035, whereas it will continue to decline in India and Pakistan up to 2050. Consequently, this decline is expected to have a greater positive impact on economic growth in these two countries than in China. The old-age dependency ratio will continue to increase in all three countries, which will have a negative impact on economic growth. Finally, whereas the growth differential between the working-age population and the total population is expected to have a positive effect on economic growth in India and Pakistan over the period 2005-2050, it will have a negative effect in China. Table 2.5 shows that as an overall result of these three projections, population dynamics are expected to have a positive effect on economic growth in India and Pakistan and a negative effect in China. The overall effect amounts to 1.49, 1.97 and -0.79 percent, respectively. It is the expected old-age dependency ratio of 0.38 in China in 2050 that may be held largely responsible for this negative effect. Since the old-age dependency ratio in India and Pakistan in 2050 will still be rather low (0.20 and 0.15, respectively), these results reconfirm the conjecture that the window of opportunity of China will close in 2020, whereas it will remain open in India and Pakistan until the middle of this century.

Table 2.4: Contribution of demographic transition process to past economic growth, 1961-2003

Countries	Average annual growth rate of real GDP per capita	Average growth differential between working-age population and total population (Diff)	Average growth rate child dependency ratio (CD)	Average growth rate old-age dependency ratio (OD)	Estimated Contribution			
					Diff	CD	OD	Total
China	7.24	0.56	-1.87	0.54	0.31	3.29	-0.25	3.35
India	2.62	0.23	-0.70	0.72	0.13	1.24	-0.34	1.03
Pakistan	2.57	0.11	-0.23	-0.37	0.06	0.40	0.17	0.64

*The average growth rates are calculated using data from the World Bank.

Table 2.5: Expected contribution of demographic transition process to economic growth, 2005-2050

Country	Average growth differential between working-age population and total population (Diff)	Average growth rate child dependency ratio (CD)	Average growth rate old-age dependency ratio (OD)	Estimated Contribution			Total contribution
				Diff	CD	OD	Total
China	-0.307	-0.46	3.04	-0.18	0.84	-1.92	-0.79
India	0.290	-1.43	2.51	0.17	2.67	-1.58	1.49
Pakistan	0.718	-1.38	1.81	0.42	2.58	-1.14	1.97

Our results show that China has been able to take advantage of the growth potential offered by the demographic transition process. Whether India and Pakistan will also be able to realize the growth potential is still to be seen. There are three serious obstacles. First, whereas the literacy rate in China is 91 percent by now, more than one-third of the adult population in India is still illiterate and approximately one-half of the adult population in Pakistan. Second, India and Pakistan seem to have leap into the post-industrial phase without industrializing their economies. Whereas the manufacturing sector is the dominant sector in China (with a GDP share of almost 50 percent in 2006), the services sector is the dominant sector in India and Pakistan (approximately 55). Third, China's reform process, which began in the late 1970s, started in the agricultural sector rather than in the manufacturing and financial sectors. Pakistan, and to a lesser extent India, introduced reforms as a result of deteriorating external sector conditions and under the support of international financial institutions' (IFIs) adjustment and stabilization programs. The focus of these reforms was on financial, fiscal, trade and manufacturing sectors rather than on the agricultural sector, the initial source of rapid economic growth in China. In this respect, a comparison of the impact of these reforms on economic growth in China and India is revealing. In 1978, at the inception of its reforms, China's per capita GDP[7] was $165 (in constant 2000 US dollars), whereas it was $231 in India. China caught up with India in per capita GDP terms in 1984 ($259 vs. $250), and surpassed it in 1986 ($311 vs. $267). In the first post-reform decade, the Chinese economy grew at 9.6 percent, while the Indian economy grew at 5.7 percent in the corresponding post-reform decade (1990s).

[7] Data source: World Development Indicators

To realize the growth potential caused by the demographic transition process, Pakistan and India should create a more productive and better skilled workforce, stimulate investments and create a much bigger market for goods and services. They also need to stimulate industrialization, since it has greater multiplier effects on other sectors of the economy. The expected increase of the working-age population may also be absorbed by greater investments in infrastructure that can employ relatively large numbers of unskilled labor and that do not require much capital. To meet the challenges of an aging population, China should establish a sustainable pension system and should consider an increase of the retirement age in order to reduce the number of people dependent on this system.

2.6 Conclusions

By extending the framework proposed by Bloom and Williamson (1998) meant to address imbalanced age-structure changes when mortality and fertility rates change from high to low levels, we have demonstrated that three demographic variables may temporarily boost or slow down economic growth during a process of demographic transition: the growth differential between the population of working-age and the total population, the child dependency ratio and the old-age dependency ratio.

An empirically relevant question asks to what extent differences found in the contribution of demographic variables are attributable to the way in which applied econometricians analyze a given body of data. To be able to answer this question, we have estimated an augmented Solow-Swan model extended to include these three demographic variables using the data in cross-section over the entire sample period, by moving to time-series cross-sectional data pooled over periods of five years, and to panel data including country and time-period fixed effects. We found that the coefficient of the growth differential between the population of working-age and the total population is positive and significant and of the child dependency ratio is negative and significant for these three regression specifications. By contrast, the coefficient of the old-age dependency ratio appeared to be positive for the first regression specification and negative for the last two regression specifications. However, in neither of these cases it was significant. Although these results may therefore said to be robust to the kind of econometric specification being adopted, we also found that the fixed effects model best described the data when these specifications were tested against one another.

Based on this model, we found that population dynamics explain 46 percent of economic growth in per capita GDP in China over the period 1961-2003, 39 percent in India, and 25 percent in Pakistan. We also found that the decline in child dependency was the major contributor to GDP per capita growth. These results corroborate Kelley and Schmidt's argument that the growth differential between the population of working-age and the total population, as in Bloom and Williamson (1998), is not sufficient to address the multi-faceted role of demography in economic growth. Furthermore, population dynamics are expected to have a positive effect on economic growth in India and Pakistan over the period 2005-2050, and a negative effect in China. Even though the coefficient of the old-age dependency ratio was found to be insignificant and thus ambiguous, it is the expected increase of this ratio that may be held responsible for this negative effect in China. One explanation for its insignificance is that most developed countries just reached the last phase of the demographic process that is the period in which the population ages, as a result of which negative effects, if present, have not yet been able to manifest themselves. In other words, even though the impact of the old-age dependency ratio is ambiguous, policymakers in China better remain alert.

Chapter 3

Economic Development, Fertility Decline and Female Labor Force Participation [1]

3.1 Introduction

This chapter presents theoretical and empirical work on women's labor force participation across the process of economic development. Many studies have investigated the relationship between economic development and fertility and the relationship between fertility and female labor force participation, but the relationship between economic development and female labor force participation has received considerably less attention in the literature. Although one might expect that women want more children if income levels rise (Becker, 1960; Hotz *et al.*, 1997, pp. 292-293), the first relationship has generally been found to be negative. The quality-quantity model of fertility is one of the first models that acknowledged that economic progress simultaneously increases the return to human capital, which in turn can lead to a reduction in fertility as families choose smaller family size with increased investments in each child (Hotz *et al.*, 1997, pp. 294-308). Another reason is that the need to have children as a form of old-age security diminishes. In addition, lower mortality reduces the return to large families, representing another additional force toward lower fertility (Falcao and Soares, 2007). Finally, children who are useful from an early age on the farm

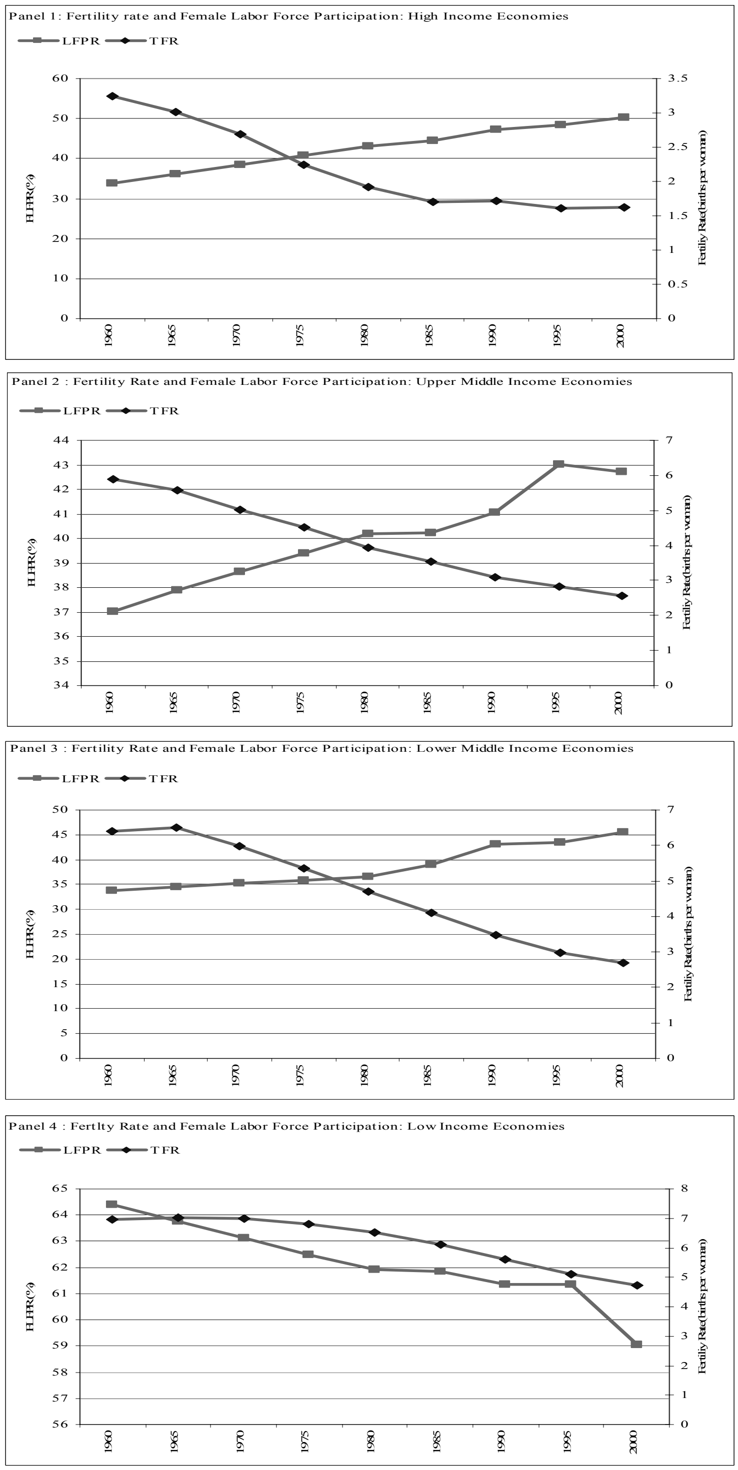
[1] This chapter is based on joint work with Paul Elhorst. The authors are thankful to the participants of the European Economic Association conference 2009, Scottish Economic Society Conference 2009 and 4th European workshop on labor economics. The usual disclaimer applies.

in low-income economies become increasingly less useful and more expensive to raise if income levels increase, all the more so as they spend an increasing number of years in school (Jacobsen, 1999).

The second relationship between fertility and female labor force participation has been found to be negative too. The reason is that with fewer children to take care of, women are able to spend an increasingly larger share of their life working for pay, both in terms of participation and in number of hours. Figures 3.1(a)-(d) illustrate that high-income and (lower and upper) middle-income countries show a negative relationship between the fertility rate and female labor force participation over the period 1960-2000. Only in low-income countries does this negative relationship seem not to exist. There may be two reasons for this. First, studies of the behavioral response to changes in fertility are complicated by issues of endogeneity, since the increase in female labor force participation may have a negative feedback effect on the fertility rate. Endogeneity requires instrumental variable methods, such as two-stage least squares (2SLS) to obtain consistent parameter estimates. Second, the income level should be controlled for, an important aspect that often is not adequately modeled as we will show in this paper.

Goldin (1995) and Mammen and Paxson (2000) were among the first to point out that the third relationship between female labor force participation rates and per capita income around the world is U-shaped. In poor, mainly agricultural economies, the number of women who are in the labor force is relatively high. In most cases they are unpaid workers on family farms who combine agricultural work with child care. When income levels rise, often because of an expansion of the manufacturing sector and the introduction of new technologies, women's labor force participation rates fall. Men move into new blue-collar jobs that increase family income, exerting so-called unearned income effects that reduce women's participation. Furthermore, as men move out of agriculture and into paid employment, there are fewer family farms on which women can work. In other words, opportunities for women decline in absolute terms due to the separation of market work from household work. At the same time, women may be barred from manufacturing employment by social custom or by employer preference. Those women who are in manufacturing are mostly self-employed or, again, unpaid family workers, for example, in home-based craft production (Schultz, 1990).

Figure 3.1: Fertility rate and female labor force participation by income



Source: Key Indicators of Labor Markets & World Development Indicators

When economic development continues, women move back into the labor force. There are several reasons for this. First, since the educational attainment of women tends to improve in more developed countries, the value of women's time in the market increases, which strengthens the incentives of women to work outside the home. Second, since employment in the agricultural and in the manufacturing sector tends to fall and employment in the services sector tends to increase in more developed countries, more women tend to enter the labor market because these jobs are experienced as more acceptable forms of employment as far as women are concerned. Bowen and Finegan (1969) were among the first to point out that the sectoral composition of employment might explain structural differences between metropolitan areas in the relative abundance of those jobs commonly held by females. This study however mainly focused on developed countries. In a study on women's labor force participation from a world perspective, Shultz (1990) found that the shift in the composition of production out of agriculture and into manufacturing and services was associated with an expansion of opportunities for women's employment relative to men's, particularly as wage earners. The possibility of doing this kind of work part-time, especially in the services sector, is also of importance since part-time work permits women to combine work outside the household with their domestic activities within the household (Jaumotte, 2003). Third, more women are able to enter the labor market since fertility tends to decline when the economy develops. This is also known as one of the main effects of demographic transition — a change from high to low rates of mortality and fertility.[2] Bloom *et al.* (2009) found that total labor supply would rise by about 11% due to increased female labor market participation when fertility declines by four births per woman.

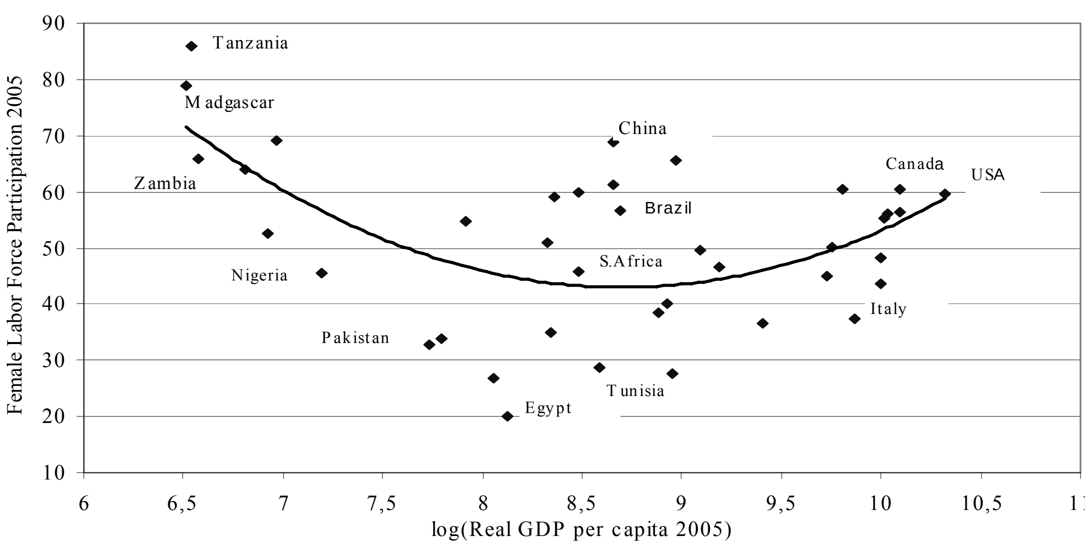
Taken as a whole, this story tells us that across the process of economic development women's labor force participation rates first fall and then start to increase again.[3] Figure 3.2 shows the female labor force participation rate in 2005 for a cross-section of 40

[2] Other effects are changes in per capita income growth, investment in human capital, savings, and age of retirement, etc.

[3] The U-shaped behavior of female economic participation with economic development resembles with the inverted-U hypothesis of inequality and growth. Kuznets (1955) suggested that economic progress (measured by income per capita) is initially accompanied by rising inequality but then these disparities disappear as benefits of development spread widely. Similarly, female participation initially decline with economic development but then this decline changes into an increase.

countries, while Table 3.1A in appendix gives an overview of the countries included and the income classes to which they belong. Figure 3.2 illustrates that the female participation rate is indeed relatively high in low-income countries (e.g., Tanzania, Madagascar and Zambia), relatively low in lower middle-income countries (e.g., Egypt and Tunisia), and again relatively high in both upper middle-income countries (e.g., China and Brazil) and high-income countries (e.g., Canada, Italy and the US). However, although Goldin (1995) and Mammen and Paxson (2000) recognized the U-shaped relationship between economic development and female labor force participation from a theoretical viewpoint, it is another issue as to how to model this relationship empirically.

Figure 3.2: GDP per capita and female labor force participation (2005)



A textbook overview of the theory behind the U-shaped relationship can be found in Hoffman and Averett (2010), but illustrative of this literature is that empirical approaches to this relationship are sparse. To cover the U-shaped relationship Bloom *et al.* (2009) adopted a linear regression model and controlled for the level of urbanization, that is, the percentage of the total population living in an urban area. The idea was that the time cost of working in an urban setting increases (commuting time is one reason), as a result of which labor supply falls. Although they indeed found a negative and significant effect, it is questionable whether this variable is really able to cover the supposed U-shaped relationship, since such a nonlinear relationship cannot be covered by adding another explanatory variable to a linear regression model. This is because the same change in economic development is likely to be less influential in high-income countries than in low-income countries.

Another possibility is that economic development affects female labor force participation interactively with other explanatory variables, that is, it modifies the effects that these variables have on female labor force participation (Pampel and Tanaka, 1986). For example, a shift to manufacturing employment in industrializing countries may eliminate work opportunities for women to such a degree that variation in fertility and education may make little difference for female labor force participation. For these two reasons we propose a regression model with interaction effects between the level of income per worker and the three key variables that explain female labor force participation across the process of economic development, namely, fertility, the share of employment in agriculture and the level of education. The square of the level of income per worker will also be considered. This approach offers the opportunity to model the regime shift between female participation rates, which first decline and then increase if the economy develops, as well as the opportunity to compute the turning points of this regime shift for the different explanatory variables in the model, as we will show in this chapter.

The previous studies by Pampel and Tanaka (1986), Tansel (2002) and Fatima and Sultana (2009) already considered the square of the level of income per worker.[4] In all three of these studies the coefficient of the level of income per worker was found to be negative and significant, and that of its square to be positive and significant. However, since we find that the coefficients of other interaction terms are significant too, we must conclude that just one interaction term is not sufficient to cover the supposed U-shaped relationship. In addition, to investigate the existence of a U-shaped curve, the latter two studies only used data from a single country, whereas we will be using time-series cross-section data from different countries around the world. The time-series component of the data is utilized to investigate whether countries move along this curve if the economy

[4] Pampel and Tanaka (1986) considered the square of energy use per capita, a variable they used as a proxy for economic development.

develops, while the cross-sectional component is utilized to cover every part of the U-shaped relationship. If the analysis would be limited to one country or to a set of developing or developed countries only, then the sample might not be representative for the relationship we would like to examine. In this respect, Pampel and Tanaka (1986) pointed out that if the effects of development are linear, examination of a sample dominated by nations at one level of development would not greatly bias the results — the linear effect would be the same at different levels of development. However, if the effects are not linear, a restricted sample might misspecify the true relationship.

This chapter is structured as follows. In Section 3.2, we postulate a microeconomic framework for the labor force decision and its causal factors. This framework will then be aggregated across individuals to make it suitable for analyzing the labor force participation rate at the country level. In addition, we will show that aggregation across individuals or across groups of people is not allowed if their marginal reactions are significantly different from each other. In addition, we will present a framework to test this hypothesis. Section 3.3 describes the data and the empirical implementation of the data into the model. In Section 3.4, we present and discuss the results of our empirical analysis. This will also include the turning points of the explanatory variables for different female age groups, that is, the income level at which the impact of the explanatory variables changes sign. These turning points throw more light on the question of whether the relationship between women's labor force participation and economic development is really U-shaped. The last section of the paper summarizes the empirical results and discusses their policy implications.

3.2 The theoretical framework

Simple textbooks models of labor supply specify that the labor force participation rate may be derived from a model of choice between consumption and working time. At micro level, the decision to participate in the labor market can be considered as a dichotomous random variable that takes the value of 1 if the decision is positive and 0 if it is negative. If we start from data observed at country level instead of individual data, the observed variable consists of a proportion L_j of a group of women belonging to the female working age population in country c (c=1,...,C) who decide to participate. In

Section 2.1 we will present a theoretical framework to identify the key determinants of the individual labor force decision. In Section 2.2 we will explain the transition from the micro level to the country level.

The decision at the micro level

A woman is assumed to participate in the labor market if the utility level U associated with participation exceeds the utility level associated with being inactive.[5,6] These utility levels depend on whether this woman is already employed or not.

First, suppose a woman is already employed. If she is able to keep her job, she receives an hourly wage (w_f) for the number of hours being supplied (h_f). Women who work on a family farm do not receive an hourly wage rate, but their wage rate may be approached by the shadow wage rate from the production part of a household production model (Elhorst, 1994). The probability (P_d) that a woman will lose her job depends on labor market conditions (l), with a high value of l assumed to refer to favorable conditions. If labor market conditions are unfavorable (e.g., loss of employment in agriculture), this implies a decrease in l and an increase in $P_d(l)$. When a woman loses her job involuntarily in higher-income countries, she may receive unemployment benefits, but in lower-income countries this is generally not the case. In addition to this, the woman's utility level depends on the number of children she gives birth to (fertility) and the quality per child (q). Although having more children may increase the woman's utility level in principle, the counteracting effect is that the time available for work will be reduced due to childcare responsibilities. This implies that working time is a function of fertility, $h_f=h_f(\tau)$, where the first derivative of h_f with respect to τ is negative, $\partial h_f / \partial \tau < 0$. A decline in fertility may be offset by increasing the expense per child associated with desiring a higher quality of life. The possibilities of doing so depend on the wage levels of both man and wife within the household, $q=q(w_m,w_f)$. Finally, the woman's utility depends on the income earned by her husband. Improvements in men's

[5] Although unemployed people may also be said to participate in the labor market, being unemployed in developing countries is often comparable to being inactive.

[6] Hill (1983) treats the decision to enter the labor force as an employee as being distinct from the choice to enter the labor market as a family worker. Although this is another way to model different regimes, it is only applicable when having individual data and when it is observed which women do paid work and which women do family work. At the aggregated level, this information is not available.

wages due to an expansion of the manufacturing sector without corresponding improvements in women's wages reduce the labor force participation of women, since a rise in unearned income (i.e., the income of a woman independent of hours worked) leads unambiguously to a reduction in hours worked. In lower-income countries this may have the effect that a woman will quit working altogether. In sum, a woman already employed will remain active as long as

$$U\{ [1-P_d(l)]\times w_f \times h_f(\tau) , \tau, q(w_m,w_f), w_m\} > U\{ 0, \tau, q(w_m,0), w_m \}. \quad (3.1)$$

Second, suppose a woman is not yet participating in the labor market. If she is able to find a job, she will obtain the benefits of being active ($w_f h_f$), as well as face the disadvantage of having less time available for childcare. In addition, a woman seeking a job incurs search costs (s), or relatively more so than a woman who already has a job and might be looking for another one. The probability of finding a job depends again on labor market conditions (l). If labor market conditions are unfavorable (e.g., relatively few jobs in the services sector), this probability ($P_f(l)$) decreases. In sum, a woman will become active if

$$U\{ P_f(l)\times w_f \times h_f(\tau) , \tau, q(w_m,w_f), w_m\} > U\{ 0, \tau, q(w_m,0), w_m \}. \quad (3.2)$$

From this theoretical framework it follows that the participation decision is positively related to the female wage rate (w_f) and favorable labor market conditions (l), and negatively related to the male wage rate (w_m), fertility and search costs.

There are more variables that have been found or have been argued to affect the labor force participation rate of women. Overviews have been provided by Elhorst (1996), Jacobsen (1999), Lim (2001), Jaumotte (2003), and Hoffman and Averett (2010). In this paper, however, we will focus on the key variables across the process of economic development.

The participation rate at the country level

The transition from the micro level to the macro level for homogeneous groups is discussed in Pencavel (1986), while Elhorst and Zeilstra (2007) extended this study by addressing the problem of heterogeneous population groups. Pencavel used the concept of reservation wage, the individual's implicit value of time when on the margin between participating in the labor market and not participating. This reservation wage, w^*, depends on observable explanatory variables (X) and unobservable explanatory variables (ε). Suppose women of a particular age group (g) have identical observable explanatory variables X_g, but different unobserved explanatory variables ε. Wages (w) may vary between age groups and between countries, but (like X_g) they do not vary within age groups within countries, that is, $w=w_g$. Consequently, differences in reservation wages are caused by different values of the unobserved explanatory variables ε only. Let $f_g(w_g^*)$ be the density function describing the distribution of reservation wages across women of group g and $F_g(w_g^*)$ the cumulative distribution function corresponding to the density function. This cumulative distribution function $F_g(w)$ is interpreted as giving for any value of w_g the probability of the event $w_g^* \leq w_g$, that is, the proportion of women who offer positive hours of work to the labor market since the market wage rate exceeds their reservation wage. Then the labor force participation rate L_g of age group g is the cumulative distribution of w_g^* evaluated at $w_g^*=w_g$, given X_g and a set of fixed but unknown parameters β_g,

$$L_g(w_g, X_g, \beta_g) = F_g(w_g | X_g, \beta_g), \tag{3.3}$$

where the dependence of the labor participation rate of age group g has been made explicit on w_g and X_g.

Since different age groups within each country may have different observable explanatory variables w_g and X_g, the total labor force participation rate is determined by the sum of the group-specific cumulative density functions $F_g(w_g|X_g,\beta_g)$ $(g=1,\ldots,G)$, weighted by the share of each age group in the total female population of working age (a_g). In mathematical terms

$$L_{total} = \textstyle\sum_{g=1}^{G} a_g F_g(w_g | X_g, \beta_g) \,. \tag{3.4}$$

From this equation it follows that there are two ways to deal with the problem of heterogeneous groups. One way is to consider a limited number of regression equations for broad population groups and to correct for the composition effect of groups having different observable explanatory variables X. This approach was followed by Pampel and Tanaka (1986), Tansel (2002), Jaumotte (2003), Elhorst and Zeilstra (2007) and Fatima and Sultana (2009). The other, more prevalent, way is to consider as many population groups as necessary to obtain within-group homogeneity and then to estimate a separate regression equation for each age group. This approach was followed by Bloom *et al.* (2009), but only for women whose age was below 45. Women aged 45 and over were excluded with the argument that fertility beyond age 45 is very low. However, it would have been interesting to test whether fertility indeed has no effect on the participation rate of older women. Older women may still have to care for children who have not yet left home or they may not be able to re-enter the labor market even if they want to.

Generally, the extent to which the participation rate may be aggregated or must be disaggregated can be considered as offering two competing models to choose from. Supposing that the participation rate of two female age groups can be explained, say A and B, or their joint participation rate can be explained, then the first model consists of two participation rate equations

$$L_A = \frac{n_A}{N_A} = X_A \beta_A + \varepsilon_A, \quad L_B = \frac{n_B}{N_B} = X_B \beta_B + \varepsilon_B, \tag{3.5}$$

where n is the female labor force, N is the female working age population, and w is assumed to be part of X. The second model consists of one participation rate equation

$$L_{A+B} = \frac{n_A + n_B}{N_A + N_B} = X_{A+B} \beta_{A+B} + \varepsilon_{A+B}, \tag{3.6}$$

where $L_{A+B}=W_A L_A+W_B L_B$ with $W_A=N_A/(N_A+N_B)$ and $W_B=N_B/(N_A+N_B)$. ε_A and ε_B in (5), and ε_{A+B} in (6), are independently and identically normally distributed error terms for all women with zero mean and variance σ^2_A, σ^2_B and σ^2_{A+B}, respectively.

Starting from two participation rate equations of two different age groups and from $X_A = X_B$, it is possible to investigate whether the marginal reactions of two age groups are the same by testing the hypothesis $H_0 : \beta_A = \beta_B$ against the alternative hypothesis $H_1 : \beta_A \neq \beta_B$. Note that the participation rate of every age group is taken to depend on the same set of explanatory variables. If one equation is to contain an explanatory variable that is lacking in the other and its coefficient estimate is statistically different from zero, H_0 would have to be rejected in advance.

The so-called Chow test can be used to test the equality of sets of coefficients in two regressions, but this test is only valid under the assumption that the error variances of both equations equalize, $\sigma_A^2 = \sigma_B^2$. The empirical analysis to be discussed later in this paper reveals that this assumption is rather implausible; if the parameter vector β differs between two age groups, the error variance is different as well. Therefore, the Wald test is adopted here. Let β_A and β_B denote two vectors of k parameters, one for group A and one for group B, with covariance matrices V_A and V_B, then the Wald statistic

$$(\hat{\beta}_A - \hat{\beta}_B)'(V_A + V_B)^{-1}(\hat{\beta}_A - \hat{\beta}_B), \tag{3.7}$$

has a chi-squared distribution with k degrees of freedom under the null hypothesis that the estimates of β_A and β_B have the same expected value.

3.3 Empirical analysis: Implementation

The data we use for the empirical analysis comprises 40 countries over the period 1960-2000. We selected observations over five-year intervals (1960, 1965, …, 2000). Since the data set is not complete, the total number of observations is 326. The countries included belong to different income classes, so as to cover every part of the supposed U-shaped relationship between the female labor force participation rate and economic development.

The variable to be explained is the female labor force participation rate of ten five-year age groups (15-19, 20-24, …, 60-64). According to the International Labor Organization (ILO), the organization from which the data were extracted, a woman is economically active if she is employed or actively seeking work.[7] The female labor force participation rate is defined as the number of economically active women belonging to a particular age group divided by the total female population in that age group.

[7] The data from 1960-1980 and 1980-2005 were taken from different data sets (ILO 1997, 2007).

The theoretical framework set out in Section 2 invites the use of regression analysis to evaluate the empirical reliability of the female wage rate (w_f), the male wage rate (w_m), labor market conditions (l), fertility (τ) and search costs (s). However, further explanation of how these variables have been implemented and the functional form of the relationship to be estimated would seem appropriate.

One difficulty that immediately emerges empirically is that we do not have comparable international data on male and female wage levels. To address this problem, Bloom *et al.* (2009) assumed a simple Cobb-Douglas function where output Y depends on capital K and aggregate labor L and men and women are paid according to their marginal products. In mathematical terms

$$Y = K^{\alpha}[L_m h_m + L_f h_f]^{1-\alpha}, \tag{3.8}$$

where effective labor L is the sum of the male and female forces, L_m and L_f, weighted by their education levels, h_m and h_f, respectively, and $0<\alpha<1$. Consequently,

$$w_f = (1-\alpha)(\frac{K}{L})^{\alpha} h_f \quad \text{and} \quad w_m = (1-\alpha)(\frac{K}{L})^{\alpha} h_m. \tag{3.9}$$

Put into words, female wages rise with female education, male wages with male education, and both female and male wages rise with the capital-labor ratio. As an alternative to male and female wages, one may therefore also use the capital-labor ratio and the educational levels of males and females. This alternative approach, however, raises two complications. Formally, the capital-labor ratio cannot be treated as an exogenous explanatory variable. This is because the size of the labor force, the denominator of this ratio, depends on the number of women who decide to participate. Following Bloom *et al.* (2009), we therefore proxy the capital-labor ratio by K/W, where W represents the total male and female population of working age (15-64). Second, the correlation coefficient between the educational levels of men and of women is high (0.94). Including highly correlated variables in a regression may cause the coefficients to have the wrong sign or implausible magnitudes and to have high standard errors and low significance levels even if they are jointly significant and the R^2 for the regression is high (Greene, 2008, p. 59). To avoid that the regression results are undermined by multicollinearity issues, we will only consider the educational level of women.[8] This variable is proxied by the average years of schooling of the female population aged 15 and over, and taken from Barro and Lee (2000). To measure the numerator of the capital-labor ratio, we took data from Penn World Tables 6.2 with respect to the physical capital stock (Heston *et al.*, 2006).

In addition to the wage level, the better educated women, compared with the less educated, (1) possess skills that are in demand more often by an economy that pursues continued technological progress, (2) are likely to conduct more efficient searches, and (3) are less prone to layoffs and exhibit more stable patterns of employment. In this respect, the educational level of women can also be said to cover search costs.

The labor market conditions of a country are measured by employment in agriculture, that is, the percentage share of employed people in agriculture. This is because we have seen that the number of women who are in the labor force is relatively high in poor, mainly agricultural economies, and that this number diminishes if employment in agriculture falls.

Fertility is defined as the total number of children a woman will have by the end of her fertile period based on prevailing age-specific fertility rates. Data on the total fertility rate were taken from World Development Indicators (World Bank 2007). The fertility rate is treated as an endogenous explanatory variable. As instrumental variables we use the birth rate, the number of childbirths per 1,000 of the population (but then lagged five years in time), the infant mortality rate (up to one year of age) and the mortality rate under five years of age. Data on the birth rate were extracted from World Population Prospects (United Nations 2005) and data on infant mortality rates from World Development Indicators (World Bank 2007). Other instrumental variables were considered too, but rejected because they did not pass the (mis)specification tests to be discussed in the next section.

[8] Since our data set is comparable to the data set used in Bloom et al. (2009), we suspect that these problems may have affected the empirical results reported in that study as well.

Summary statistics of all the variables by different income groups[9] are presented in Table 3.2A in the appendix. This table demonstrates that the female participation rate of every age group shows a U-shaped relationship if we move from low-income economies to high-income economies. The participation rates of females aged between 15 and 19 on up to between 50 and 54 are the lowest for lower middle-income economies, while the participation rates of females aged between 55 and 59 and 60 and 64 are the lowest for the upper middle-income economies. In addition, an inverse U-shaped relationship is apparent between the number of women in the labor force and their ages. The female participation rate is low in the 15-19 age category; it increases sharply in the 20-24 age category and then remains constant or gradually increases up to the 40-44 age category. In the 45-54 age category the female participation rate starts to decline and in the 60-64 age category it falls off dramatically.

All other variables increase or decrease if we move from low-income economies to high-income economies. The average years of schooling and the capital-labor ratio increase if incomes rise, while the total fertility rate, employment in agriculture, the birth rate, infant mortality rate and mortality rate under 5 years of age fall if incomes rise.

We pose the following empirical model for every age group

$$L_{it} = f(\tau_{it}, \frac{K}{W}_{it}, A_{it}, h_{f\,it}) + \mu_i + \lambda_t + \varepsilon_{it}, \tag{3.10}$$

where L_{it} denotes the female participation rate of a particular age group of country i at time t. τ is the fertility rate, K/W is the capital-labor ratio (the denominator measured by the total population of working age), A is the share of employment in agriculture and h_f is the educational level of females. All these variables refer to country i at time t. ε_{it} are independently and identically normally distributed error terms for all i and t with zero mean and variance σ^2, μ_i denotes a country fixed effect, and λ_t indicates a time-period fixed effect. Country fixed effects control for all country-specific, time-invariant

[9] Economies are divided according to 2006 GNI per capita, calculated using the World Bank Atlas method. The groups are: low income, \$935 or less; lower middle income \$936 - \$3,705; upper middle income \$3,706 - \$11,455; and high income \$11,456 or more.

variables whose omission could bias the estimates in a typical cross-sectional study[10]; the justification for adding time-period fixed effects notes that they control for all time-specific, country-invariant variables whose omission could bias the estimates in a typical time-series study (Baltagi, 2005).

It is clear from both the introductory section of this paper and the data description in Table 2 that a linear functional form in equation (3.10) will not be able to capture the posited U-shaped relationship between economic development and female labor force participation. To model the regime shift between falling and rising female participation rates across the process of economic development, there should be a nonlinear relationship in one of the explanatory variables reflecting the income position of an economy. In (3.11) we propose a quadratic functional form in the capital-labor ratio, since this variable is used as a proxy for the wage level and therefore best reflects the transition of economies from low income levels to middle and high income levels

$$\begin{aligned} L_{it} &= \beta_1 \tau_{it} + \beta_2 \tau_{it} \frac{K}{W}_{it} + \beta_3 \frac{K}{W}_{it} + \beta_4 (\frac{K}{W})^2_{it} + \beta_5 A_{it} + \beta_6 A_{it} \frac{K}{W}_{it} \\ &\quad + \beta_7 h_{f\,it} + \beta_8 h_{f\,it} \frac{K}{W}_{it} + \mu_i + \lambda_t + \varepsilon_{it} \end{aligned} \tag{3.11}$$

This quadratic functional form is a generalization of the linear functional form in that it also contains product terms between the different explanatory variables and the capital-labor ratio. To test whether this functional form better describes the data than the linear function form, we will test the null hypothesis H_0: $\beta_2=\beta_4=\beta_6=\beta_8=0$.

Starting with (3.11) we can also calculate the turning points of the explanatory variables, that is, the point at which the positive impact of a certain variable changes into a negative impact or vice versa. For example, in a low-income economy the share of employment in agriculture is expected to have a positive effect on female labor force participation and in higher-income economies to have a negative effect (see section 3.1).

[10] There are many other social, cultural and institutional factors that may affect the female labor force participation rate. Social traditions are very important in determining the roles played by men and women in society. Women are generally considered as homemaker and care provider and men as bread earner. Antecol (2000) finds that women are more likely to participate in the labor market if their male partners exhibit greater cultural acceptance of such behavior. Since we control for country specific fixed effects, such cultural and social differences across countries are accounted for.

Its turning point depends on the income level, in the quadratic equation approached by the capital-labor ratio. The turning point of an explanatory variable can be obtained by differentiating the quadratic functional form by that particular variable, which for all explanatory variables in the model gives

$$\frac{\partial L}{\partial \tau} = \beta_1 + \beta_2 \frac{K}{W}, \quad \frac{\partial L}{\partial A} = \beta_5 + \beta_6 \frac{K}{W}, \quad \frac{\partial L}{\partial h_f} = \beta_7 + \beta_8 \frac{K}{W} \quad \text{and}$$

$$\frac{\partial L}{\partial \frac{K}{W}} = \beta_3 + \beta_2 \tau + 2\beta_4 \frac{K}{W} + \beta_6 A + \beta_8 h_f, \tag{3.12}$$

where the subscripts i and t have been left aside, because the turning points will be determined at the sample mean. The first derivative with respect to the variable A shows that the marginal effect of the share of employment in agriculture will be negative if the capital-labor ratio is smaller than $-\beta_5/\beta_6$ and positive if it is greater than $-\beta_5/\beta_6$ (note: if both βs are positive or negative, then the marginal effect can only be positive). The marginal effect of the capital-labor ratio itself not only depends on the capital-labor ratio, but also on the fertility rate, the share of employment in agriculture and the educational level of females. However, by substituting the first derivatives of these variables into the first derivative of the capital-labor ratio and by rearranging terms, we obtain following equation which only depends on the capital-labor ratio.

$$\frac{\partial L}{\partial \frac{K}{W}} = \beta_3 + \beta_1\beta_2 + \beta_5\beta_6 + \beta_7\beta_8 + (2\beta_4 + \beta_2^2 + \beta_6^2 + \beta_8^2)\frac{K}{W}, \tag{3.13}$$

This equation shows that the marginal effect of the capital-labor ratio can also be negative or positive, depending on the turning point that in this particular case can be calculated by

$$-\frac{\beta_3 + \beta_1\beta_2 + \beta_5\beta_6 + \beta_7\beta_8}{2\beta_4 + \beta_2^2 + \beta_6^2 + \beta_8^2}. \tag{3.14}$$

3.4 Empirical analysis: Results

The first panel of Table 3.1 reports the estimation results of the nonlinear regression model (3.11) for the ten age groups that have been considered. Although country fixed and time-period fixed effects have been included too, their coefficient estimates are not reported for reasons of space. Since the share of employment in agriculture is measured in percentages, its coefficient presents the shift in the participation rate measured on the interval 0-100% when this variable rises by one percentage point. The coefficient of the fertility rate shows the shift in the participation rate when this variable increases by one child, of education when this variable changes by one year of schooling, and of the capital-labor ratio when this ratio increases by US$1,000 (in the remainder of this paper we use $).

The fertility rate and the product term between the fertility rate and the capital-labor ratio have been treated as two separate endogenous explanatory variables. The results are reported in the second panel of Table 3.1. Note that the alternative approach of using fitted values for the fertility rate only and calculating the product term between the fertility rate and the capital-labor ratio based on the fitted values of the fertility rate is inconsistent (Kelejian, 1971; Greene, 2008, p.380). We also estimated the model, ignoring the endogeneity of the fertility rate, but we have not reported the results of this exercise. Instead, we will explain the main differences.

The results from the first-stage regressions show that the capital-labor ratio, employment in agriculture, and education have a negative effect on the fertility rate, and that the birth rate and the two mortality rates have a positive effect. Many of these results are in line with previous papers (see Anna and Marco 2005). Both for the fertility rate and the product term between the fertility rate and the capital-labor ratio, the R-squared is relatively high, indicating that the instruments together with the exogenous regressors do have predictive power with respect to the fertility rate. This is also illustrated by the F-tests of the first-stage regressions.

Diagnostics

The third panel of Table 3.1 reports the results of several diagnostics to test whether the model is correctly specified. To test the hypothesis that instrumental variables techniques are required, we ran the Davidson and MacKinnon (1993) test of exogeneity for a regression equation with fixed effects. The null hypothesis states that an ordinary least squares estimator of the same equation will yield consistent estimates: that is, any endogeneity among the regressors should not have deleterious effects on OLS estimates. Under the null, the test statistic is distributed F(M,N-K), where M is the number of regressors specified as endogenous in the original instrumental variables regression, N is the total number of observations and K is the number of regressors. A rejection indicates that the instrumental variables fixed effects estimator should be employed. Since the five-percent critical value of this density function is 3.04, the null must be rejected for every age group. Table 3.1 reports the results for the instrumental variables we use, the birth rate, the number of childbirths per 1,000 of the population (but then lagged five years in time), the infant mortality rate (up to one year of age) and the mortality rate under five years of age. Similar test results have also been computed for alternative sets of instrumental variables (see Table 3.3A in the appendix). However, these alternative sets did not pass all the (mis)specification tests.

To test the joint hypothesis that instruments are valid and that the model is correctly specified, we applied the Sargan-Hansen test of over identifying restrictions. The joint null hypothesis is that the instruments are valid instruments, that is, uncorrelated with the error terms, and that the excluded instruments are correctly excluded from the estimated equation. Under the null, the test statistic is distributed as chi-squared in the number of (L-K) over identifying restrictions, where L is the total number of instruments. A rejection casts doubt about the validity of instruments. For all population groups except females aged between 60 and 64, we find that the joint hypothesis cannot be rejected.

Finally, we have tested whether the instruments are redundant, irrelevant or weak. First, excluded instruments are redundant if the asymptotic efficiency of the estimation is not improved by using them. The test statistic computes the rank of the matrix cross-product between the endogenous regressors and the possibly redundant instruments after both have all other instruments partialled out. Under the null that the specified instruments are redundant, the statistic is distributed as chi-squared with degrees of freedom equal to the number of endogenous regressors (M) times the number of instruments being tested (L). Second, excluded instruments are relevant if they are correlated with the endogenous regressors. The test statistic computes the rank of the matrix of reduced form coefficients on the excluded instruments. Under the null that the instruments are irrelevant, the statistic is distributed as chi-squared with degrees of freedom equal to L1-M+1, where L1 is the number of excluded instruments. Third, excluded instruments are weak if their correlation with the endogenous regressors is weak. The critical value of the F version of the corresponding Cragg-Donald Wald statistic within our empirical setting is approximately 8.18. The results of these three tests reported in the last panel of Table 3 indicate that our instruments are neither redundant, nor irrelevant, nor weak. It should be stressed, however, that this positive result was achieved after a severe selection procedure in which several possible instrumental variables had to be dropped, among which women's life expectancy, male education, the child dependency ratio, the level of urbanization and the capital-labor ratio lagged in time. Furthermore, just as Falcao and Soaras (2007), we found that child mortality does not appear to be a particularly important determinant of female labor force participation, but that its effect on fertility is important.

We have tested whether it is necessary to adopt a quadratic functional form in the capital-labor ratio. If the coefficients of the interaction effects are not jointly significant, then a linear functional form would suffice. The test results are reported in the last line of the first panel in Table 3.1. They indicate that the linear functional form should be strongly rejected in favor of the proposed quadratic functional form for all age groups. The R-squared ranges from 0.07 percent for females aged 60-64 to 0.57 for females aged 25-29.

To investigate the hypothesis that the country fixed effects are not jointly significant, we performed an F-test. The results indicate that we should reject this hypothesis for all age groups. To test whether random effects can replace these fixed effects, we performed Hasuman's specification test (Baltagi, 2005). The results reject the random effects model in favor of the fixed effects model for all age groups.

Finally, we have tested the equality of the coefficients of the eight explanatory variables reported in Table 3.1 for all crosswise combinations of population groups (including the total female working age population), a total of 55 pairs. Since the square root of the error variance ranges from 2.31 for females aged 60-64 to 2.74 for females aged 35-39 (see σ in Table 3.1), we used the Wald statistic specified in (3.7). The results indicate that the null hypothesis has to be rejected in 46 cases. Only female labor force behavior in the successive age groups of 24-29 on up to 40-44 shows any resemblance to each other. In other words, the marginal reaction of the different population groups being identical is the exception rather than the rule. It follows from this finding that age-targeted policies to enhance the female labor force participation rate may be more successful than one uniform policy.

Interpretation of coefficient estimates

Fertility appears to have a large negative and significant effect on the participation rate of females in every age group, whereas the interaction effect between fertility and the capital-labor ratio appears to have a positive effect. This positive effect[11], however, is only significant for females aged between 15 and 19, and 20 through 24. The fact that the coefficient of the fertility variable is negative and that the coefficient of the product term with the capital-labor ratio is positive indicates that fertility has a negative effect on the female labor force participation rate in lower-income economies and a positive effect in higher-income economies. The turning point for the total female working age population, which is illustrated in Panel 1 of Figure 3.3, amounts to $69,410. In other words, in countries located in Africa, South Asia, the Middle East, North Africa and South America, fertility affects participation negatively, while in countries located in Europe, North America and Oceania, fertility affects participation positively.

[11] The finding of a positive effect of fertility on labor supply for women below 25 in developed countries may be an education effect - early childbearing may take women out of education and into the labor market.

Table 3.1: Female labor force participation, fixed effects estimation

Variables	Dependent Variable: Female Economic Participation by Age Group										
	15-19	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**50-54**	**55-59**	**60-64**	**overall**
Fertility	-13.39***	-15.065***	-13.394***	-12.040***	-12.160***	-11.356**	-9.278**	-7.466*	-9.802**	-7.595*	-9.717***
	(3.529)	(4.374)	(4.459)	(4.429)	(4.662)	(4.519)	(4.28)	(3.995)	(3.946)	(4.312)	(3.255)
Fertility × capital-labor ratio	0.307***	0.211*	0.191	0.140	0.130	0.125	0.139	0.134	0.193*	0.153	0.140
	(0.101)	(0.124)	(0.123)	(0.123)	(0.129)	(0.124)	(0.115)	(0.107)	(0.111)	(0.115)	(0.091)
Capital-labor ratio	-1.056***	-0.050	0.035	0.102	0.010	0.019	0.152	-0.244	-0.394*	-0.274	-0.222
	(0.28)	(0.298)	(0.291)	(0.289)	(0.294)	(0.276)	(0.248)	(0.219)	(0.222)	(0.215)	(0.191)
Capital-labor ratio × capital-labor ratio	-0.005	-3.28***	-2.548***	-2.601***	-2.331***	-2.462***	-2.186***	-1.836***	-2.022***	-2.173***	-1.742***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.00)
Agriculture	0.324*	0.314	0.399*	0.432**	0.355*	0.403*	0.296	0.204	0.227	0.141	0.221
	(0.171)	(0.208)	(0.206)	(0.196)	(0.207)	(0.206)	(0.199)	(0.189)	(0.20)	(0.216)	(0.151)
Agriculture × capital-labor ratio	-0.029***	-0.032***	-0.035***	-0.036***	-0.035***	-0.034***	-0.029***	-0.025**	-0.026***	-0.018*	-0.024***
	(0.009)	(0.011)	(0.011)	(0.01)	(0.011)	(0.011)	(0.01)	(0.01)	(0.01)	(0.01)	(0.008)
Education	-3.115**	-3.266**	-3.647**	-3.880**	-4.376**	-4.427**	-4.551***	-4.463***	-4.849***	-2.849*	-3.459***
	(1.294)	(1.576)	(1.594)	(1.704)	(1.809)	(1.751)	(1.697)	(1.577)	(1.464)	(1.487)	(1.217)
Education × capital-labor ratio	0.079***	0.072***	0.071***	0.065***	0.071***	0.072***	0.078***	0.076***	0.086***	0.063***	0.065***
	(0.021)	(0.023)	(0.022)	(0.023)	(0.023)	(0.022)	(0.021)	(0.019)	(0.019)	(0.019)	(0.016)
R^2	0.27	0.18	0.57	0.56	0.52	0..56	0.52	0.46	0.15	0.07	0.34
σ	2.47	2.70	2.64	2.69	2.74	2.67	2.59	2.40	2.42	2.31	2.24
Significance of country fixed effects											
F(39, 270)	40.81	22.23	24.16	23.05	23.67	25.46	30.34	43.50	44.12	42.16	36.29
p-value	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Hausman test (FE vs. RE)											
Chi-sq(8)	31.21	44.31	50.64	40.69	34.35	31.07	40.74	74.25	50.48	79.23	58.83
p-value	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nonlinearity Test											
F(4,270)	6.12	9.74	16.13	20.01	20.72	21.32	18.80	17.74	15.12	8.61	19.11
p-value	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Dependent variable: Fertility					**Dependent variable: Fertility × capital-labor ratio**					
Lagged birth rate	0.076***					2.569***					
	(0.010)					(0.369)					

Capital-labor ratio	-0.012					1.836***					
	(0.008)					(0.398)					
Capital-labor ratio × capital-labor ratio	0.001					-0.0002					
	(0.008)					(0.001)					
Agriculture	-0.003					-1.028***					
	0.005					(0.021)					
Agriculture × capital-labor ratio	(0.0001)					0.062***					
	(0.0001)					(0.006)					
Education	-0.38***					-2.23					
	(0.058)					(2.01)					
Education × capital-labor ratio	0.002***					-0.067***					
	(0.0005)					(0.033)					
Infant mortality rate	0.003					1.557***					
	(0.007)					(0.253)					
Mortality rate below 5 years of age	0.005					-0.883***					
	(0.005)					(0.161)					
R^2	0.91					0.79					
First stage F-test	28.26					27.36					
Davidson-MacKinnon Test of Exogeneity											
F (2,268)	11.32	17.79	13.75	9.09	9.98	8.13	4.90	3.91	9.82	7.88	11.5
p-value	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
Over identification test											
Sargan-Hansen test, chi-sq(1)	0.55	0.59	0.66	0.38	0.13	1.19	2.29	2.92	1.9	6.53	0.73
p-value	0.45	0.44	0.42	0.53	0.71	0.27	0.13	0.09	0.17	0.03	0.39
IV Redundancy Test	**chi-sq(1)**	**p-value**									
Lagged birth rate	55.08	0.00									
Infant mortality rate	28.47	0.00									
Mortality rate below 5 years of age	31.18	0.00									
Under identification test											
Chi-sq(2)	27.81										
p-value	0.00										
Weak identification test											
Cragg-Donald Wald Statistic	10.1										

Notes:
All regressions are based on the sample of 326 observations and include country and time-period fixed effects.
Coefficient of squared capital labor ratio is multiplied by 1000 to make results presentable.
Robust standard errors in parentheses. * Significant at 10%, ** significant at 5 %, *** significant at 1 %.

The explanation is that these countries not only provide more childcare facilities but also provide more financial support to families with young children, among which are paid parental leave and childcare subsidies (Jaumotte, 2003). First, paid parental leaves help mothers of young children reconcile work and family life, and may strengthen labor market attainment through a job guarantee. Second, childcare subsidies reduce the relative price of childcare, thereby increasing the return of market work relative to home production (in addition to increasing effective income). Figure 3.4 shows the turning points for different age groups based on the estimation results reported in Table 3.1. An inverse U-shaped relationship is apparent between these turning points and the age of women. The turning points for females in the prime age groups are greater than those for the younger and older age groups. This implies that teenagers and elderly women are the first who will enter the labor market as a result of fertility decline when income levels rise, even though the impact of fertility decline is weaker for these age groups (see below). The second group will be women in the younger age groups 20-24 and 25-29 and, finally, women in the age groups 30-34, 35-39 and 40-44.

If the endogeneity of the fertility is not accounted for, the coefficients of the fertility variable remain negative and significant, but they decrease substantially in magnitude. Furthermore, for five age groups (20-24, 25-29, 30-34, 35-39 and 40-44) the sign of the interaction variable changes sign. Consequently, fertility would always have a positive effect on the female participation rate in these apparently younger age groups, which is rather implausible and clearly not in line with previous studies. These findings corroborate the hypothesis that fertility should be treated as an endogenous explanatory variable.

On the basis of our regression results we can also compute the demographic transition effect, that is, the increase in female labor force participation due to the change from high to low rates of fertility when an economy develops. Table 3.2A in appendix shows that the fertility rate declines from 6.03 births per woman in low-income economies to 2.14 in high-income economies. Taking into account that the positive effect of fertility decline diminishes the higher the capital-labor ratio, we find that the total female labor force participation rate will rise by about 19% as a result of such a decline in fertility when using the estimation results for the total female labor force (last column of Table 3.1). Figure 3.5 graphs the results that are obtained when using the estimation results for the different age groups. This figure shows that the impact of fertility decline for the prime age groups is stronger than for teenagers and elderly women. If these impacts are weighted with the share of each age group in the total female population of working age, the total effect becomes 22%. Bloom *et al.* (2009) found 11%, but they pointed out that this percentage may underestimate the total effect since they only considered female labor supply of those females aged below 45 (according to our estimation result these age groups explain approximately five percentage points of the total increase). Furthermore, they estimate a linear instead of a quadratic functional form as in this study[12] and therefore cannot account for regime switch effects. For emerging economies like India and Pakistan our model predicts an increase in the female labor force participation rate by about 10 and 20 percentage points over the period 2010-2050, respectively, based on the decline in fertility over that period projected by the United Nations (2006).[13]

The share of employment in agriculture has a positive effect on the female participation rate of every group, while the interaction effect between the share of employment in agriculture and the capital-labor ratio has a negative effect. The former effect is significant for five age groups and the latter effect for all age groups. The positive sign of the agricultural variable itself can be explained by the fact that women can combine farm work with family responsibilities in low-income and developing economies. The explanation for the negative sign of the interaction term is twofold. First, a rising capital-labor ratio represents a structural shift from employment in agriculture to industry and services.

[12] Although they do take into account the fact that capital increases in line with the rise in labor supply.

[13] According to the medium variant, total fertility will decline from 2.76 in 2010 to 1.85 in India and from 4.00 to 2.16 in Pakistan.

Figure 3.3: Marginal effects, confidence intervals and turning points

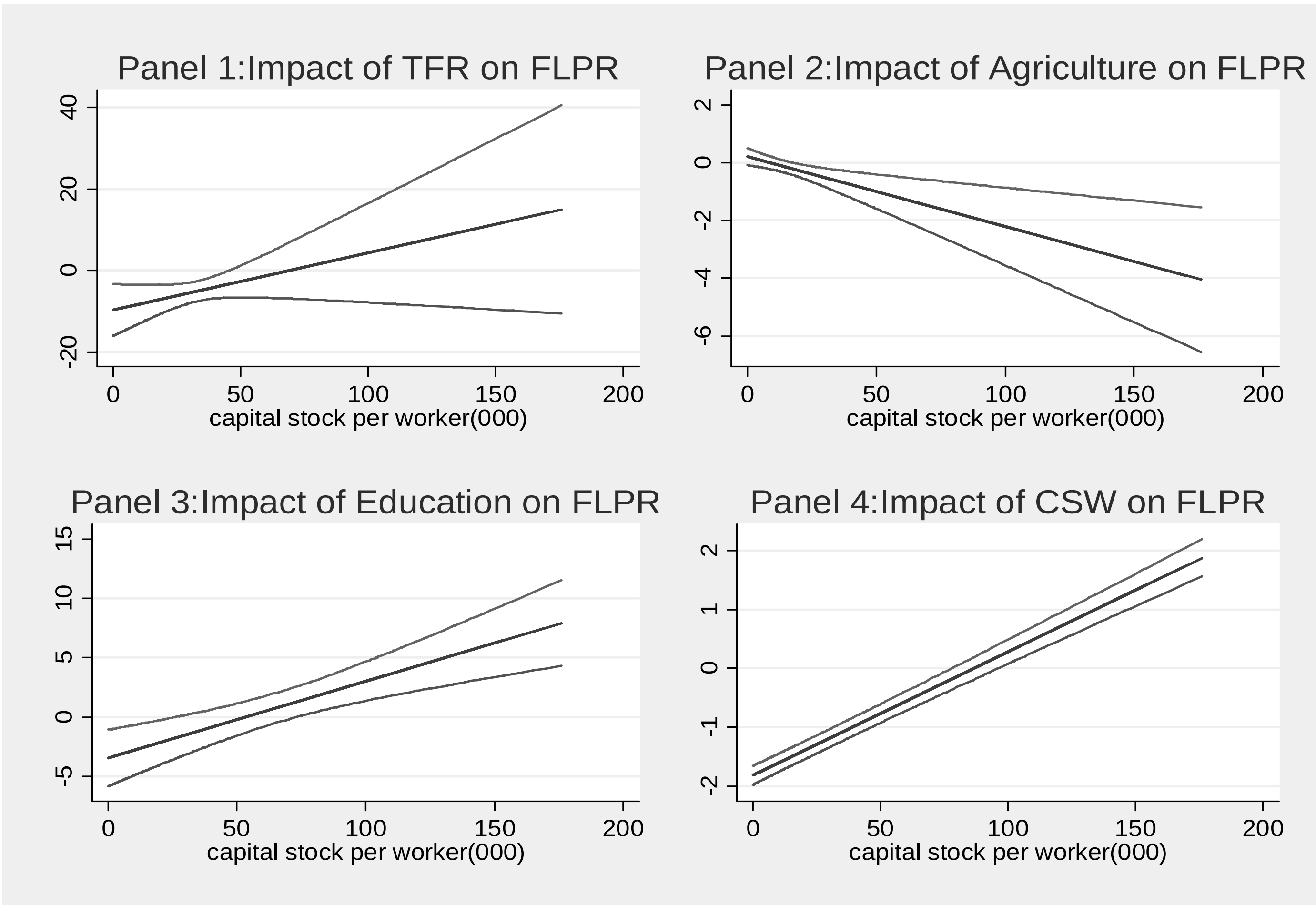
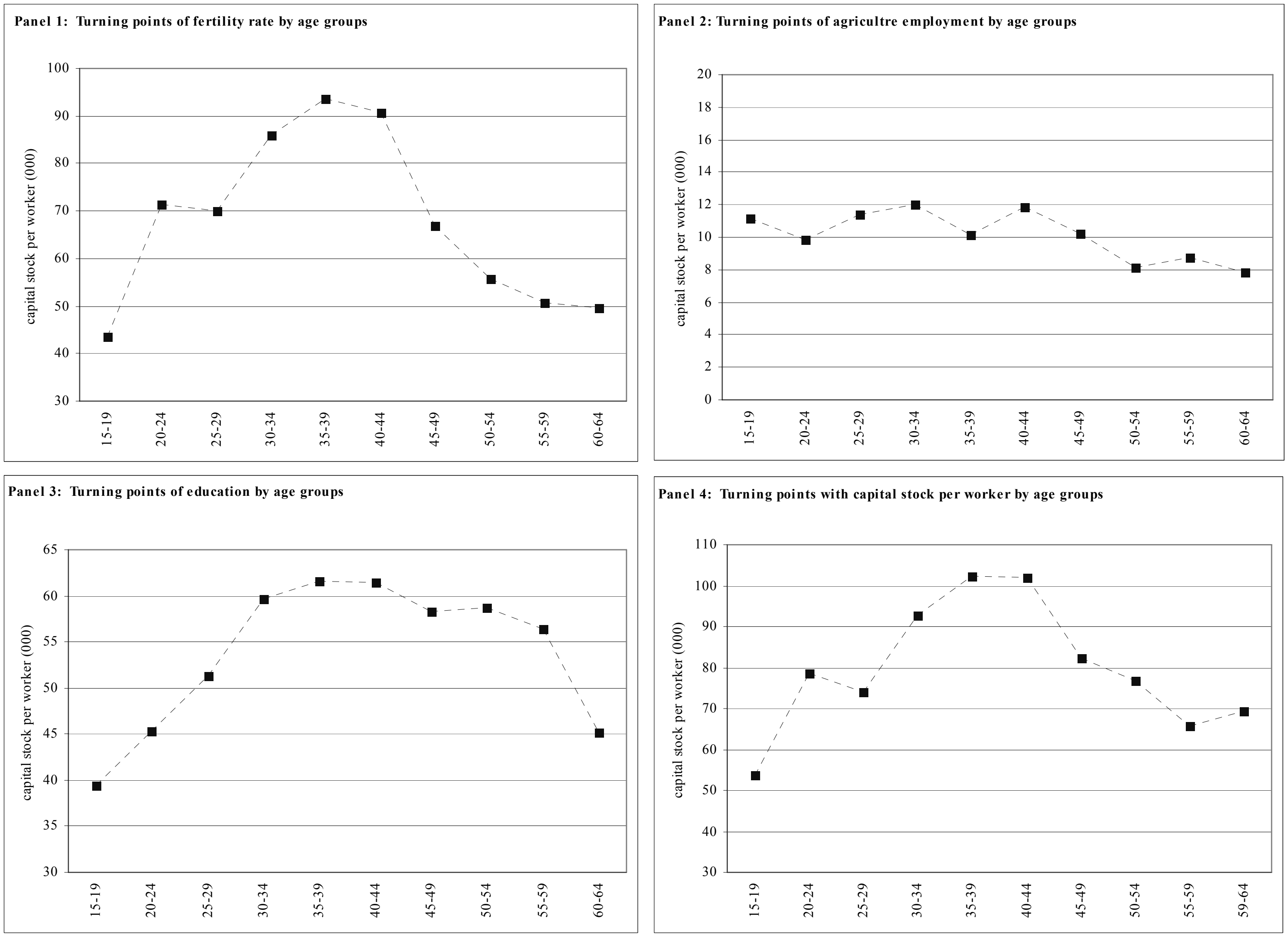


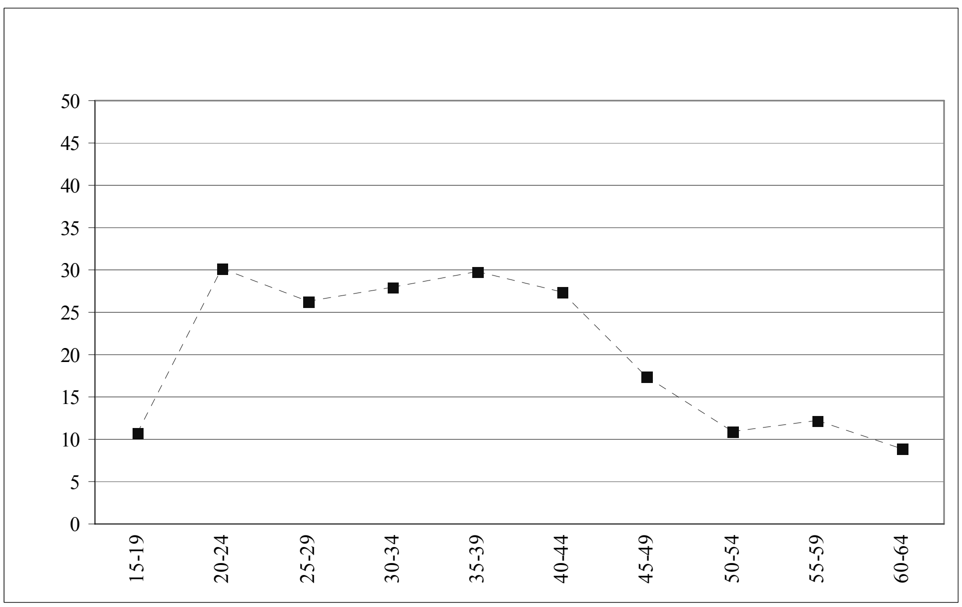
Figure 3.4: Marginal effects and turning points for different age groups



Consequently, the agricultural sector can employ fewer females. Furthermore, they cannot immediately move to other sectors due to lack of skills and knowledge. Second, when an economy develops, mechanization of farm activities increases labor productivity, as a result of which fewer people are needed in the agricultural sector. In this respect, Boserup (1970, 1990) argued that industrialization marginalized women in the sense of hindering their participation in wage work. In sum, our results corroborate the hypothesis that agricultural employment has a positive effect in lower-income countries and a negative effect in higher-income countries. The turning point for the total female working age population, as illustrated in Panel 2 of Figure 3.3, amounts to $9,210. In addition to this, Panel 2 of Figure 3.4 shows that there are hardly any differences with respect to different age groups. The turning point ranges from $11,170 for females aged 15-19 to $7,830 for females aged 60-64 years. These results reflect the actual situation prevailing in the world. In countries located in Africa and South Asia, the capital-labor ratio is lower than the level at which the marginal effect of the share of employment in agriculture changes sign; these are two regions of the world that also happen to have the highest rate of females employed in the agricultural sector, namely 69 percent and 61 percent in 2007, respectively. Schultz (1990) found that changes in the sectoral composition of the labor force traced out the U-shaped relationship between female labor force participation rate and economic development. Our results confirm this finding.

Education has a negative and significant effect on the female participation rate of every age group, while the interaction effect between education and the capital-labor ratio has a positive and significant effect. These coefficient estimates indicate that education does not have a positive effect on women's labor force participation in lower-income countries, but only in higher-income countries. The turning point for the total female working age population, as illustrated in Panel 3 of Figure 3.3, amounts to $53,215. In other words, education only has a positive effect for countries located in Europe, North America and Oceania. A similar result was found by Smith and Ward (1985) for the US in 1900 and by Kottis (1990) for Greece over the period 1971-1981 in that the impact of education depended on a country's stage of development. The explanation is that most women in low-income countries are unpaid workers on family farms and that more schooling does not help to improve their position on the labor market under these circumstances. Furthermore, women may be barred from manufacturing employment by social custom or employer preference as soon as the economy starts to develop. The results are also in line with the OECD (1994, p.127), which has pointed out that there is little evidence to support an across-the-board increase in educational attainment in developed countries, because there seems to be a dividing line at upper secondary education below which labor market opportunities are worse than above it. Empirical evidence in favor of this proposition was also found by Elhorst and Zeilstra (2007). On the other hand, Panel 3 of Figure 3.4 shows that females in the lowest age groups (15-19 and 20-24) are the first who will benefit from more education when the economy develops. For these age groups we find turning points of \$39,430 and \$45,361, respectively, which is below the value of \$53,215 found for the total female working age population.

Figure 3.5: The impact of fertility decline on female labor force participation for different age groups



Since every regression equation of a particular age groups contains five explanatory variables that depend on the capital-labor ratio (note that in most equations three of these variables appear to be significant), it is difficult to draw any conclusion as to whether the capital-labor ratio affects the female participation rate positively or negatively. Therefore, we have calculated the marginal effect of the capital-labor ratio using (13). Panel 4 of Figure 3.3 graphs this relationship for the total female working age population. It shows that the capital-labor ratio has a negative effect on the female labor force participation rate in countries with capital-labor ratio's below $86,445 and a positive effect above it. The explanation for this is that improvements in men's wages due to an expansion of the manufacturing sector in developing countries without corresponding improvements in women's wages exert (unearned) income effects that reduce women's participation. Only when the value of women's time considerably increases, do women move back into the labor force.

3.5 Conclusions

A few studies have argued that women's participation in the labor force first declines and then rises with economic development, but they were unable to model this relationship empirically. Since such a U-shaped relationship cannot be covered by a linear regression model, we adopted a quadratic functional form with interaction effects between the capital-labor ratio (as indicator of the income level in a particular country) and three variables that are seen as the key explanatory variables of the female labor force participation rate across the process of economic development, namely, fertility, the share of employment in agriculture and the level of education. In addition, the square of the capital-labor ratio was considered. Previous studies by Pampel and Tanaka (1986), Tansel (2002) and Fatima and Sultana (2009) already considered the square of the level of income per worker. However, since the coefficients of the other interaction terms have been found in this paper to be significant too, we must conclude that only one interaction term is not sufficient to model the posited U-shaped relationship. Since female labor force participation may have a negative feedback effect on the fertility rate, we also tested for exogeneity of the fertility rate. Since this hypothesis had to be rejected, instrumental variables were then used to obtain consistent parameter estimates. After a severe selection procedure, three valid instrumental variables were found, namely, the birth rate five years lagged in time, the infant mortality rate (up to one year of age) and the mortality rate under five years of age.

We also investigated the extent to which the labor force behavior of females in different age groups may be lumped together for the purpose of a common treatment.

Previous studies by by Pampel and Tanaka (1996), Tansel (2002), Jaumotte (2003), Elhorst and Zeilstra (2007) and Fatima and Sultana (2009) have ignored population distribution effects, relying instead on the representative-agent paradigm. In order for representative-agent models to accurately describe aggregate behavior, all marginal reactions of individuals to changes in aggregate variables must be identical. We have found strong empirical evidence against this condition being applied to females across different age groups.

For every age group and for every explanatory variable in the model we found a particular point where the regime of falling participation rates changes into a regime of rising participation rates. Fertility has a negative effect in countries if the capital-labor ratio is below $69,410 and a positive effect above it. The same applies to the level of women's education and the capital-labor itself, although the turning points are different, $53,215 and $86,445, respectively. Conversely, the share of employment in agriculture has a positive effect in countries if the capital-labor ratio is below $9,210 and a positive effect above it. Each of these findings corroborates the hypothesis that the relationship between female labor force participation rates and per capita income around the world is U-shaped.

Since women's labor force status relative to that of men is an important benchmark of their status in society, their integration into the economy is a desirable goal for both equity and efficiency considerations. The existence of a U-shaped relationship between female labor force participation rates and per capita income around the world shows that it is possible to narrow the gap between men and women. The more an economy develops, (1) the lower will be the fertility rate which can free up time from childcare and the more childcare facilities will become available; (2) the more the industry mix will shift into the direction of employment in services which is experienced as a more acceptable form of employment for women, and which, since this kind of work can often be done part-time, permits women to combine work outside the household with their domestic activities; (3) the better women will be educated, as a result of which the value of women's time in the market will increase, which strengthens the incentives of women to work away from home; and (4) the higher the female wage rate will be, as a result of which the probability will be less that the unearned income effect (the income of a woman independent of hours worked, i.e., the income of her husband) will have the effect that a woman will quit working altogether. Concurrently, it should be pointed out that, just because the relationship between female labor force participation rates and per capita income is U-shaped, low-income countries will first have to go through a trough and even then they will have a long way to go before the gap eventually disappears.

Chapter 4

Tradeoff between Productivity and Employment: An International Comparison[1]

4.1 Introduction

In order to attain long term sustainable economic growth of an economy, creation of employment opportunities along with promotion of higher productivity is a basic essential. Policy makers in developed, developing, emerging and transition economies are emphasizing the need to improve workers' productivity. However, at the same time it needs to be considered that labor productivity will be increased by the substitution of capital intensive methods for labor intensive methods in production process, leading to a potential loss of jobs.

Although productivity gain can lead to job losses, as technological progress leads to efficient utilization of resources, it can also lead to employment creation due to expansion of new product markets. The new jobs may be created in different areas, sectors and industries. Sectoral shifts of employment have been taking place in all regions of the world. On balance an increase in employment is more prominent in the services

[1] This chapter is based on the paper "Tradeoff between productivity and employment in transition economies: An international comparison" written with Bart van Ark. The paper is published as a book chapter in "Economic growth and structural features of transition" edited by E. Marelli and M. Signorelli, Palgrave Macmillan Publishers.
The authors are thankful to the participants of the AIEL XXIII Conference on Labor Economics, 2008, held in Brescia, Italy for their valuable comments. The usual disclaimer applies.

sector, but with considerable variation among different regions of the world. Similarly, the composition of the labor force, human capital development, investment in physical capital goods and adoption of ICT is changing over time. Since this transition process takes time, a tradeoff can be expected between employment growth and productivity growth during this transition process.

This chapter focuses on the impact of increasing labor force participation rates on labor productivity. The theory of demographic transition predicts that there will be a change in the age composition of the population as a result of fertility decline. An increase of the relative size of the working-age population may lead to more labor supply. The purpose of this study is to investigate whether an increase in labor supply, caused by demographic transition, will affect labor productivity positively. One of the factors affecting labor productivity is the availability of productive and decent employment. In developing countries, where there is already a substantial level of unemployment and underemployment, a rise in labor supply often results in further underemployment and unemployment, since these economies do not have the capacity to produce employment opportunities for the new entrants on the labor market. To evaluate the impact of increased labor supply, the relationship between labor force participation and productivity growth needs to be investigated (Van Ark et al., 2004; McGuckin and Ark, 2005; Broersma, 2008). This chapter focuses on the productivity and labor force participation tradeoff in dynamically changing economies with particular focus on transition and developing countries. The hypothesis is that there will be a tradeoff in productivity growth and employment due to structural changes in short and medium run. But in the long run, the economy will benefit from these structural changes as higher productivity is combined with employment growth. The chapter also investigates whether this development can be verified for all regions of the world or whether it is specific to some countries belonging to particular income groups. The chapter provides an international comparison of this tradeoff between different regions, as well as by different income groups of the world. Below we analyze (i) the relationship between productivity and employment for transition and developing economies belonging to different income groups; (ii) the impact of gender and different age groups of labor force on the productivity-participation tradeoff; and (iii) possible reasons that explain the differences in the tradeoff across regions and income groups. This chapter also highlights the potential requirements for the transformation of short term tradeoffs into long run positive effects for sustainable growth in transition and developing economies.

To investigate the intensity of the tradeoff between productivity and participation, we use a panel approach for 45 countries[2] across the world for the period of 1980-2005 and the sub-period of 1995-2005. We find that there is tradeoff between labor productivity and labor participation for all regions and income groups of the world. The intensity of this tradeoff varies for economies belonging to different regions and income groups. The tradeoff increases as we move from high income developed economies to upper middle, lower middle and lower income developing and emerging economies. The analysis shows that during 1995-2005, the tradeoff has reduced for all regions, except for the transition economies of Central and Eastern Europe (CEE) and it has become almost insignificant for high income group and upper middle income group economies.[3] We also find that the impact of female participation is negative and significant during 1980-2005. However, during the period of 1995-2005, female participation has a negative impact on productivity for a period lasting three years and becomes insignificant thereafter. Moreover, our results show that the impact of the participation of younger workers is negative and significant on productivity during 1980-2005 and becomes insignificant after 1995.

The chapter is structured as follows: section 4.2 explores the employment-productivity relationship. In section 4.3, the patterns of the employment-productivity tradeoff are analyzed across different regions and time periods at macro level. Empirical analysis of this tradeoff by applying panel analysis is presented in section 4.4. Impact of gender and age of workers on the tradeoff are analyzed in section 4.5. Finally, section 4.6 summarizes the findings and suggests policy recommendations to handle this tradeoff.

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[2] A list of countries is provided in Table 4.1A in the appendix.

[3] Transition economies are taken as five economies from Central and Eastern Europe which include Bulgaria, Poland, Albania, Hungary and Romania.

4.2 The relationship between employment and productivity

We start with a basic relation where output is considered as a multiplicative term of employment and productivity. A given level of output can be achieved either with high productivity and low employment (i.e. the employment intensity of economic growth is low) or, in contrast, with low productivity and high employment (a high-employment intensity). The important question is whether an increase in productivity necessarily implies a decline in employment. In fact, it is not always the case as there are other sources such as better capacity utilization, efficient use of inputs, and training and skill development of labor, which lead to an increase in productivity. In this case, the productivity can grow without reducing the employment. Similarly, there may be "displacement effects" that occur due to expansion of market share with increase in productivity level of particular firms. There can be a prompt employment decrease in other competing firms, so displacement effects should be kept in mind while focusing on the net impact on employment. Moreover, whenever productivity increases with mechanization, there may be less demand of labor (for example in the agricultural sector) but at the same time there will be more labor demand due to expansion of output and related activities of mechanical developments (as in the manufacturing sector of developing countries). Although the immediate impact may be a slight decline or displacement in labor demand, market forces will compensate through output expansion and demand for new products demand in the longer term.[4] For evaluating the productivity-employment tradeoff, both the time framework, the response of markets and institutions towards productivity increase are important. There are compensating mechanisms through which productivity growth in a particular sector can affect output and employment growth at the aggregate level. These compensating mechanisms work through decline in product prices, increased wages, increase in investment and overall employment and new products through innovation (World Employment Report, 2005). It is important to investigate whether these compensating factors play a positive role in the long run, especially in developing and emerging economies.

[4] There is considerable variation in short, medium and long term. Here we use 3-5 years for the short run, 5-20 years for the medium and long term and 20+ years for the very long term.

4.3 The tradeoff between productivity and employment

Theoretically, when net participation is associated with employment growth then the productivity-participation tradeoff follows directly from the neoclassical production function (Broersma, 2008). Under decreasing returns to labor, any increase in employment rate will reduce capital per worker, which will in turn lower output per worker. Another theoretical argument to the productivity-participation tradeoff is based on skilled heterogeneity among workers. New entrants in the labor market are relatively less skilled than those already employed (Becker and Gordon, 2008). An increase in labor participation will imply a decline in labor productivity (McGuckin and Van Ark, 2005). Another related explanation for this possible tradeoff is that high growth rates of labor make it difficult to exploit the benefits from new technologies which help to boost labor productivity (Beaudry and Collard, 2003).

To evaluate the productivity-participation tradeoff, we analyze a cross section of 45 countries from all over the world for the period 1980-2005. In our sample, nearly 70 percent of the countries are developing and emerging economies and they belong to different income groups.[5]

We start our analysis with an identity reconciling per capita income and labor productivity through labor intensity and participation

$$\left(\frac{Y}{P}\right)=\left(\frac{Y}{H}\right)\cdot\left(\frac{H}{E}\right)\cdot\left(\frac{E}{P}\right) \tag{4.1}$$

where

$$\left(\frac{E}{P}\right)=\left(\frac{E}{L}\right)\cdot\left(\frac{L}{P_{15-64}}\right)\cdot\left(\frac{P_{15-64}}{P}\right) \tag{4.2}$$

where Y is GDP, P is population, H is hours work, L is labor, $P_{15\text{-}64}$ is working age population and E is the number of employed persons. In our detailed econometric analysis, we use the broader definition of the participation rate, the share of employed

[5] Economies are divided according to GNI per capita into four groups. The groups are: low Income, $935 or less; lower middle income, $936 - $3,705; upper middle income, $3,706 - $11,455; and high income, $11,456 or more.

persons in total population, instead of the narrower definition of the population between 15-64 years of age. This is done intentionally as the employment rate is widely available and less subject to measurement differences across countries. Moreover, the working age population (15-64 years) measure is somewhat arbitrary because people older than 64 years may still be working. Data for (4.1) is drawn from The Conference Board and the Groningen Growth and Development Centre (GGDC).

Descriptive analysis

Since we found that the annual percentage growth rates of the series are stationary[6], we continue our analysis based on them. Most economies represent developing countries and lack data on annual hours worked for these economies. So we will use GDP per employed person as a measure of labor productivity.

Graphical description of data is presented in Figures 4.1 and 4.2 in which we focus on the long term development of per capita income and labor productivity from 1981-2005 taking account of each country's starting position, which is the level of per capita income and productivity in 1980. This shows whether there has been convergence among these 45 countries in past 25 years in terms of welfare (GDP per capita), productivity (GDP per person employed). As the major part of sample countries consists of developing economies, there is no convergence in the sample. The negative annual growth of some countries shows that these economies are prey to a low level of income trap (see Figure 4.1). These economies are Zambia, Zimbabwe, Madagascar and Nigeria. All these four economies are from Africa and belong to the lower income economies group. On contrary, countries like China, Malaysia, South Korea and Thailand show good performance despite of their low initial level of income. All these economies belong to the East and Southeast Asian region and explain some part of East Asian miracle growth.

A scatter plot of the initial level of labor productivity and the annual average growth during 1980-2005 is presented in Figure 4.2. This scatter plot pretty much coincides with the per capita income scatter plot, indicating that labor productivity growth is a major explanatory factor for income growth. There are many countries with low initial productivity level and high annual growth in productivity representing a

[6] Levin, Lu and Chu (2003) panel unit root test result suggest that data series are stationary.

catching up phenomenon, i.e. Malaysia, South Korea, China, Thailand and Turkey. However, there are also economies in the sample that are prey to a low productivity trap, i.e. Zambia, Zimbabwe and Madagascar, Peru, Syria, Brazil, Ecuador, and Kenya. There is also variation in labor productivity growth performance among transition economies. For example, Albania with quite a low initial productivity level showed reasonable annual productivity growth while Bulgaria did not perform well during the period under analysis (see Figure 4.2**)**. In the next section we will discuss the possible reasons for variation in productivity performance across different regions and income groups.

An assessment of the long term interaction between employment growth and productivity growth for sample countries is presented in Figure 4.3. Although a negative relationship can be seen between employment and productivity growth, there is quite some variation across countries. Most countries are in the northeast quadrant of the diagram showing both productivity and employment growth. At one end there is China, South Korea and Malaysia which show evidence of both productivity and employment growth. At the other end, there are economies mostly from Africa, Latin America and Middle East in the southeast quadrant of Figure 4.3. These economies show high employment growth accompanied by poor performance in productivity which implies that there is a high rate of underemployment in these economies. There are also four countries in the northwest quadrant which show negative employment growth during 1980-2005. All these economies are transition economies which experienced a rapid decline in employment during the 1990s with productivity gains related to a contracting economy because of the collapse of the former socialist regimes, leading to a huge shake-out of employment from unproductive enterprises and the beginnings of market liberalization.

Another way to explore the productivity-participation tradeoff is a decomposition of output growth by the change in employment and productivity (see Table 4.1). The regional growth rates are calculated by unweighted average growth rates in sample countries belonging to a particular region. In most cases we can observe a negative relationship between employment and productivity growth in different regions, i.e. in Europe, Africa and Middle East and North Africa.

Figure 4.1:Scatter plot of GDP per capita in 1980 and average per capita income growth (1981-2005)

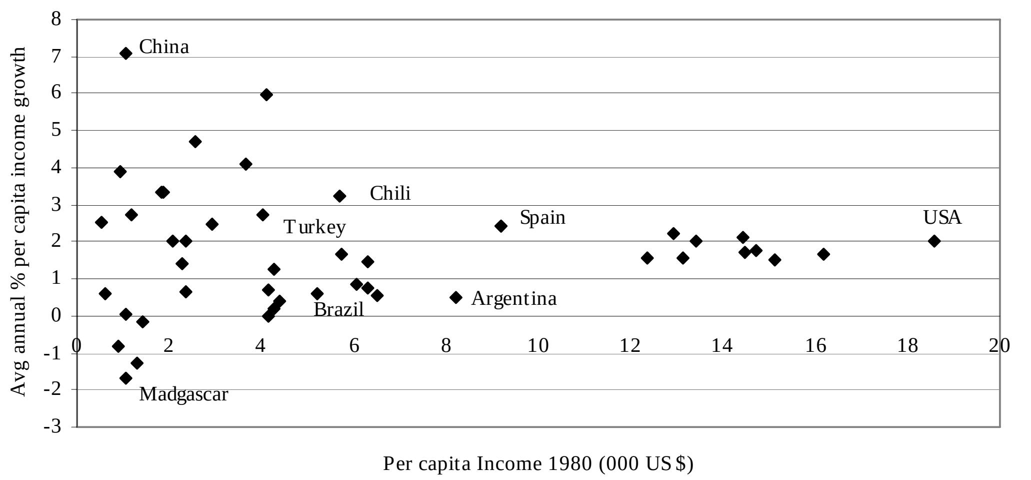
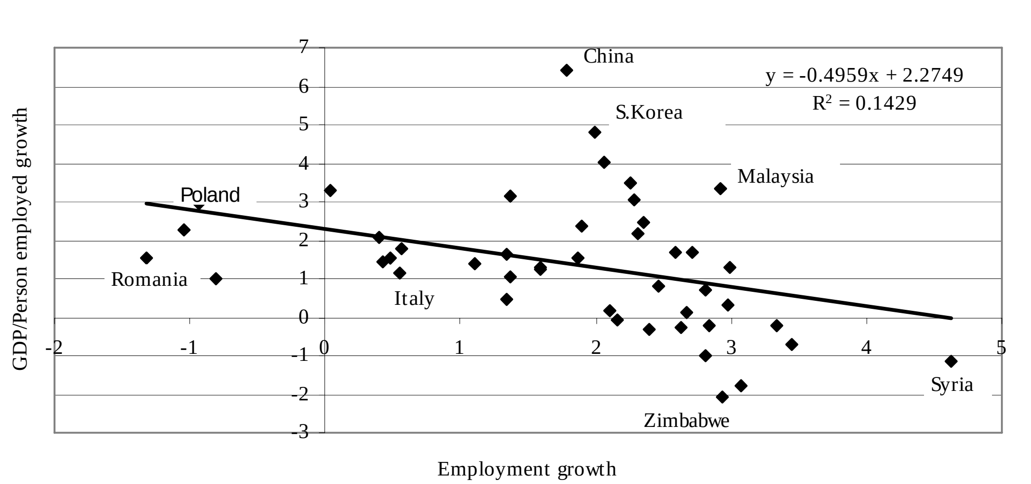


Figure 4.2: Scatter plot of labor productivity in 1980 and average labor productivity growth (1981-2005)

Figure 4.3: Relationship between growth f employment and labor productivity (1981-2005)



Source: The conference Board and the Groningen Growth and Development Centre, Total Economy Database (2008).

Table 4.1: Output decomposition by employment and productivity (1960-2005) by regions

	Africa			**East Southeast Asia**			**Europe**		
	Output growth	Emp growth	Produc growth	Output growth	Emp growth	Produc growth	Output growth	Emp growth	Produc growth
1960-70	5.00	2.46	2.53	6.21	2.52	3.69	5.29	0.64	4.65
1970-80	3.11	2.71	0.39	6.35	2.68	3.66	3.27	0.35	2.92
1980-90	2.11	3.36	-1.25	5.66	2.85	2.8	2.38	0.59	1.79
1990-00	1.48	2.77	-1.29	4.78	1.53	3.25	2.32	0.85	1.47
2000-05	2.95	2.1	0.85	5.04	1.44	3.6	1.76	1.23	0.53
	Middle East & North Africa			**North America**			**Transition Economies**		
	Output growth	Emp growth	Produc growth	Output growth	Emp growth	Produc growth	Output growth	Emp growth	Produc growth
1960-70	4.89	1.65	3.24	5.22	2.49	2.72	5.11	1.30	3.82
1970-80	6.87	2.76	4.11	5.38	3.59	1.79	3.54	0.96	2.58
1980-90	3.92	3.1	0.81	2.3	2.52	-0.22	0.07	0.30	-0.22
1990-00	3.89	2.88	1.01	3.03	1.58	1.45	0.80	-1.86	2.66
2000-05	3.63	2.51	1.12	2.33	1.67	0.66	4.86	-0.94	5.80
	South America			**South Asia**			**Oceania**		
	Output growth	Emp growth	Produc growth	Output growth	Emp growth	Produc growth	Output growth	Emp growth	Produc growth
1960-70	4.81	2.03	2.77	4.38	1.86	2.52	4.28	2.48	1.81
1970-80	4.21	2.47	1.73	3.17	2.38	0.78	2.69	1.52	1.16
1980-90	1.23	3.19	-1.96	4.88	2.21	2.67	2.51	1.09	1.41
1990-00	3.81	1.52	2.27	4.86	2.02	2.84	3.16	1.43	1.72
2000-05	3.75	2.72	1.03	5.24	2.76	2.47	3.31	2.4	0.91

Source: The Conference Board and the Groningen and Growth Development Centre, Total Economy Database (2008).

One can also notice that in *Africa* output growth is mainly due to employment growth with very low productivity except for 1960-70. In Europe, productivity growth is mainly responsible for the output growth over the four decades up to 2000. However, the situation is reversed in the recent past (2000-2005). In *Transition economies*, output growth is mainly due to high productivity growth related to a rapid decline in employment in these economies. Only Bulgaria and Hungary showed slightly positive growth in employment during 2000-05, while the other economies in the sample showed negative employment growth during 1980-2005. The *Southeast Asian* region showed positive employment and productivity growth during the last decade, with productivity growth dominating employment growth. Similarly, in *South Asia* both employment and productivity growth moved together positively since 1980s.

Output growth in developed economies during 1960-2005 showed that the employment elasticity of output is low relative to developing economies. Similarly, output decomposition by different income groups reveals that in high income economies output growth was mainly due to productivity growth, whereas in low income economies low output was due to unproductive employment growth (see Tables 4.2A & 4.3A in the appendix).

Gain in productivity means that more real income is generated which can be distributed among workers through higher wages. It will lead to an increase in per capita income which can further boost productivity through better standards of living and increased human capital investment. By looking at the impact of productivity and labor participation on per capita income, we provide a breakdown of this relationship as mentioned in (4.2).

This breakdown of labor productivity growth into effects of labor force participation and GDP per capita by region and by different income groups has been provided in Table 4.2. It appears that the relationship between labor force participation and labor productivity tends to be negative in most cases. The share of active population to total population has turned strongly positive in most of developing economies during the 1990s. On the other hand, in some countries the demographic transition has not materialized into demographic benefits as can be seen from the poor performance with regard to productivity in Africa and South American economies, i.e. Kenya, Madagascar, Mexico, Syria, Zambia and Zimbabwe. A similar analysis by different income levels shows that the share of active population in total population decreased in high income economies, whereas it was high during 1995-2005 compared to 1980-95 for other income groups. In transition economies, there is a strong negative relationship between participation and productivity. Labor productivity growth during 1995-2005 was rapid as compared to the period of 1980-95, whereas the impact of the active population share on per capita income was only slightly positive.

Table 4.2: Decomposition of labor productivity into effects of labor force participation and GDP per capita (1980-2005) annual average % growth

Region/Area	GDP per Person Employed (%)	Effect of Employment as a percent of labor force (age 15-64) (in % points)	Effect of labor force as percent of working age population (age 15-64) (in % points	Effect of Active population(age 15-64) as a percent of total population	GDP per Capita (%)
Africa					
1980-95	-1.775	-0.028	0.030	0.293	-1.480
1995-05	0.384	-0.093	-0.157	0.388	0.523
Southeast Asia					
1980-95	3.479	0.131	0.111	0.640	4.361
1995-05	3.038	-0.337	0.200	0.308	3.208
Europe					
1980-95	1.782	-0.375	0.153	0.244	1.804
1995-05	0.904	0.540	0.560	-0.040	1.964
Eastern Europe					
1980-95	0.628	-0.749	-0.704	0.255	-0.570
1995-05	4.874	0.144	-1.064	0.389	4.343
Middle East and North Africa					
1980-95	0.812	0.045	0.056	0.628	1.541
1995-05	1.207	-0.142	0.159	0.930	2.154
North America					
1980-95	0.260	-0.349	0.504	0.378	0.792
1995-05	1.072	0.162	0.067	0.410	1.711
Oceania					
1980-95	1.529	-0.460	0.214	0.177	1.460
1995-05	1.174	0.583	0.304	0.139	2.199
South America					
1980-95	-0.042	-0.801	1.109	0.433	0.699
1995-05	1.188	-0.584	0.695	0.441	1.740
South Asia					
1980-95	2.875	-0.231	-0.263	0.266	2.647
1995-05	2.616	0.323	-0.170	0.652	3.421
By Development					
Developed					
1980-95	1.789	-0.322	0.155	0.259	1.882
1995-2005	1.414	0.408	0.324	0.067	2.212
Developing					
1980-95	0.650	-0.251	0.110	0.453	0.948
1995-2005	2.033	-0.170	-0.056	0.554	2.344
By Income Group					
High income					
1980-95	1.963	-0.291	0.106	0.239	2.017
1995-05	1.474	0.440	0.351	0.029	2.295
Upper middle					
1980-9522	0.598	-0.462	0.040	0.436	0.612
1995-05	2.424	0.013	-0.372	0.469	2.533
Lower Middle					
1980-95	1.365	-0.190	0.278	0.597	2.050
1995-05	2.382	-0.261	0.199	0.647	2.966
Low income					
1980-95	-0.675	-0.155	-0.009	0.200	-0.663
1995-05	0.759	-0.221	-0.103	0.493	0.867

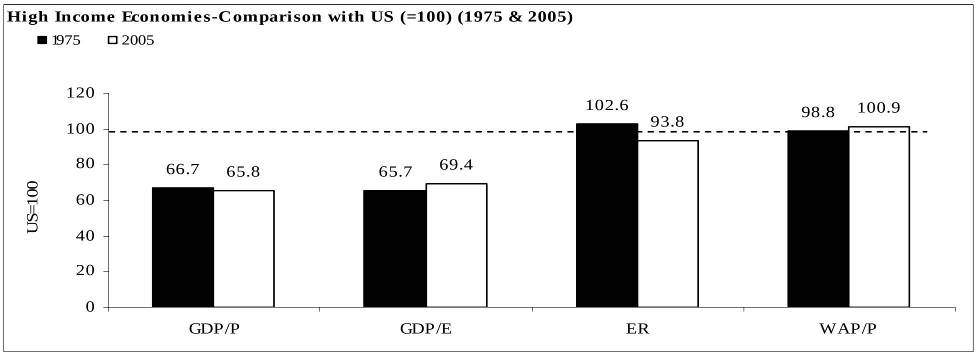
Source: TCB/GGDC, Total Economy Database (2008) with GDP converted to US $ at 1990 GK PPP

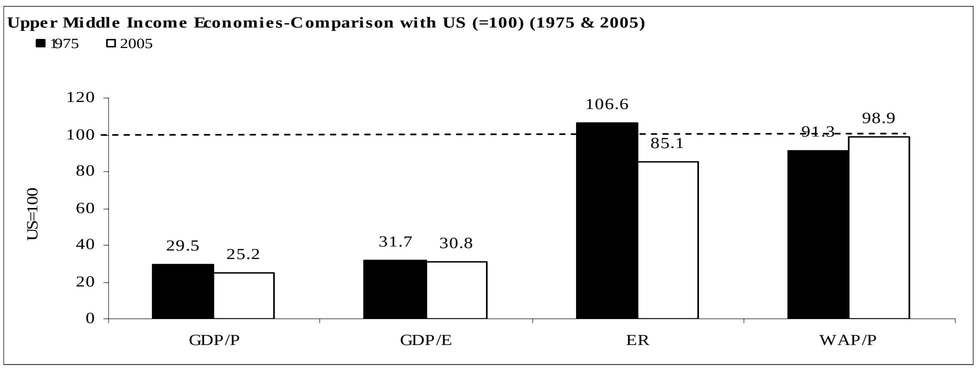
An analysis with regard to time period shows that in all regions except East and South East Asian economies per capita income growth has increased during 1995-2005 as compared to 1980-95, with in most cases an increased role for productivity growth in driving the improvements in per capita income around the world. A similar analysis by income group shows that except in high income economies, growth in per capita income is high during 1995-2005. The labor productivity analysis shows that in developing economies labor productivity during 1995-2005 is high as compared to period 1980-95 and its opposite is true for developed economies. This reflects the catching up of developing economies with low initial productivity level.

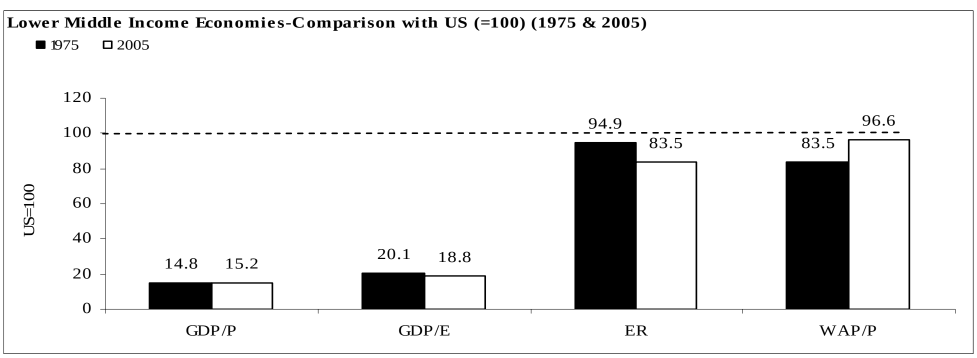
The impact of participation, whether it is measured as employment rate or labor force participation rate, on productivity is negative or very low (see Table 4.2). It demonstrates the tradeoff between labor participation and employment, although one has to keep in mind that this relationship is not perfect as other factors can impact this relationship.

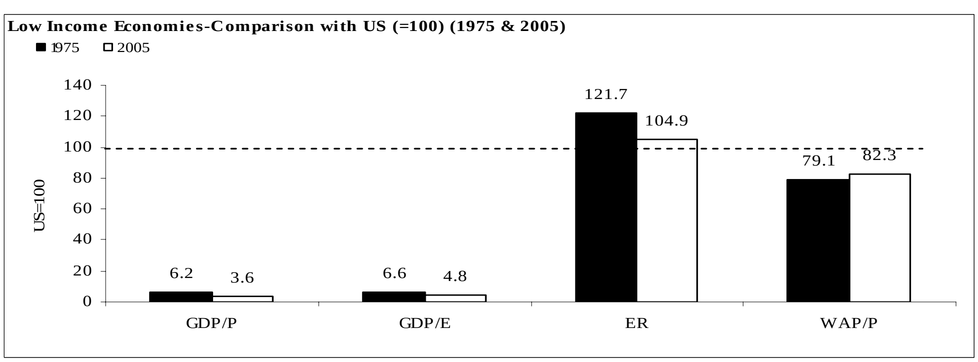
Productivity growth and changes in labor intensity can also be viewed from a comparative perspective by focusing on relative levels. We present relative performance of different income groups economies in labor productivity and per capita income as a percentage of the US level in Figure 4.4 below for the years 1975 and 2005. For per capita income and labor productivity, there exists a significant gap between US and other income group economies. Comparison of the performance of these income groups for the years of 1975 and 2005, shows that in 2005, only high income economies managed to reduce the gap with the US productivity level while in all other income groups, this gap has further widened. In 1975, employment rate in high, upper middle and low income economies was higher than in the US, while in 2005 only low income economies have employment higher than the US. The lowest level of labor productivity in low income economies in comparison with the US reflects the less productive employment growth and it also indicates the presence of a strong high tradeoff between employment and productivity in these economies.

Figure 4.4: Comparison of per capita income, productivity and labor market indicators with US (=100) (1975 & 2005)









Note: GDP/P =per capita income, GDP/E= labor productivity, ER= Employment Rate and WAP/P = ratio of working age population to total population

To analyze the impact of financial and economic crises (2007-09), the latest trends in growth in labor productivity, employment and output for the different regions of the world are presented in Table 4.4A in the appendix. The current global financial crisis, which started in 2007, has led to a decline in output growth in most of the economies around the world. Labor productivity growth reduced for all income groups in 2008, which resulted in a decline in output growth. The Conference Board (2009) shows that world productivity growth slowed sharply in 2008 and is set to decelerate further in 2009 as the global recession deepen. However, this crisis is more severe for high income developed economies as compared to emerging economies. Generally, the pro-cyclical nature of productivity growth (higher in a boom and lower in a recession) can be observed from Table 4.4A in the appendix.

The regional level analysis suggests that the impact of the recent crisis differs widely across regions and depends upon various factors e.g. country reliance on international trade, dependence on natural resources, financial liberalization of banking system and fiscal resources at government disposal (The Conference Board, 2009). Although the productivity growth is affected in almost all regions, the adverse effects of the financial crisis are more visible in developed regions, i.e. North America, Western Europe and Japan. There is a significant decline in employment and productivity growth in these regions, for example, labor productivity growth in high income economies declined from 1.38 in 2006 to 0.57 in 2008.

In 2009, the global crisis resulted in a rapid decline in output, job losses and high unemployment rate in most economies but the productivity effect in developing and emerging economies is relatively low so far as compared to high income economies. However, for coming out of the recession and to achieve a sustainable productivity growth, there is a need for investment in tangible and intangible capital and for proper government responses around the world.

4.4 Empirical analyses

The empirical strategy focuses on the relationship between productivity and participation. We follow the methodology adopted by McGuckin and Van Ark (2005), mainly because we are not only interested in the intensity of tradeoff between employment and productivity growth but also in the duration of this tradeoff. As discussed above for equation (4.1), we start with a simple accounting identity that includes per capita income. So we can rewrite the identity in equation (4.1) as

$$\left(\frac{Y}{H}\right) = \frac{\left(\frac{Y}{P}\right)}{\left(\frac{H}{E}\right)\cdot\left(\frac{E}{P}\right)} \tag{4.3}$$

and equation (4.3) in terms of growth as

$$\Delta\log\left(\frac{Y}{H}\right) = \Delta\log\left(\frac{Y}{P}\right) - \Delta\log\left(\frac{H}{E}\right) - \Delta\log\left(\frac{E}{P}\right) \tag{4.4}$$

Since this is an identity, it cannot be estimated in order to assess the effect of a change in either right hand side variable to labor productivity growth. Since the dependent variable consists of Y/H and the first two terms on the right hand side of (4.4) might cause endogeneity problems since they also consist of Y and H, we move these two terms to the error term. So our equation for estimation in restricted form is:

$$\Delta\log\left(\frac{Y}{H}\right) = \beta_0 + \beta_1\Delta\log\left(\frac{E}{P}\right) + \varepsilon \tag{4.5}$$

For estimating this model we use overlapping[7] panels of different time spans ranging from annual data to 10 years. Each equation is estimated without and with initial productivity levels (taken at the beginning of each time span) and country specific fixed effects. The initial labor productivity level is included as a control variable to capture the catching up phenomenon of developing economies. Our alternative equation (with controls) for estimation is

[7] Overlapping time spans are e.g. years 1-3, 2-4, 3-5, 4-6, to define growth periods for participation in the regression analysis.

$$\Delta \log\left(\frac{Y}{H}\right) = \beta_0 + \beta_1 \Delta 1og\left(\frac{E}{P}\right) + c * D_j + d * \left(\frac{Y}{H}\right)_{j,to} + \varepsilon \tag{4.6}$$

where j stands for the country and t stands for the period over which growth is measured. The measurement time span will consist of 1, 2, 3, 5, 7 and 10 years. As mentioned in the previous section, the employment to population ratio is used to measure labor force participation and will be referred to as the employment rate from here onward. GDP per employed person is our measure for labor productivity and as mentioned above our data is from The Conference Board and the Groningen Growth and Development Center.

Econometric problem of analysis

One potential problem is that of endogeneity of the employment rate (Becker and Gordon, 2008; Bourles *et al.* 2010). To test for that, we applied different estimation methods. Results are presented in Table 4.3.

Column 1 in Table 4.3 presents the result of simple ordinary least squares (OLS) without country specific fixed effects and any control variable. In column 2, we include country specific fixed effects and the initial level of labor productivity. The coefficient of the change in the employment rate is negative, significant and very close to the value that has been reported in column 1.

The instrumental variable approach is applied in column 3 to correct for potential measurement error and simultaneity bias. We instrument the change in the employment rate by a first and second lag of the change in employment rate and a lagged value of GDP per capita. The Sargan test is used to evaluate the relevance and validity of these instruments. The test statistic and corresponding p-value is also presented. The test results point out that our instruments are valid and relevant. To test the hypothesis that the specified endogenous regressor can actually be treated as exogenous, we ran the Davidson and MacKinnon (1993) test of exogeneity for a regression equation with fixed effects. The null hypothesis states that an ordinary least squares estimator of the same equation will yield consistent estimates: that is, any endogeneity among the regressors would not have deleterious effects on OLS estimates. A rejection indicates that the instrumental variables fixed effects estimator should be employed. Since the five-percent critical value of this density function is 3.04, the null cannot be rejected, which implies that the change in employment rate may be treated as an exogenous explanatory variable and that the OLS estimator produces unbiased results.

Table 4.3: Effect of change in employment rate on value added per employed growth

Dependent variable is growth in value added per person employed				
	TSCS	Ordinary Least Squares Fixed Effects Model	Instrument al Variable Approach	Generalized Method of Moments
	I	II	III	IV
Change in Employment to population ratio	-0.682***	-0.705***	-0.707***	-0.791***
	(12.062)	(12.631)	(3.102)	(15.447)
Initial level of labor productivity		0.000	0.000	0.000
		(0.578)	(1.473)	(0.699)
Constant	1.661***	2.025***		1.623***
	(13.941)	(3.252)		(11.206)
Number of observations	1170	1170	1080	1170
Number of countries	45	45	45	45
Sargan statistic			6.48	
P-value			0.096	
Davidson Mackinnon test of exogeneity			0.146	
P-value			0.701	
Endogeneity test statistic			0.14	
P-value			0.70	

*** significant at 1 percent,** significant at 5 percent,* significant at 10 percent
In column 4, the employment rate is instrumented by the first and the second lag of change in employment to population ratio and the lagged value of GDP per capita

The coefficient estimates in column 3 quite similar to those we obtained from the OLS method in column 1. This may be also due to the fact that we have large sample size.[8] (Bourles *et al.* 2010). Following Belorgey *et al*. (2006), we have also applied the generalized method of moments (GMM) as a robustness check, the estimation results are presented in column 4 of Table 4.3. The results remain very similar and reconfirm that OLS fixed effects model gives robust results. In following sections we will therefore use this estimator. The relationship between productivity and participation is evaluated in

[8] Previous studies (Belorgey, 2006; Bourles and Cette, 2007; Becker and Gordon, 2008) are based on a small number of high income OECD countries and find that the coefficient estimates vary while using different estimation methods.

more extensive framework in Chapter 5 where we bring in additional explanatory variables.

Panel estimation results

We apply the panel approach to measure the relationship between the change in the employment rate and productivity growth. The basic panel analysis results are presented in Table 4.4, in which growth in labor productivity is a dependent variable and the change in the employment rate is our independent variable. To evaluate the change in this tradeoff over the past decades we estimate the model for two time periods, 1980-2005 and 1995-2005. We estimate the tradeoff between participation and productivity with and without control variables. The first and third columns in Table 4.4 show the results of simple regressions without any control variable. The second and fourth columns show the regression results with controls. We use the initial productivity level and country fixed effects as control variables. The top panel of the table provides the results for the impact of participation on labor productivity (GDP per employed growth). There is a strong tradeoff between participation and productivity and it remains significant even after 10 years both in controlled and uncontrolled estimation results. During 1995-2005, the tradeoff between participation and employment is still significant statistically but its economic impact has decreased.

The bottom panel of Table 4.4 presents the result of the impact of increased participation on per capita income growth. The impact of the participation (employment to population ratio) is positive and significant for nearly all time spans (measurement intervals) in the uncontrolled regressions as well as the controlled regressions. The positive impact of participation on per capita income is higher in the recent time period of 1995-2005 as compared to 1980-2005 (see column 4 in the bottom panel of Table 4.4). Regression results with controls (grey area in Table 4.4 are our main results as they include the country specific fixed effects which capture the impact of unobserved control variables in our model.

Our finding of the existence of the tradeoff between labor productivity and participation growth rate is in consonance with previous studies (Beaudry and Collard, 2002; Belorgey *et al.* 2006; Becker and Gordon, 2008). However, all these studies focused on the tradeoff between employment and productivity among highly developed and industrialized economies only. In the case of developed economies, this tradeoff is short term and fades away in less than 5 years (McGuckin and van Ark, 2005; Broersma, 2008). As in our sample of 45 countries, most economies are developing countries so the tradeoff persists even after 10 years for the period 1980-2005. Our sub period analysis of 1995-2005 shows that this tradeoff becomes weaker as compared to coefficients of whole period analysis. The elasticity estimates for the employment rate to productivity tradeoff ranges from -0.32 to -0.78 in all cases. This means that the increase in productivity is not by definition translated in an increase in per capita income in case of developing and low income economies.

To check the robustness of the relationship between participation and productivity growth, we evaluated the impact of various participation indicators (raw employment growth, employment/labor force, employment/working age population, labor force/working age population and labor force to total population ratios). Table 4.5A in the appendix shows the results, which reconfirm the existence of a strong tradeoff between participation and productivity.

4.5 The impact of age and gender on the tradeoff

To evaluate the tradeoff between productivity and participation, not only quantitative but also qualitative factors of labor force are important. In this section we test the hypothesis whether a disaggregation of the labor force participation rate into different gender, age groups and skill levels affects the determination of this tradeoff. Educational data of the employed labor force is not available for most developing economies, but we can evaluate the impact of gender and different age groups on the productivity-participation tradeoff. As data on the employment rate by gender and by different age groups is not available either, we will use information on female labor force participation and participation by different age groups provided by the ILO. Some cautions are needed when interpreting these results because the model estimates the impact of female participation and of different age groups on the overall labor productivity level, and not specifically on the productivity level of that particular group.

Table 4.4: Effect of change in employment/population ratio on growth in value added per person employed				
	1980-2005		**1995-2005**	
	Uncontrolled	Controlled	Uncontrolled	Controlled
	I	II	III	IV
Annual	-0.682 (12.06)**	-0.705 (12.63)**	-0.689 (8.18)**	-0.353 (4.04)**
2-year	-0.600 (10.07)**	-0.636 (11.00)**	-0.795 (9.56)**	-0.485 (5.59)**
3-year	-0.586 (9.46)**	-0.616 (10.36)**	-0.774 (8.67)**	-0.34 (3.54)**
5-year	-0.577 (8.77)**	-0.639 (10.41)**	-0.941 (9.30)**	-0.386 (2.29)**
7-year	-0.517 (7.43)**	-0.634 (9.03)**	-1.05 (9.21)**	-0.328 (2.50)**
10-year	-0.455 (5.79)**	-0.78 (10.84)**	-	-
Effect of change in employment/population ratio on growth in value added per capita				
Annual	0.349 (6.182)**	0.327 (5.901)**	0.36 (4.31)**	0.695 (8.05)**
2-year	0.431 (7.25)**	0.401 (6.67)**	0.256 (3.10)**	0.562 (6.57)**
3-year	0.445 (57.20)**	0.416 (7.063)**	0.276 (3.11)**	0.695 (7.29)**
5-year	0.454 (6.91)**	0.367 (6.08)**	0.105 (1.04)	0.626 (5.38)**
7-year	0.512 (7..36)**	0.342 (5.46)**	0.05 (0.04)	0.66 (5.12)**
10-year	0.577 (7.343)**	0.156	-	-

Note: Controlled regressions include country fixed effects and initial level of labor productivity. The coefficient of initial level of labor productivity is not reported here.
Grey are preferred results.
Absolute value of t statistics in parentheses.
** significant at 1 percent,* significant at 5 percent

The impact of female participation on productivity growth is negative and significant for nearly all time spans during the 1980-2005. The estimation result for annual observation in column 1 implies that a one percent variation in the female participation rate changes labor productivity per worker by -0.31 percent. This tradeoff exists up to three years for the recent time period 1995-2005 (see first two columns in Table 4.5**)**. After three years the tradeoff for females turns insignificant. The negative impact of female participation is probably due to a lack of education and skills, less experience (i.e., more entry and exit from labor market due to family responsibility) and an overrepresentation of jobs in low productivity sectors.

Table 4.5: Effect of change in labor force participation on value added per employed growth

	Females		**15-24 years old**		**55-64 years old**	
	1980-2005	1995-2005	1980-2005	1995-2005	1980-2005	1995-2005
	I	II	III	IV	V	VI
Annual	-0.31 (4.82)***	-0.23 (2.88)***	-0.27 (5.65)***	-0.06 (1.16)	-0.13 (3.11)***	-0.11 (1.77)*
2-year	-0.33 (4.04)***	-0.27 (2.17)**	-0.33 (4.97)***	-0.10 (1.17)	-0.04 (0.70)	-0.11 (1.17)
3-year	-0.36 (3.64)***	-0.43 (2.47)**	-0.37 (4.29)**	-0.17 (1.40)	-0.04 (0.69)	-0.19 (1.53)
5-year	-0.35 (2.65)**	-0.46 (1.54)	-0.43 (3.57)***	-0.25 (1.34)	-0.05 (0.53)	-0.23 (1.14)
7-year	-0.41 (2.45)**	-0.54 (0.87)	-0.43 (2.76)***	-0.08 (0.18)	-0.05 (0.53)	-0.24 (0.68)
10-year	-0.10 (0.40)	-	-0.34 (1.48)	-	-0.002 (0.014)	-

Note: as mentioned in table 4.3.
** significance at 1 %
* Significance at 5 %. .

Similarly, the young and aged workers are considered as less productive on average than middle-aged workers. Younger workers are new entrants in the labor market and lack experience while aged workers may be characterized by lower ability to deal with new problems and age-related health issues. However, the argument can also be made that young workers come to the labor market with up-to-date knowledge, whereas skilled and aged workers are more productive because of on-the-job learning and experience over the years.

The estimation results indicate that the impact of the young labor force (aged 15-24 years) is negative and significant. After 1995, this tradeoff is no more significant (see column four in Table 4.4). Similarly, aged workers' participation impacts the productivity negatively for all time spans, although gradually there is decline in intensity of the tradeoff. For the period 1995-2005, the tradeoff between aged workers participation and productivity disappears even after one year (see last two columns of Table 4.5).

Extending the analysis to examine the differences in the tradeoff for economies and regions belonging to different income ranges, we used the same specification as above. The estimation results by income ranges and for different regions are presented in Table 4.6. We make three observations on the basis of the results in Table 4.6. First, during 1980-2005 the tradeoff between productivity and participation remained significant for all time spans and all income categories, except for high income group economies. In the latter group, the tradeoff between participation and productivity fades away in less than five years. When we consider the sub period of 1995-2005, there is no tradeoff for high income economies and upper middle income economies during this period. For lower middle income economies and lower income economies, the tradeoff becomes insignificant after five years. Second, the value of the participation coefficient becomes higher as we move from high income economies towards low income economies. In other words, the negative impact of increased participation is high in low income economies compared to high income groups. Third, the negative and significant value of the participation coefficient is lower in the sub period 1995-2005 as compared to 1980-2005, which indicates that the negative impact is declining over the time. The analysis above shows that the tradeoff between productivity and participation is large in low income economies as compared to advanced and developed economies.

Table 4.6: Effect of employment/population growth on labor productivity (GDP/employed) growth by income group

	High Income Economies		**Upper Middle Income Economies**		**Lower Middle Income Economies**		**Low Income Economies**	
	1980-2005	1995-2005	1980-2005	1995-2005	1980-2005	1995-2005	1980-2005	1995-2005
Annual E/ P Growth	-0.171 (3.03)**	0.035 (0.40)	-0.560 (4.94)**	-0.36 (2.53)*	-0.987 (9.78)**	-0.802 (5.46)**	-1.679 (5.91)**	-1.508 (3.91)**
2- years E/ P Growth	-0.147 (2.96)**	-0.10 (0.14)	-0.367 (3.01)**	-0.21 (1.25)	-1.08 (10.17)**	-0.58 (3.57)**	-1.83 (6.19)**	-0.88 (2.56)*
3- years E/ P Growth	-0.111 (2.38)*	-0.03 (0.44)	-0.33 (2.57)*	-0.21 (1.06)	-1.18 (10.53)**	-0.54 (3.15)**	-1.78 (4.57)**	-0.92 (2.29)*
5-years E/ P Growth	-0.059 (1.37)	-0.09 (1.15)	-0.445 (3.21)**	-0.36 (1.45)	-1.22 (10.77)**	-0.48 (2.45)*	-2.16 (4.33)**	-1.78 (2.36)*
7-years E/ P Growth	-0.002 (0.06)	-0.12 (1.13)	-0.46 (3.26)**	-0.28 (1.24)	-1.18 (10.34)**	-0.37 (1.68)	-1.76 (3.62)**	-1.14 (1.20)
10-years E/ P Growth	-0.08 (1.27)	-	-0.58 (3.74)**	-	-0.916 (10.41)***	-	-1.74 (3.27)**	-

Note: These regressions are based on overlapping panel and include initial level of labor productivity and country specific fixed effects.
High Income Economies: Australia, Belgium, Canada, France, Italy, Japan, Netherlands, New Zealand, South Korea ,Spain ,Hungary, UK and USA
Upper Middle Economies: Argentina, Brazil, Bulgaria, Chile, Malaysia, Mexico, Poland, Romania, South Africa and Turkey
Lower middle Income Economies: Albania, China ,Colombia, Ecuador, Egypt, Indonesia, India , Morocco, Peru , Philippines, Sri Lanka, Syria, Thailand and Tunisia
Low Income Economies: Bangladesh, Kenya, Madagascar, Nigeria, Pakistan, Tanzania, Zambia and Zambia.

A comparison of our results (for high income group economies) with the findings from Belorgey *et al.* (2006), shows that our estimated coefficient of participation on productivity is considerably smaller (-0.17) than their estimate of (-0.37). The comparison of our high income group results with the analysis by McGuckin and van Ark (2005) for 36 OECD countries shows similarity in terms of coefficient value (-0.21) as well as for the period of this tradeoff. Our analysis also suggests that this tradeoff disappears in less than five years for the high income economies. Broersma (2008) presents similar findings for Europe and for Anglo-Saxon countries.

4.6 Summary and policy conclusions

This chapter has analyzed the existence of a tradeoff between productivity and participation for the period 1980-2005 and the sub-period 1995-2005, across different regions of the world. We find the tradeoff to exist in most parts of world but its strength varies across countries and with different income ranges. Moreover, this tradeoff becomes insignificant or very low in 1995-2005 as compared to 1980-2005 in all economies, except for transition economies. In developed or high income economies the tradeoff is weak and low as compared to other income groups. This implies that in developing economies along with the emphasis on labor productivity growth there should be some short term and medium term arrangement for the productive absorption of the existing and new entrants of workers. Regional analysis shows that Africa is trapped in a low productivity trap because of unproductive employment growth whereas the Southeast Asian region performed well with positive employment and productivity growth during the period under analysis.

Previous studies suggest that this diversity in the pattern of tradeoffs can be explained by differences in human capital investment, demographic dynamics, structural transformation phases and dissimilar labor market institutions between transition and developed countries (Bresnahan *et al.*, 2002; Nicoletti and Scarpetta, 2003; Cavelaars, 2004; Cette, 2004 and Van Ark *et al.*, 2008). Extensive analysis of these variables will be considered in the next chapter.

To reduce the productivity-participation trade-off in the short or medium run and to realize the long term growth potential, there is a need for the working of market forces which allocate resources more productively and efficiently. While job growth may initially suffer, the productivity growth will bring prices down and create access to goods and services for a broader group of the population. As this creates new demand, the opportunities for creating productive jobs will ultimately increase, putting in motion a positive spiral of job and productivity growth. As this mechanism is not working automatically in transition and developing economies, there is a need of creating an environment which can alleviate/ reduce the negative short /medium term effects without affecting the long run growth potential. This can be done by facilitating the creation of jobs in infrastructure and other investment enriching sectors or by developing a national strategy for productivity growth. But focus should be on productivity enhancement along with employment growth as it will be the only way to achieve sustainable economic growth and better standard of living in long run.

Chapter 5

Age Dependency and Labor Productivity Divergence[1]

5.1 Introduction

This chapter explores the relationship between the age composition of the population and labor productivity. This relationship is important, because countries are almost continuously passing through different demographic phases. While developed nations are characterized by a rapidly increasing aging population share, youth dependency in developing and emerging economies is still quite high, despite a declining trend. A better understanding of how these changes in age composition affect labor productivity growth is very important for a meaningful analysis of economic growth potential and realization.

In this chapter, we use a panel of up to 110 countries[2] to examine the determinants of labor productivity (output per worker) growth over the period 1980-2005. Along with other socio-economic determinants of labor productivity growth, our main focus is on the role played by changes in the demographic structure of a country. There is a large body of literature on demographic transition and economic growth, suggesting that an increase of the working age population share or a decline of the dependent population can promote economic growth. Examples are Sarel (1995), Bloom and Williamson (1998), International Monetary Fund (2004), Kelley and Schmidt (2005) and Choudhry and Elhorst (2010). The effects of participation and of the age composition of the labor force

[1] The author is thankful to Bart van Ark, Paul Elhorst, Dirk Bezemer and participants of the European Economic Association Conference, 2009, held in Barcelona, Spain for their valuable comments and suggestions. The usual disclaimer applies.

[2] The sample of countries varies from 71 to 110 countries depending on data availability of the explanatory variables.

on labor productivity have also been analyzed, see Kogel (2005), Feyrer (2007) and Choudhry and Van Ark (2010). The hypothesis we test in this chapter is whether the age structure of the total population not only directly affects cross-country labor productivity growth differentials but also indirectly affects the effectiveness of other determinants of labor productivity growth. To our knowledge no other study has investigated this hypothesis before. Except for considering both advanced and developing economies, we also analyze whether the effects in high-income OECD[3] are different from those in other countries.

We focus on labor productivity and factor inputs (other than labor) rather than total factor productivity (TFP). We decided to follow this approach rather than investigating the efficiency by which these inputs are being used, since TFP remains a residual factor in growth empirics. Nevertheless, it is recognized that TFP plays an important role in explaining cross-country differences in output per capita (see e.g. King and Levine, 1994; Prescott, 1998; Hall and Jones, 1999; Kogel, 2005; Islam, 2008). Kogel (2005) find that high youth dependency affects the total factor productivity through the channel of lower savings and consequently lower spending on research and development.

Our results show that child dependency has a stronger adverse effect on labor productivity than old age dependency. In addition, higher age dependency impacts labor productivity growth negatively not only directly but also indirectly by modifying the impact of other social, economic and infrastructural determinants. More specifically, we find that the marginal effects of gross capital formation, labor market reforms, and information and communication technology investment are statistically significant and higher at lower levels of age dependency. These findings hold for both developed and developing economies. Conversely, the marginal effect of financial development increases at higher levels of age dependency but is statistically insignificant. On the other hand the marginal effect of financial development at higher levels of age dependency in high income countries appears to be greater than in other countries.

[3] For the sake of brevity, we will refer to high-income OECD countries as developed economies in the rest of the chapter, while other economies will be referred to as developing economies.

The remainder of this chapter is organized as follows. Section 5.2 discusses labor productivity growth trends across countries and regions during 1980-2005. It also presents a brief literature review of labor productivity determinants to provide a rationale for the selection of the explanatory variables in our empirical analysis. Section 5.3 presents the empirical framework and provides an overview of the data. Section 5.4 presents the empirical results and their implications. Section 5.5 offers various sensitivity analyses and robustness checks. Section 5.6 concludes the chapter.

5.2 Labor productivity trends across regions

In this section, we present labor productivity growth trends across different regions during 1980-2005. As productivity growth not only varies across regions, but also within regions, there is a reasonable diversity with respect to productivity performance. To examine the performance of labor productivity across regions and income groups, we use the Labor Productivity Index (LPI) which is graphed in Figure 5.1.[4] The figure shows that Africa‘s productivity growth performance is the worst of all regions. It is the only region in which labor productivity fell since 1990. The best performing regions are the Southeast and East Asia. In these regions all economies registered an increase in productivity during the 1990s. In East Asia, all economies were more or less on the same growth path until 1993, but since then China’s productivity growth increased more rapidly. The South Asian region has also seen improvements in terms of productivity growth, especially since 1990, because of the impressive labor productivity growth figures in India. India’s output per person employed increased by more than 75 percent during 1990-2005, which was faster and far better than in its neighboring countries.

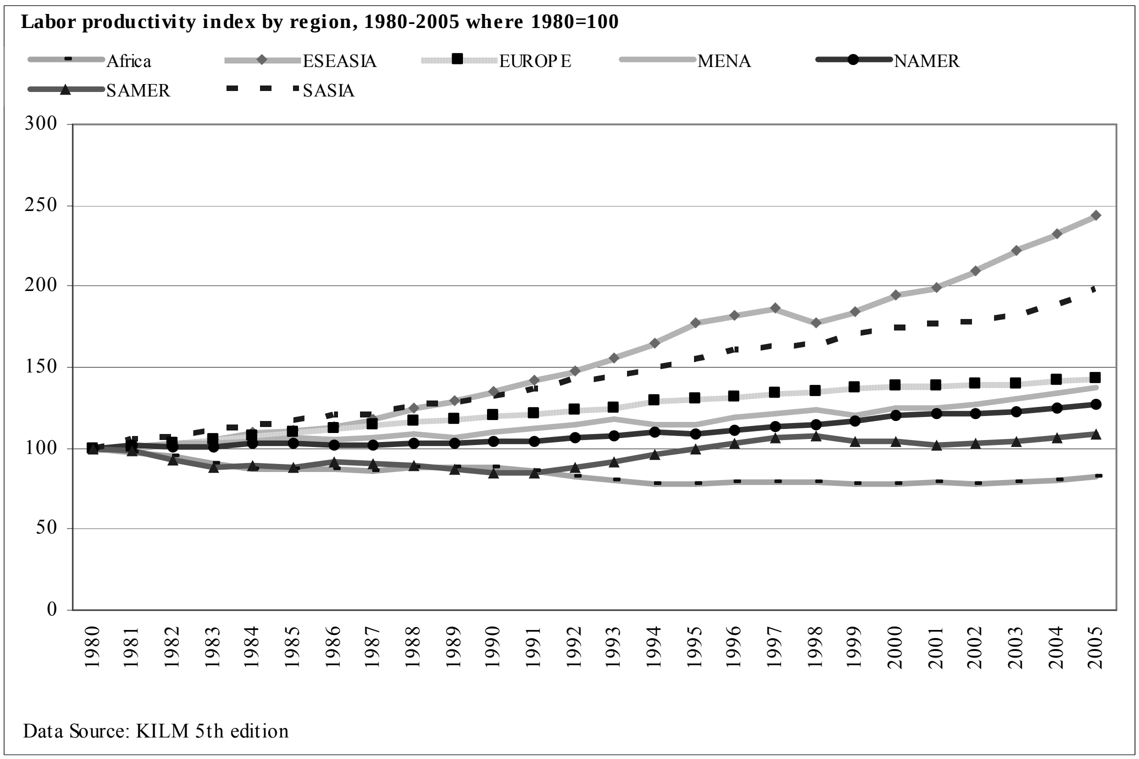
Determinants of labor productivity

There is a large theoretical and empirical literature on the determinants of labor productivity. In this section we review a selection of these studies, especially those focusing on the variables considered in the empirical part of this chapter. The literature has mainly used two methods of analysis. The first one is a short term business cycle approach. In this approach, productivity growth is mostly related to employment growth (Beaudry and Collard, 2002; Becker and Gordon, 2008 and Choudhry and Van Ark,

[4] We set labor productivity to 100 in year 1980.

2010). The second one can be described as the long term growth approach. Starting from Solow's neoclassical growth model, these studies focus on the main determinants of labor productivity growth (or per capita income growth, as a proxy) both in the steady state as well in the transition state. In conditional convergence versions of the Solow model, other exogenous variables have also been considered in this literature (Barro, 1991).

Figure 5.1: Labor productivity index (1980-2005), output per person employed (1980=100)



Note: ESEASIA= East and Southeast Asia, MENA = Middle East & North Africa, NAMER= North America, SAMER= South America and SASIA= South Asia

The number of studies investigating the effect of the age structure on aggregate productivity growth is limited. Some studies focus on the impact of the age structure on economic growth (Bloom and Williamson, 1998; Choudhry and Elhorst, 2010), or on firm (plant) productivity (Skirbekk, 2003; IImakunnas and Maliranta, 2005). Others examine the effect of the age structure of the labor force on labor productivity (Feyrer, 2007; Choudhry and Van Ark, 2010). In addition, Kogel (2005) finds that a negative relationship between youth dependency and total factor productivity. Finally, some studies find that the age structure of the entire population affects output (Sarel, 1995; Persson, 2002).

This chapter differs from the studies mentioned above in that it focuses on the impact of the age composition of the entire population on labor productivity (while other studies mainly evaluate the impact of the age composition of the working population on labor productivity), and because it considers an interactive model of age composition with other determinants (explanatory variables) of labor productivity. We will show that these determinants not only have a direct effect on labor productivity but due to these interactions also indirect effects conditional on the age composition of the total population.

In this study[5], we evaluate the impact of gross capital formation, financial development, ICT development and labor market reforms on labor productivity growth. However, since other socioeconomic indicators have also played an important role in recent growth studies (Barro, 1995; Bourlès and Cette, 2007; Islam, 2008; Marelli and Signorelli, 2010), we also consider several additional control variables, such as labor force participation rate, human capital, infrastructure development, openness and inflation.

The most discussed variable in recent studies as a potential determinant of labor productivity is ICT investment (Van Ark *et al*., 2003; Belorgey *et al*., 2006; Jorgenson, 2007). These studies find that ICT investment and diffusion can explain part of productivity differential between Europe and the U.S. We therefore incorporate ICT expenditure as a percentage of GDP as an explanatory variable. The positive impact of new technologies for developing economies also depends on the availability of skilled labor (Acemoglu and Zilibotti, 2001). It has been argued that many technologies adopted by developing economies, which are developed in the OECD economies, are complementary to the skill set of these richer countries' workforces. Low income developing economies often lack these skilled workers for an efficient utilization of these

[5] Our dependent variable is labor productivity (output per worker) growth, our independent variables are age dependency, gross capital formation, financial development (domestic credit provided by the banking sector as percentage of GDP), ICT development (ICT expenditure as percentage of GDP), labor market reforms (labor market reforms index), participation rate (total employment/total population) and inflation rate.

technologies, which reduces the positive impact these countries might obtain of a relatively young labor force. The technology-skill mismatch could account for a large part of observed output-per-worker differences around the world.

Labor Market Reforms (LMR) is another determinant that might improve the performance of labor markets. We are evaluating LMR's role at different levels of age dependency. Our hypothesis is that labor market reforms can promote labor productivity in countries where the working age population share in total population is relatively high. In addition, financial sector development may promote economic growth and labor productivity by providing better access to funding opportunities for highly productive and efficient projects. Our hypothesis is that financial services can be better utilized if the share of productive population in total population is higher.

5.3 Model specification

The dependent variable in our model is labor productivity growth, measured as the change in output per employed person. Alternatively, as a part of the sensitivity analysis, we consider output per hour as the dependent variable. In our baseline model, we assume that labor productivity is dependent on several economic indicators, labor market institutions, age composition of population, financial development and the growth in information and communication technology (ICT) in an economy. We test whether these determinants have a direct impact on labor productivity as well as an indirect impact conditional on the age composition of the total population. So our baseline model is

$$\Delta \mathrm{LP}_{\mathrm{it}} = \alpha_{\mathrm{i}} + \beta_1 \Delta ER_{it} + \beta_2 IPEY_{it} + \beta_3 INF_{it} + \beta_4 AD_{it} + \beta_5 AD_{it}^{\ 2} + \beta_6 \Psi + \partial_i + \tau_t + \varepsilon_{it} \qquad (5.1)$$

where i represents a country and t a time period. *LP* denotes labor productivity growth[6]; ΔER is the change in the broad participation rate measured as total employment divided by total population, *IPEY* is the initial level of labor productivity in an economy, *INF* is the inflation rate and *AD* is the ratio of the dependent population to the working age population. Ψ represents one of the variables of our interest[7] which includes gross capital

[6] LP is measured by taking the log difference of labor productivity at t and t-1.

[7] For these variables we want to check their effect on labor productivity at different levels of age dependency.

formation, ICT expenditure, labor market regulations and financial development. β_6 represents the corresponding coefficient of the variable of interest. ∂_i is a country fixed effect, τ_t is a period fixed effect and ε_{it} is an independently and identically normally distributed error term with zero mean and variance σ^2. Country fixed effects control for all country-specific, time-invariant variables whose omission could bias the estimates in a typical cross-sectional study. For example, these country specific fixed effects allow for different labor market institutions and cultural and social norms across countries. The justification for adding time-period fixed effects notes that they control for all time-specific, country-invariant variables whose omission could bias the estimation in a typical time-series study (see Baltagi, 2005).

To check whether the impacts of other productivity determinants are conditional on the age structure of the population, we introduce an interaction term between age dependency and one of the variables of our interest. Consequently, our model extends to

$$\Delta LP_{it} = \alpha_i + \beta_1 \Delta ER_{it} + \beta_2 IPEY_{it} + \beta_3 INF_{it} + \beta_4 AD_{it} + \beta_5 AD_{it}^2 + \beta_6 \Psi_{it} + \beta_7 \Psi_{it} * AD_{it} + \partial_i + \tau_t + \varepsilon_{it} \tag{5.2}$$

where $\Psi * AD$ is the interaction term of one of our variables of interest with age dependency. Since we are primarily interested in evaluating the effect of four explanatory variables and their interaction with age dependency, we will estimate four separate[8] models extended to include: 1) age dependency * gross capital formation; 2) age dependency * ICT expenditure; 3) age dependency * labor market reforms and 4) age dependency * financial development. For example, to determine the effect of ICT expenditure on labor productivity at different levels of age dependency we estimate the model

$$\Delta LP_{it} = \alpha_i + \beta_1 \Delta ER_{it} + \beta_2 IPEY_{it} + \beta_3 INF_{it} + \beta_4 AD_{it} + \beta_5 AD_{it}^2 + \beta_6 ICT_{it} + \beta_7 ICT_{it} * AD_{it} + \partial_i + \tau_t + \varepsilon_{it} \tag{5.3}$$

[8] We estimate four separate models for the following reasons: 1) to have a sufficient number of observations. For example, we have only 416 observations for ICT expenditure while we have more than 2000 observations for gross capital formation and financial development; 2) we have also carried out a regression analysis including all linear and interaction terms in one single equation. Although the number of observations declined significantly (361), the results were comparable. The estimation results are presented in Table 5.3A in the appendix.

As a next step we calculate the marginal effect of each variable of interest at different levels of age dependency. For this purpose we differentiate equation (5.2) with respect to that particular variable. Thus for the calculation of the marginal effect of ICT expenditure conditional on age dependency, we take the derivative of equation (5.3) with respect to the ICT variable to get

$$\partial LP / \partial ICT = \beta_6 + \beta_7 AD \qquad (5.4)$$

The marginal effect of other variables of interest can be calculated accordingly.

Data description and analysis

We use data on labor productivity (output per worker, measured as GDP per person employed) taken from The Conference Board and Groningen Growth and Development Centre.[9] Labor productivity levels vary significantly across countries. The average labor productivity level of high income economies was 11 times higher than that of low income economies in 1980. This difference in labor productivity increased further to 12.1 in 2005. We use the employment to population ratio as a measure of the labor force participation rate. This variable is taken from the TCB/GGDC database. In chapter 4 it was found that the relationship between labor productivity and the labor force participation rate is negative in the short term.

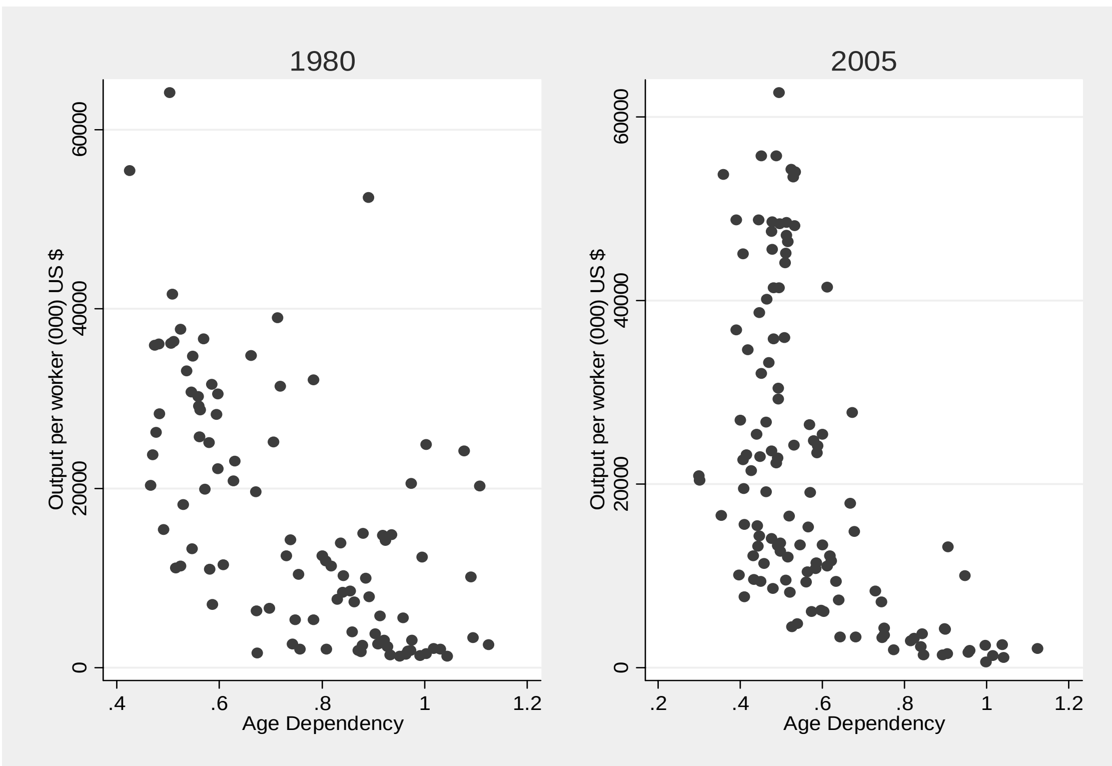
Age dependency is measured as the ratio of dependent population to working age population, which is obtained from the World Development Indicators. The dependent population is defined as the sum of the young population (0-14 years) and the aged population (65+ years). The working age population is measured by the population aged 15-64 years. To evaluate the relationship between labor productivity and age dependency, a scatter plot is presented in Figure 5.2 which suggests a negative and non-linear relationship between these two variables. We therefore included a square term of age dependency as an additional explanatory variable in our empirical model.

A comparison of age dependency and labor productivity performance for different income groups is presented in Figure 5.3. Age dependency in low income economies is nearly twice as high than that in high income economies. At the same time, labor

[9] Version June, 2009

productivity is relatively low compared to high income and upper middle income economies. Age dependency seems to have come down most rapidly in the upper and lower middle income countries.

Figure 5.2: Relationship (scatter plot) between labor productivity and age dependency (1980 & 2005)



As discussed above other potential determinants of labor productivity are macroeconomic indicators like labor market institutions, ICT development and financial development. Two macroeconomic variables will be included: (i) adjusted inflation as a proxy for changes in the price level and macro economic instability of a country;[10] and (ii) gross capital formation[11] growth to capture macroeconomic developments. Data on

[10] To adjust for extreme movements, we modify the inflation rate (P) as $\frac{P/100}{1+(P/100)}$.

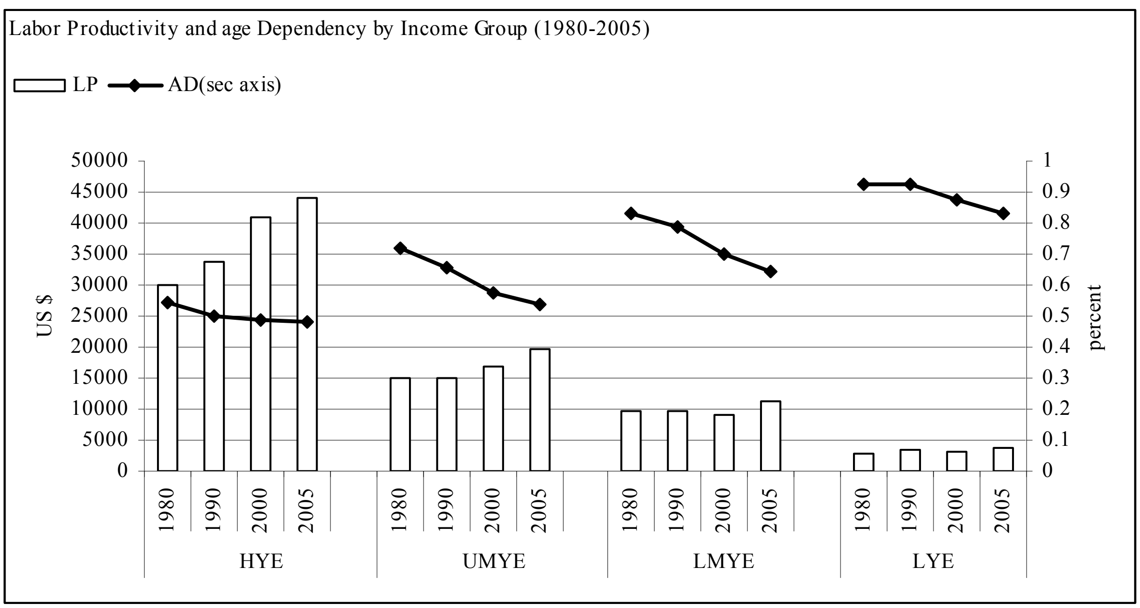
[11] Gross capital formation (formerly gross domestic investment) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories.

inflation and gross capital formation is taken from the World Development Indicators (WDI).

To evaluate the role of labor market institutions and regulations, we incorporate the Labor Market Regulations (LMR) index as an explanatory variable. LMR is a composite index based on six measures of labor market institutions (minimum wage, hiring and firing regulations, centralized collective bargaining, mandated cost of hiring, mandated cost of worker dismissal and conscription). The LMR index is an unweighted average of these six measures and its value varies from 1-10. Data on LMR index is taken from the Fraser Institute.[12]

Additionally, we use ICT expenditure as a percentage of GDP as a proxy for ICT development, and domestic credit by the banking sector as a percentage of GDP as a proxy for financial development. Both are taken from WDI.

Figure 5.3: Labor productivity and age dependency by country groups ranked according to average income



Note: LP is labor productivity measured as output per employed worker and AD is age dependency measured as ratio of dependent population to working age population.
HYE= High Income Economies, UMYE = Upper Middle Income Economies, LMYE= Lower Middle Income Economies and LYE= Lower Income Economies

[12] http://www.freetheworld.com

We also use a set of control variables suggested in previous studies on the determinants of labor productivity to check the robustness of our empirical model. We include the initial level of GDP per person employed to reflect the different levels of development that characterize each of the countries. Other control variables include employment in the agricultural sector, openness, foreign direct investment and infrastructure development. Data on these control variables is taken from the historical database of World Bank Development Indicators (WDI). We also used the corruption indicator to evaluate its importance for labor productivity growth.

The precise definitions and data sources of all variables used are given in Table 5.1A in the appendix. Summary statistics of the dependent variable and the independent variables are presented in Table 5.2A in the appendix. Table 5.1 reports the correlation matrix of our variables. The low correlation coefficients indicate that multicollinearity will not be a problem in our estimations.

Table 5.1: Correlation matrix between dependent variable and explanatory variables

	LP	PART	ILP	INF	GCF	ICT	LMR	FDEPTH	AD
Labor Productivity Growth (LP)	1.00								
Participation Growth (PART)	0.07	1.00							
Initial Labor Productivity Level (ILP)	-0.16	0.33	1.00						
Inflation (INF)	-0.12	-0.14	-0.29	1.00					
Gross Capital Formation Growth (GCF)	0.28	0.29	-0.05	-0.21	1.00				
ICT Expenditure	-0.04	0.13	0.24	-0.06	0.01	1.00			
Labor Market Regulations (LMR)	0.04	0.09	-0.04	-0.11	0.02	0.15	1.00		
Financial Depth (FDEPTH)	-0.10	0.24	0.43	-0.29	0.12	0.26	0.23	1.00	
Age Dependency (AD)	-0.18	-0.30	-0.45	0.22	-0.34	-0.03	0.05	-0.32	1.00

5.4 Empirical results

The estimation results are reported in Table 5.2. The results are based on annual data over the period 1980-2005 for a large number of countries at different stages of economic development. The number of countries in different specifications varies from 71 to 110 depending on data availability of the explanatory variables. The fixed effects model has been selected on the basis of the Hausman specification test (Baltagi, 2005). The Hausman test statistic points out that the fixed effects model should be used rather than the random effects model (see Table 5.2). To account for time specific effects, we introduced time dummies for five year periods.[13] To investigate the hypothesis that the country fixed effects are not jointly significant, we performed an F-test. The low p-value of F-test statistic in Table 5.2 suggests that we must reject this hypothesis.

First we carried out a regression analysis with age dependency, its quadratic term and other control variables without any interactive term (see columns 1 - 4 of Table 5.2). The F-statistics indicate an overall significance level of the models at 1 percent.

We find that the initial labor productivity level is significant and negative which reflects the conditional convergence in per capita productivity growth in our sample of countries. The impact of age dependency is negative and significant which implies that a higher dependency rate leads to a decline in labor productivity growth. The coefficient of the quadratic age dependency term is positive and statistically significant in two specifications (Model 1 & Model 4). Based on the marginal effect of age dependency, we see that a lower level of age dependency leads to a higher level of labor productivity.[14] The control variables have their expected signs. The impact of labor force participation (employment/ population ratio) growth on labor productivity is negative and significant.[15] This finding is consistent with the literature that evaluated the role of increasing rates participation on labor productivity (see e.g. Beaudry and Collard, 2003; Choudhry and Van Ark, 2010). As expected, higher inflation is negatively related to labor productivity growth, while higher gross capital formation and ICT development promote labor productivity. The impact of LMR is not significant (see column 3 of Table 5.2).[16]

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[13] Time dummy D1 takes the value 1 for 1981-1985 and otherwise is 0.

[14] Calculations were made by taking the derivative of equation (5.1) with respect to age dependency.

[15] To ensure that the effect of changes in age dependency on labor productivity growth is not simple due to labor force participation growth, we also excluded the labor force participation rate variable from the specification, and found that the impact of age dependency remained negative and significant. This is because the correlation between age dependency and labor participation rate is in fact quite low (-0.30).

[16] Before we turn to the results regarding the impact of various indicators conditional on age dependency, it is important to note that inference cannot be based on simple t-statistics because the model parameters do not provide substantial information in case of models with multiplicative terms (Brambor *et al*., 2006 and Shehzad and De Haan 2009). As Aiken and West (1991) point out, in interactive models we need to take the derivative of the model with respect to the variable of interest and evaluate its effect conditional on the means of other constituent terms part of the derivative.

Table 5.2: Impact of demographics on labor productivity

	Direct Model				Interactive model			
	1	2	3	4	5	6	7	8
Age Dependency	-0.414***	-0.937*	-0.08	-0.619***	-0.392***	-0.667	-0.004	-0.627***
	0.129	0.5	0.248	0.185	0.131	0.541	0.220	0.179
Age Dependency*Age Dependency	0.226***	0.416	-0.029	0.347***	0.213***	0.292	0.044	0.346***
	0.080	0.337	0.187	0.115	0.080	0.345	0.159	0.115
Change in Participation	-0.702***	-0.492***	-0.612***	-0.555***	-0.731***	-0.493***	-0.614***	-0.555***
	0.057	0.149	0.144	0.077	0.056	0.148	0.144	0.076
Initial level of labor productivity	-0.030***	-0.155***	-0.051***	-0.065***	-0.030***	-0.159***	-0.055***	-0.065***
	0.008	0.041	0.017	0.014	0.008	0.041	0.018	0.014
Inflation	-0.103***	-0.174**	-0.117***	-0.124***	-0.100***	-0.175**	-0.122***	-0.124***
	0.024	0.071	0.035	0.021	0.024	0.071	0.034	0.021
Change in Gross Capital Formation	0.001***				0.002***			
	0.000				0.000			
Gross capital Formation*Age Dependency					-0.001***			
					0.000			
ICT Expenditure		0.010**				0.026**		
		0.004				0.011		
ICT expenditure*Age Dependency						-0.026		
						0.016		
Labor Market Reforms			0.002				0.018***	
			0.003				0.005	
Labor Market Reforms*Age Dependency							-0.028***	
							0.009	
Financial Depth				-0.008				-0.02
				0.009				0.02
Financial Depth*Age Dependency								0.019
								0.041
Constant	0.474***	1.872***	0.582***	0.886***	0.463***	1.800***	0.554***	0.890***
	0.111	0.528	0.202	0.178	0.109	0.522	0.203	0.176
Significance of Fixed Effects								
P-value of F-statistics	0.001	0.000	0.002	0.001	0.003	0.002	0.005	0.001
Hausman Test	46.67	57.10	11.95	144.34	43.63	64.9	17.29	141.19
	0.000	0.000	0.051	0.000	0.001	0.000	0.011	0.000
Joint significance of Interaction and Constituent Term					29.6	4.57	4.03	4.27
					0.001	0.003	0.005	0.002
Number of observations	2111	419	621	2381	2111	419	621	2381
Number of Countries	110	71	106	115	110	71	106	115
R^2	0.402	0.257	0.253	0.261	0.410	0.263	0.261	0.260
F Statistic	59.779***	11.780***	6.832***	20.376***	51.938***	11.974***	6.473***	17.647***

Robust standard errors are reported below the coefficients.
Coefficient of financial depth is multiplied with 100 to make results presentable.
*** indicates significance at 1 percent level, ** indicates significance at 5 percent and * indicates a significance at 1 percent level

The coefficient of financial development (measured by domestic credit provided by the banking sector as a percentage of GDP) is negative but statistically insignificant. It may be due to the fact that a large number of countries in our sample are developing and emerging economies, where the financial sector is not yet fully developed and financial services' outreach is still limited. Time specific effects, although not shown in Table 5.2, are statistically significant in model 4 (with financial development included) both in the linear and interactive specifications of the model.

One potential problem of the estimation results reported in Table 5.2 is that of reverse causality between age dependency and labor productivity. To test for this potential problem, we apply an instrumental variable approach. For this purpose, age dependency is instrumented by child dependency lagged two years in time and population growth lagged five years in time. The validity of these instruments is tested by applying statistical tests. The corresponding estimation results are presented in Table 5.4A in the appendix. The Davidson test computes a statistic for the exogeniety of one or more regressors in a fixed-effect regression estimated via instrumental variables, the null hypothesis of which states that an ordinary least squares (OLS) estimator of the same equation would yield consistent estimates: that is, any endogeneity among the regressors would not have deleterious effects on OLS estimates. The high p-value that has been found indicates that there is no endogeneity problem in our model. The coefficient of age dependency remains negative and significant which is in line with our previous empirical findings.

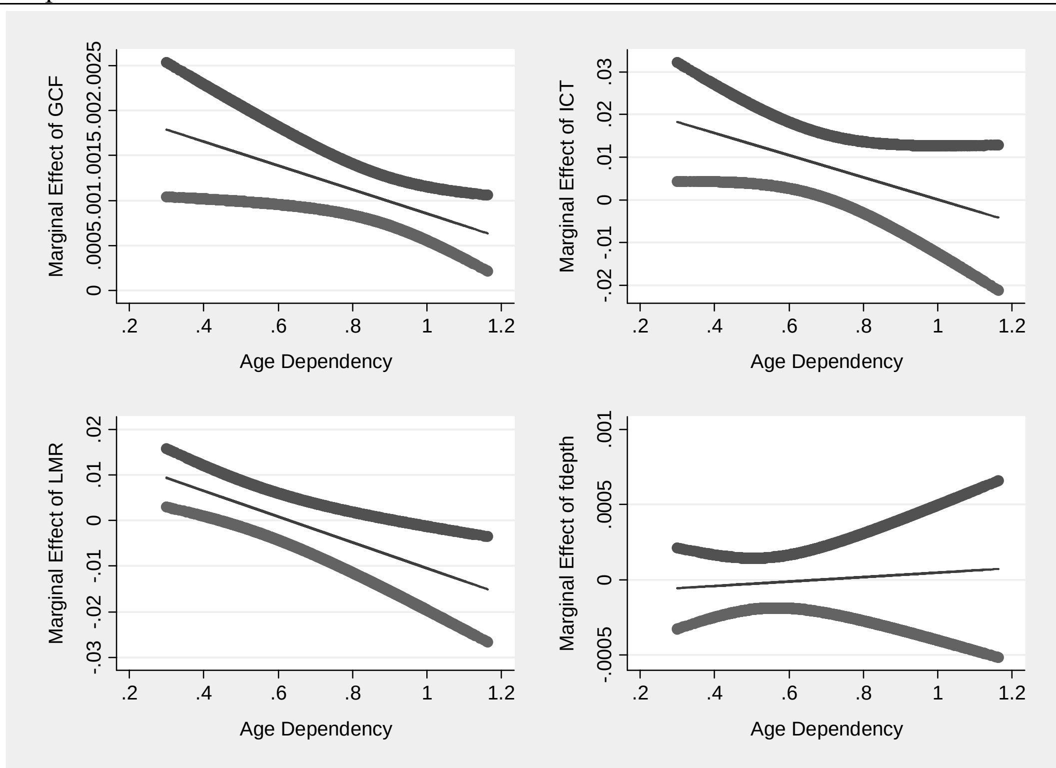
To investigate the other productivity determinants are also conditional on the age structure of the population, we introduced the interaction term of age dependency with gross capital formation, ICT development, labor market reforms and financial development. The estimation results are presented in columns 5-8 of Table 5.2. Our key hypotheses relate to the significance of the marginal effect of our variables of interest represented by Ψ on our dependent variable. By taking the first-order derivative of the dependent variable with respect to the variable of interest as mentioned in equation (5.4), we will get our hypothesis to test

$$H_0: \beta_6 + \beta_7 * AD = 0$$

$$H_1: \beta_6 + \beta_7 * AD \neq 0$$

Rejection of the null hypothesis implies that the impact of our variable of interest on labor productivity is significant and conditional on the size of age dependency. In order to assess the significance of these variables, we need to draw confidence intervals, for which standard errors can be calculated following the methodology of Aiken and West (1991).[17]

Figure 5.4: Marginal impact of gross capital formation, ICT expenditure, labor market reforms and financial development on labor productivity at different levels of age dependency - complete sample



This figure examines the impact of gross capital formation, ICT expenditure, labor market reforms and financial development on labor productivity growth at different levels of age dependency. These figures correspond to our main results as given in columns 5-8 of Table 5.2. The upper panels show the marginal effect of Gross Capital Formation (GCF) and ICT expenditure (ICT) and the lower panels show the marginal effect of Labor Market Reforms (LMR) and Financial development (fdepth) at different levels of age dependency.

[17] Technical details on calculating marginal effects and confidence intervals can be found in Brambor *et al* (2006).

On the basis of the results presented in columns 5-8 of Table 5.2, we consider the marginal impact of the multiplicative term. Figure 5.4 presents the marginal effect of various explanatory variables on labor productivity, conditional on different levels of age dependency. The solid line in each panel of Figure 5.4 shows the marginal impact of one variable of interest on labor productivity at different levels of age dependency. The 95 % confidence intervals around the solid line allow us to determine the conditions under which that variable has a statistically significant effect on labor productivity – that is, its effect is statistically significant positive (or negative) whenever the upper and lower bounds of the confidence interval are both above (or below) the zero line.

For example, the upper left panel in Figure 5.4 shows the marginal effect of growth in gross capital formation (GFC) on labor productivity at different levels of age dependency. This figure corresponds to the main result in the fifth column of Table 5.1. Downward sloping, statistically significant marginal effects of GCF reflect that as the age dependency level in an economy increases, the positive impact of investment on labor productivity growth will be lowered. A possible explanation for this significant downward sloping marginal effect is that a higher working age share offers the opportunity to utilize gross capital formation more efficiently, which in turns promotes labor productivity growth.

The marginal effect of ICT on labor productivity at different levels of age dependency is presented in the upper right panel of Figure 5.4 (corresponding to the results in column 6 of Table 5.2). The downward sloping marginal impact line suggests that ICT helps to promote labor productivity growth at lower levels of age dependency. If the dependency burden in an economy falls, it raises the positive role of ICT for productivity growth. Empirical results imply that a 1 % increase in ICT expenditure as a percentage of GDP at the average level of age dependency (0.66) raises labor productivity by 0.88 %. If age dependency is greater than 0.80, the ICT role towards labor productivity growth declines to 0.58 %. To absorb and utilize ICT development properly, an abundant skilled active labor force is apparently a basic requirement. However, this is difficult to fulfill in the presence of a large dependent population as many people are still in school or already retired so that skill demands do not match supply.

The effect of labor market regulations on labor productivity also changes at different levels of age dependency. Contrary to the results in the model without interaction term (column 3 of Table 5.2), we find that labor market regulations promote labor productivity in countries with a relatively large working age population, as well as that it increases its impact (see lower right panel of Figure 5.4). In countries with high dependency rates, the role of labor market regulations is relatively small in promoting labor productivity.

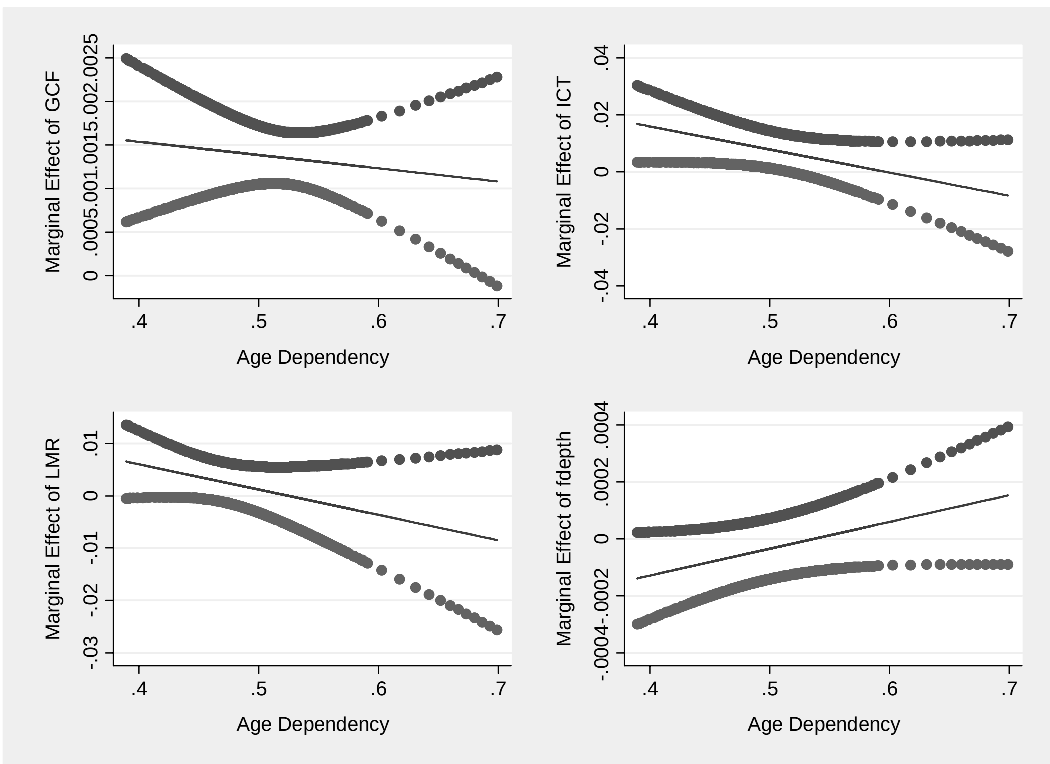
The role of financial development in promoting economic growth is greatly acknowledged in the literature (King and Levine, 1993; Nourzad, 2002; and Arizala *et al.*, 2009). However, there are some studies that have found a negative effect (Eichengreen and Arteta, 2000; Borio and Lowe, 2002). We use domestic credit by the banking sector as percentage of GDP as a proxy for financial depth (fdepth). Our results show that its marginal effect is slightly positive at high levels of age dependency. It reflects the fact that an increase in financial depth increases labor productivity if age dependency rises, although its coefficient is not statistically significant.

Overall, our empirical analyses provide empirical evidence in favor of the hypothesis that the age composition of the population matters. Our results indicate that higher age dependency impacts labor productivity growth negatively not only directly but also indirectly. More specifically, we find that the marginal effects of gross capital formation, labor market reforms and information and communication technology investment on labor productivity growth are significantly higher at lower levels of age dependency. Furthermore, although the marginal effect of financial development on labor productivity is slightly higher at higher levels of age dependency, it is not statistically significant. Size and nature of age dependency vary across different income groups. For example, age dependency in low income economies is 1.9 times higher than in high income economies. The diversity in size and nature of age dependency across regions and different income levels thus helps to explain labor productivity differentials among them.

5.5 Robustness and extensions

We carried out a number of robustness checks to examine whether our results hold when we restrict our sample to only developed or only developing economies. The results are presented in the appendix in Tables 5.5A and 5.6A, respectively, while the marginal effects corresponding to these empirical results are presented in Figures 5.5 and 5.6, respectively. Our findings remain almost the same for both groups of economies with the exception of the marginal effect of financial development.

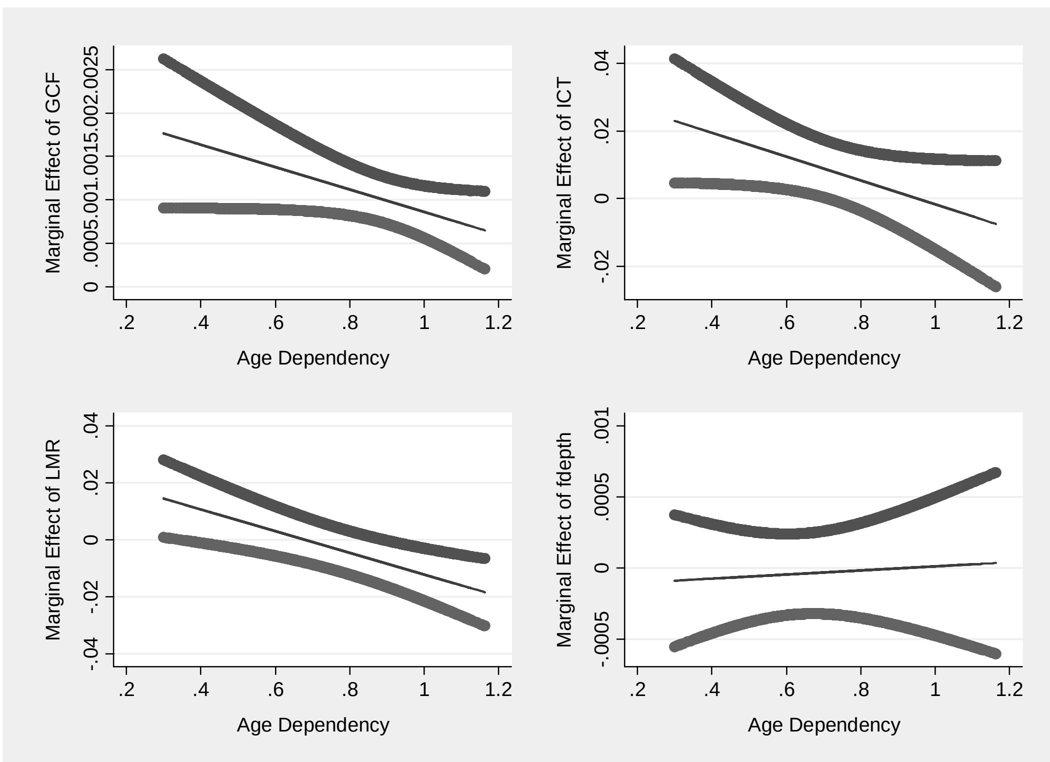
Figure 5.5: Marginal impact of gross capital formation, ICT expenditure, labor market reforms and financial development on labor productivity at different levels of age dependency – developed countries



This figure examines the impact of gross capital formation, ICT expenditure, labor market reforms and financial development on labor productivity growth at different levels of age dependency. These figures correspond to our main results as given in columns 5-8 of Table 5.4A. The upper panels show the marginal effect of Gross Capital Formation (GCF) and ICT expenditure (ICT) and the lower panels show the marginal effect of Labor Market Reforms (LMR) and financial development (fdepth) at different levels of age dependency.

We find that the marginal effect of gross capital formation, ICT expenditure and labor market reforms declines at higher levels of age dependency. Separate analyses for developed and for developing economies also provide very similar marginal effects of GCF on labor productivity conditional on age dependency. However, in the case of developed countries, the slope is somewhat flatter indicating a slower decline in labor productivity as compared to developing countries (see upper left graphs of Figures 5.5 and 5.6, respectively). The same is true for ICT expenditure and LMR (see upper right and lower left graphs in Figures 5.5 and 5.6, respectively).

Figure 5.6: Marginal impact of gross capital formation, ICT expenditure, labor market reforms and financial development on labor productivity at different levels of age dependency – developing countries



This figure examines the impact of gross capital formation, ICT expenditure, labor market reforms and financial development on labor productivity growth at different levels of age dependency. These figures correspond to our main results as given in columns 5-8 of Table 5.5A. The upper panels show the marginal effect of Gross Capital Formation (GCF) and ICT expenditure (ICT) and the lower panels show the marginal effect of Labor Market Reforms (LMR) and financial development (fdepth) at different levels of age dependency.

Table 5. 3: Demographics and determinants of labor productivity – sensitivity analysis

	Interactive model							
	1	2	3	4	5	6	7	8
Age Dependency	-0.356***	-0.264***	-0.403***	-0.538***	-0.415***	-0.362***	-0.268	-0.086
	0.081	0.079	0.085	0.156	0.083	0.132	0.202	0.101
Age Dependency*Age Dependency	0.201***	0.137***	0.212***	0.300***	0.228***	0.190*	0.124	0.041
	0.052	0.051	0.055	0.105	0.054	0.1	0.129	0.066
Change in Participation	-0.738***	-0.791***	-0.750***	-0.739***	-0.727***	-0.704***	-0.810***	-0.755***
	0.036	0.036	0.036	0.048	0.037	0.036	0.106	0.041
Initial level of labor productivity	-0.037***	-0.021***	-0.027***	-0.061***	-0.030***	-0.020***	0.011	-0.031***
	0.006	0.006	0.006	0.011	0.006	0.008	0.015	0.007
Inflation	-0.106***	-0.067***	-0.080***	-0.142***	-0.101***	-0.107***	-0.043***	-0.074***
	0.006	0.007	0.007	0.009	0.006	0.008	0.014	0.007
Change in Gross Capital Formation	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.004***	0.002***
	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
Gross capital Formation*Age Dependency	-0.001***	-0.001***	-0.001***	-0.002***	-0.001***	-0.001*	-0.003***	-0.001***
	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000
Openness	0.000***							
	0.000							
Remittances		0.174***						
		0.043						
Foreign direct Investment			0.001					
			0.000					
Infrastructure (roads)				0.000**				
				0.000				
Telephone lines per 1000					0.001			
					0.000			
Employment in Agriculture						0.001***		
						0.000		
Education							0.000	
							0.001	
Corruption								-0.001
								0.001
Constant	0.493***	0.325***	0.440***	0.807***	0.471***	0.344***	0.037	0.349***
	0.072	0.073	0.079	0.131	0.073	0.1	0.182	0.089
Number of observations	2103	1798	1978	1113	2097	1298	290	1403
Number of Countries	110	103	109	107	110	97	82	81
R^2	0.418	0.4	0.404	0.462	0.41	0.461	0.435	0.43
F Statistic	178.415***	140.710***	157.545***	107.266***	172.153***	127.572***	19.265***	123.806***

Robust standard errors are reported below the coefficients.
*** indicates significance at 1 percent level, ** indicates significance at 5 percent and * indicates a significance at 1 percent level

The marginal effect of financial development on labor productivity growth at old age dependency is larger in high income OECD countries, but it is only statistically significant at low levels of age dependency (see bottom left panel in Figure 5.4). For developing economies, the financial development marginal impact curve is flatter and insignificant for labor productivity at different levels of age dependency.

These differences in marginal impact of financial development may be due to the different nature of age dependency in developed and developing countries. Developed countries are characterized by high old age dependency contrary to developing countries where high child dependency mainly represents age dependency (see Figure 5.1A in the appendix). It may be because of the fact that older people make good use of their savings, as a result of which financial deepening is more effective than for younger people.

We have also splitted up age dependency in child dependency and old age dependency. The marginal effects of the various determinants of labor productivity at different levels of child dependency and old age dependency are presented in Figures 5.2A to 5.2.2A and 5.4A to 5.4.2A in the appendix.[18] The results show that child dependency affects labor productivity adversely both in the complete sample and in the sub-samples of developed and developing countries.

However, in the case of high income developed economies, the impact of gross capital formation remains positive and significant at higher levels of child dependency. The marginal effects curves for developing countries are slightly steeper than those for the high income economies. The impact of old age dependency is not negative in the complete sample and in the sample of developing countries. This can be explained by the low level of old age dependency in developing countries (in low income developing economies, the higher share of age dependency is due to child dependency; moreover, due to poor health conditions, life expectancy is also lower in comparison to developed economies). It is only the marginal effect curve of financial development that becomes downward sloping, though not significant.

[18] The corresponding tables of results are not presented but are available on request.

In the sample of developed countries, the marginal effect of GCF is slightly lower at different levels of old age dependency, while the ICT impact on labor productivity remains almost the same at different levels of age dependency. The impact of labor market reforms is positive in presence of old age dependency. Altogether, the analysis by child and old age dependency burdens reflect that child dependency has a stronger adverse effect on labor productivity than old age dependency. However, the long run effects of children might still be positive since they receive schooling and develop skills for higher productivity in the future. [19]

We have also determined the impact of other control variables that have been suggested by previous studies in the literature along with our preferred interactive model. The empirical results are presented in Table 5.3. In columns 1-8 we add several economic, human capital and infrastructural variables. We find that openness, remittances and infrastructure development are significantly related to labor productivity. But the sign and significance of the variables of interest remain unchanged.

As a sensitivity analysis we also changed our period of analysis to 1995-2005. The results, which are presented in Figure 5.4A in the appendix, show that the marginal effects of various determinants, conditional on age dependency, hardly change and thus may said to be robust to the period of analysis. Finally, we changed our dependent variable from output per worker to output per hour. This led to a significant decline in the number of observations, as data on hours per worker is not available for a large number of countries. However, the findings are very similar to the results obtained for developed countries. This is because data on output per worker is mostly only available for developed economies.

On the basis of these sensitivity analyses, we may conclude that our main finding that age dependency has a negative effect on labor productivity growth and lowers the impact of other determinants of labor productivity growth holds.

[19] But after gaining proper education and required skills they can be more productive in the long term. There is need to explore this effect, but comparable time series data are missing.

5.6 Conclusion

We examine the effect of gross capital formation, labor market institution, ICT expenditure and financial development on labor productivity (measured by output per worker) conditional on different levels of age dependency for up to 110 countries over the period 1980-2005. We find that age dependency matters for labor productivity growth. This finding is in line with the conclusion of Kogel's (2005) study that youth dependency may be harmful for labor productivity. Our results show that higher age dependency impacts labor productivity growth negatively not only directly but also indirectly by modifying the impact of other social, economic and infrastructural determinants.

In our sensitivity tests, we use a number of variations in the definitions of the variables used, in the sample of countries and the period of analysis. It turns out that our results are generally very robust and hold for both sub samples of developed and developing countries. We also find that child dependency has a stronger adverse impact on labor productivity than old age dependency. Age dependency in low income economies is 1.8 times higher than in high income developed economies. This implies that our finding that age dependency affects labor productivity negatively helps to explain productivity growth differentials across country groups at different income levels. Furthermore, our finding suggests that in the future when child dependency in developing and emerging economies declines, there may be an expected increase in labor productivity not only directly but also through improved performance of other determinants of labor productivity. In developing and emerging economies, foremost priority should therefore be given to an increase in the education and skill training of the working age population, so that these economies can properly utilize the favorable demographic changes to increase labor productivity and economic growth.

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Appendices

Appendix:

Table 2.1A: List of sample countries by continent

Europe	Asia	Africa	South America	North/Central America	Oceania
Austria	Bangladesh	Chad	Argentina	Barbados	Australia
Belgium	China	Egypt	Bolivia	Canada	New Zealand
Cyprus	Hong Kong	Ghana	Brazil	Costa Rica	Papua New Guinea
Denmark	India	Madagascar	Chile	El Salvador	
Finland	Indonesia	Mali	Colombia	Guatemala	
France	Japan	Nigeria	Ecuador	Jamaica	
Germany	Kenya	South Africa	Paraguay	Mexico	
Greece	South Korea	Swaziland	Peru	United States	
Hungary	Malaysia	Togo	Uruguay		
Iceland	Pakistan	Tunisia	Venezuela		
Ireland	Philippines	Zambia			
Italy	Singapore	Zimbabwe			
Luxembourg	Sri Lanka				
Malta	Syria				
Netherlands	Thailand				
Norway	Turkey				
Portugal					
Spain					
Sweden					
Switzerland					
United Kingdom					

Table 2.2A: Contribution of demographic transition process to past economic growth: results per decade

	China				India				Pakistan			
	1963-70	**1971-80**	**1981-90**	**1991-2000**	**1963-70**	**1971-80**	**1981-90**	**1991-2000**	**1963-70**	**1971-80**	**1981-90**	**1991-2000**
Average annual growth rate of real GDP per capita	7.169	4.373	7.768	9.279	1.867	0.760	3.589	3.649	4.798	1.515	3.495	1.430
Average growth rate child dependency ratio	-0.019	3.080	6.199	2.361	-0.405	1.296	1.431	1.764	-0.660	-0.156	-0.601	1.610
Average growth rate old-age dependency ratio	0.507	-0.146	-0.232	-0.864	-0.358	-0.361	-0.170	-0.446	0.954	0.199	0.026	-0.298
Average growth differential between working-age population and total population	0.026	0.368	0.622	0.134	-0.067	0.148	0.164	0.175	-0.043	-0.013	-0.082	0.210

Table 2.3A: Projected changes in dependency ratios in China, India and Pakistan

	China			India			Pakistan		
Year	Total	Child	Old-age	Total	Child	Old-age	Total	Child	Old-age
2000	48	38	10	65	58	7	82	75	7
2005	42	31	11	60	53	7	73	67	7
2010	39	28	11	56	48	8	69	62	7
2015	40	27	13	52	44	8	65	58	7
2020	44	27	17	49	40	9	62	54	8
2025	46	26	19	47	36	11	58	50	8
2030	49	25	24	45	33	12	54	45	9
2035	54	24	30	44	30	14	51	41	10
2040	59	24	35	44	28	15	50	39	11
2045	61	24	36	45	27	18	49	36	13
2050	63	25	38	47	27	20	50	35	15

Source: United Nations (2008)

Table 3.1A: List of sample countries by income group

Low income economies	Lower middle income economies	Upper middle income economies	High income economies
Bangladesh	China	Argentina	Australia
India	Colombia	Brazil	Belgium
Kenya	Ecuador	Chile	Canada
Madagascar	Egypt	Malaysia	France
Nigeria	Indonesia	Mexico	Italy
Pakistan	Morocco	South Africa	Japan
Tanzania	Peru	Turkey	Netherlands
Zambia	Philippines		New Zealand
Zimbabwe	Sri Lanka		South Korea
	Syria		Spain
	Thailand		UK
	Tunisia		USA

Table 3.2A: Summary Statistics by Income Group

Variable Name	Low Income Economies			Lower Middle Income Economies			Upper Middle Income Economies			High Income Economies		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Female Participation Age 15-19	50.31	17.00	85.35	31.14	3.90	82.70	34.89	7.70	69.55	39.81	4.40	84.60
Female Participation Age 20-24	60.55	24.29	99.80	44.82	5.01	91.70	49.46	20.03	72.40	62.85	19.68	80.30
Female Participation Age 24-29	65.02	28.57	99.65	46.06	3.79	93.00	49.35	16.32	79.80	58.56	19.78	85.30
Female Participation Age 30-34	69.55	29.55	100.00	46.35	5.77	91.40	47.85	13.86	81.90	55.13	16.03	82.20
Female Participation Age 35-39	71.01	29.34	100.00	46.18	7.35	91.50	49.05	13.89	82.50	57.38	16.85	82.10
Female Participation Age 40-44	70.38	27.09	100.00	46.53	8.03	90.11	47.97	13.86	82.90	58.33	16.78	83.40
Female Participation Age 45-49	70.18	25.33	100.00	44.19	9.16	86.67	45.81	14.62	80.70	55.99	17.31	83.30
Female Participation Age 50-54	68.71	24.70	97.90	39.34	8.51	82.78	41.46	13.98	72.00	48.98	18.17	78.90
Female Participation Age 55-59	64.85	23.85	94.15	33.31	9.79	77.19	31.72	13.59	67.30	37.60	14.20	70.50
Female Participation Age 60-64	56.37	18.29	83.30	23.26	4.60	54.10	21.63	5.00	65.30	22.21	4.00	50.80
Total Fertility Rate	6.03	2.84	8.12	4.47	1.81	7.60	3.93	1.97	6.88	2.14	1.08	5.67
Average years of schooling (females, age>15)	2.15	0.11	5.04	3.99	0.25	8.18	4.65	1.15	8.90	8.13	3.02	12.02
Capital stock per worker (000)	4.95	0.06	21.34	15.20	1.46	37.55	29.18	3.36	68.05	90.30	5.24	175.89
Employment in agriculture (%)	73.56	43.00	92.60	47.55	6.20	83.20	30.49	7.71	78.70	11.04	1.40	61.30
Lagged Birth Rate/1000	42.63	16.98	51.59	36.44	15.98	50.79	29.67	12.17	47.97	20.06	9.22	49.34
Infant Mortality Rate/1000	102.45	53.00	165.00	66.61	12.00	186.00	55.62	8.00	163.00	14.19	3.00	90.00
Under 5 Mortality Rate/1000	167.15	73.00	290.00	96.84	14.00	278.00	73.36	10.00	219.00	16.75	4.00	127.00

Notes: Based on sample of 326 observations.

Table 3.3A: Alternative instrumental variables sets

	Davidson-MacKinnon Test of Exogeneity		**Over identification test**		**Under identification test**		**Weak identification test**	**First Stage F-stat***
	F statistic	p-value	Sargan-Hansen test	p-value	Chi-sq(2)	p-value	Cragg-Donald Wald Statistic	
LBR_{-5}, IMR, MR	**11.5**	**<0.01**	**0.73**	**0.39**	**27.81**	**0.00**	**10.10**	**28.2 / 27.3**
URB, CD, UN	0.72	0.48	2.01	0.15	4.28	0.12	1.31	3.8 / 15.7
AD, LEB, PCY	15.14	0.05	0.53	0.41	1.38	0.49	0.42	77.4 / 40.6
TMP, URB, AYSM	2.10	0.12	0.00	0.91	0.64	0.72	0.19	2.4 / 0.2
POP_{-1}, TMP, AYSM	7.88	0.04	0.05	0.82	6.56	0.04	2.28	5.6 / 25.1
UN, PCY, CD	22.38	0.01	0.25	0.61	5.76	0.07	1.90	6.8 / 16.0
AYSM, TMP, PCY	8.60	0.02	0.00	0.92	2.92	0.23	0.88	2.5 / 0.9
MR_{-1}, $AYSF_{-1}$, URB	2.03	0.13	0.01	0.91	0.04	0.98	0.01	11.7 / 4.5
LBR_{-5}, LEB, URB	18.33	0.00	0.00	0.97	0.38	0.82	0.13	19.4 / 16.5
TFR_{-1}, LEB_{-1}, PCY	13.20	0.00	0.29	0.55	1.10	0.57	0.33	91 / 35

Note: LBR_{-5}=lagged crude birth rate; IMR=infant mortality rate; MR=mortality rate under 5 years of age; URB=urbanization; CD= child dependency; UN=unemployment rate; AD=age dependency; LEB= life expectancy at birth for women; PCY= per capita income; TMP= labor force participation for men; AYSM= average years of schooling for men; POP= total population size; TFR_{-1}=lagged total fertility rate

* First value is for first stage regression for total fertility rate and second value is for interaction term (total fertility rate*capital stock per worker)

Table 4.1A: List of Countries in sample by region

East and Southeast Asia	**South America**	**Middle East and North Africa**	**Africa**	**Europe**
China	Brazil	Egypt	Nigeria	France
Indonesia	Colombia	Turkey	South Africa	UK
Japan	Argentina	Syria	Tanzania	Italy
Philippines	Peru	Morocco	Kenya	Spain
Thailand	Chile	Tunisia	Madagascar	Netherlands
S. Korea	Ecuador		Zimbabwe	Belgium
Malaysia			Zambia	
				Central and Eastern Europe
South Asia	**North America**	**Oceania**		Albania
Pakistan	USA	Australia		Hungary
India	Canada	New Zealand		Bulgaria
Sri Lanka	Mexico			Poland
Bangladesh				Romania

List of Countries in sample by income Groups				**Development**			
High Income Economies	**Upper Middle Income Economies**	**lower middle income economies**	**lower income Economies**	**Developed Economies**	**Developing Economies**		
Australia	Bulgaria	China	Bangladesh	Australia	Albania	China	Bangladesh
Belgium	Argentina	Colombia	India	Belgium	Argentina	Colombia	India
Canada	Brazil	Ecuador	Kenya	Canada	Brazil	Ecuador	Kenya
France	Chile	Egypt	Madagascar	France	Chile	Egypt	Madagascar
Italy	Malaysia	Indonesia	Nigeria	Hungary	Malaysia	Indonesia	Bulgaria
Hungary	Mexico	Morocco	Pakistan	Italy	Mexico	Morocco	Poland
Japan	S Africa	Peru	Tanzania	Japan	South Africa	Peru	Romania
Netherlands	Turkey	Philippines	Zambia	Netherlands	Turkey	Nigeria	
New Zealand	Poland	Sri Lanka	Zimbabwe	New Zealand	Philippines	Pakistan	
South Korea	Romania	Syria		South Korea	Sri Lanka	Tanzania	
Spain		Thailand		Spain	Syria	Zambia	
UK		Tunisia		UK	Thailand	Zimbabwe	
USA		Albania		USA	Tunisia		

Table 4.2A: Output decomposition by employment and productivity 1960-2005 by region

	Output Growth	Employment Growth	Productivity Growth
Africa	2.93	2.68	0.25
East and Southeast Asia	5.61	2.21	3.40
Europe	3.01	0.73	2.27
Eastern Europe	2.88	-0.05	2.93
Middle East and North Africa	4.64	2.58	2.06
North America	3.65	2.37	1.28
Oceania	3.19	1.79	1.40
South America	3.56	2.39	1.17
South Asia	4.51	2.25	2.26
By Income Group			
	Output Growth	Employment Growth	Productivity Growth
High income economies	3.43	1.13	2.30
Upper middle income economies	3.60	1.48	2.12
Lower Middle income economies	4.66	2.46	2.21
Low income economies	3.30	2.68	0.62
By Development Level			
	Output Growth	Employment Growth	Productivity Growth
Developed	3.48	1.24	2.23
Developing	3.99	2.19	1.80

Source : TCB\GGDC, Total Economy Database, 2008

Table 4.3A: Output decomposition by employment and productivity 1960-2005 by income groups

	High Income Economies			**Upper Middle Income Economies**		
	Output growth	Emp growth	Produc growth	Output growth	Emp growth	Produc growth
1960-70	5.48	1.50	3.99	5.26	1.70	3.56
1970-80	3.65	1.15	2.50	4.71	2.03	2.68
1980-90	2.91	0.97	1.93	1.55	1.94	-0.40
1990-00	2.65	0.79	1.86	2.96	0.81	2.16
2000-05	2.47	1.24	1.22	3.54	0.94	2.59
	Lower middle Income Economies			**Lower Income Economies**		
	Output growth	Emp growth	Produc growth	Output growth	Emp growth	Produc growth
1960-70	4.85	2.15	2.70	4.94	2.43	2.52
1970-80	5.70	2.87	2.83	3.04	2.81	0.22
1980-90	3.73	3.12	0.60	2.91	3.19	-0.28
1990-00	4.04	1.87	2.17	2.20	2.61	-0.41
2000-05	5.01	2.27	2.73	3.40	2.36	1.05

Note: Emp= Employment, Produc= Productivity
Source: TCB\GGDC, Total Economy Database, 2008

Table 4.4A: Growth of labor productivity, GDP and employment by region (2006-08)

	2006	2007	2008	Avg 2006-08
Labor Productivity Growth (GDP per persons Employed, annual average, percent)				
South Asia	5.59	5.83	4.85	5.42
South America	1.83	2.51	1.95	2.10
Oceania	0.34	1.01	-0.95	0.13
North America	1.11	0.93	0.57	0.87
Middle East and North Africa	3.72	2.25	1.87	2.61
Central & Eastern Europe	4.26	3.77	3.72	3.92
Europe	1.09	0.98	0.77	0.95
Southeast Asia	4.52	4.75	2.66	3.97
Africa	2.05	2.27	0.91	1.74
Real GDP Growth (annual average, percent)				
South Asia	7.63	7.27	6.27	7.06
South America	5.83	6.41	5.90	6.05
Oceania	2.43	3.32	0.19	1.98
North America	3.56	2.64	0.97	2.39
Middle East and North Africa	6.42	4.95	4.65	5.34
Central & Eastern Europe	5.98	5.31	5.02	5.44
Europe	2.89	2.76	0.82	2.16
Southeast Asia	5.79	6.42	4.07	5.43
Africa	4.36	4.59	3.20	4.05
Growth in Persons Employed (annual average, percent)				
South Asia	2.23	1.37	1.37	1.66
South America	4.09	3.83	3.87	3.93
Oceania	2.08	2.29	1.14	1.84
North America	2.42	1.70	0.42	1.52
Middle East and North Africa	2.63	2.66	2.73	2.67
Central & Eastern Europe	1.67	1.50	1.28	1.48
Europe	1.79	1.77	0.82	1.46
Southeast Asia	1.23	1.61	1.37	1.40
Africa	2.27	2.27	2.27	2.27

Source: The Conference Board, Total Economy Database, June 2009

Table 4.5A: Effect of participation on labor productivity growth

	Employment		Employment/Labor force		Employment/Working Age		Employment/Population		Labor force/Working age		Labor force / Population	
	uncontrolled	Controlled	uncontrolled	Controlled	uncontrolled	Controlled	uncontrolled	Controlled	uncontrolled	Controlled	uncontrolled	Controlled
Annual												
Labor Productivity Growth	-0.699 (12.49)**	-0.683 (11.84)	-0.439 (6.10)**	-0.498 (7.36)**	-0.690 (10.76)**	-0.675 (11.23)**	-0.663 (10.28)**	-0.670 (11.09)**	-0.930 (8.22)**	-0.823 (7.31)**	-0.803 (7.29)**	-0.777 (6.99)**
Constant	2. 80 (16.56)**	4.63 (6.99)	1. 23 (9.95)**	2.89 (4.20)**	1. 37 (11.54)**	2.63 (3.97)**	1. 67 (13.16)**	3.32 (4.89)**	1.509 (12.08)**	3.47 (5.09)**	1.83 (12.08)**	4.29 (6.02)
Observation	1000	1000	1000	1000	1000	1000	975	975	1000	1000	975	975
5-years												
Labor Productivity Growth	-0.712 (12.19)**	-0.668 (11.27)**	-0.291 (3.12)**	-0.599 (7.75)**	-0.666 (7.95)**	-0.714 (10.75)**	-0.598 (7.23)**	-0.685 (10.35)**	-0.964 (7.52)**	-0.791 (6.26)**	-0.711 (6.10)**	-0.621 (5.26)**
Constant	2.85 (19.10)**	5.37 (13.19)**	1.27 (15.04)**	3.37 (8.27)**	1.39 (16.97)**	3.46 (8.84)**	1.65 (17.47)**	4.16 (10.47)**	1.54 (17.56)**	4.14 (10.15)**	1.79 (15.76)**	4.74 (10.79)**
Observation	840	840	840	840	840	840	819	819	840	840	819	819
10-years												
Labor Productivity Growth	-0.69 (10.68)**	-0.888 (5.92)	0.104 (0.81)	-0.70 (7.25)**	-0.566 (4.79)**	-0.79 (9.94)**	-0.474 (4.27)**	-0.710 (9.31)**	-1.01 (7.03)**	-0.777 (5.47)**	-0.754 (5.99)**	-0.60 (4.74)**
Constant	2.88 (18.32)**	4.60 (3.97)	1.40 (17.5)**	3.81 (11.67)**	1.46 (18.57)**	3.94 (12.76)**	1.67 (17.11)**	4.72 (15.17)**	1.64** (19.60)	4.65 (14.41)**	1.91 (16.98)**	5.26 (14.62)**
Observation	640	640	640	640	640	640	624	624	640	640	624	624

All independent variables are specified as growth rates.
** significance at 1 percent
* significance at 5 percent

Table 5.1A: Description of data and its sources

Variable	Variable description	Source
LP	GDP per employed person	Groningen Growth and Development Centre
PART	Employed to total population ratio	Groningen Growth and Development Centre
AD	(0-14 years)+ (65+ years) / 15-64 years	World Development Indicators
GCF	Gross capital formation is the sum of fixed gross capital formation, changes in inventories and acquisition less disposables of valuables	World Development Indicators
INF	Consumer prices % annual	World Development Indicators
ICT	Information and communication technology expenditure (% of GDP)	World Development Indicators
LMR	Un-weighted average of six measures (Minimum wage, hiring and firing regulations, centralized collective bargaining, Mandated cost of hiring, Mandated cost of worker dismissal and Conscription) and its value varies from 1-10.	Economic Freedom Index of Fraser Institute
FIND	Financial Development measured as domestic credit provided by banking sector (% of GDP)	World Development Indicators

Table 5.2A: Summary statistics

Variable	Mean	Std. Dev.	Min	Max
Labor Productivity Growth	0.01	0.05	-0.35	0.30
Age Dependency	0.66	0.19	0.30	1.16
Change in Participation	0.00	0.02	-0.15	0.27
Initial level of Labor Productivity (US $ 000)	18.03	14.35	0.53	64.15
Inflation	0.12	0.17	-0.11	1.00
Change in Gross Capital Formation	4.47	14.46	-50.26	111.40
ICT Expenditure	5.78	2.31	1.03	15.06
Financial Development	63.57	47.94	-28.22	318.67

Table 5.3A: Impact of demographics on labor productivity

Dependent variable is labor productivity growth	
	1
Age Dependency	-0.746*
	0.452
Age Dependency*Age Dependency	0.409
	0.345
Change in Participation	-0.792***
	0.057
Initial level of labor productivity	-0.105***
	0.02
Inflation	-0.105***
	0.02
Change in Gross Capital Formation	0.004***
	0
Gross capital Formation*Age Dependency	-0.003***
	0
ICT Expenditure	0.024
	0.007
ICT expenditure*Age Dependency	-0.0269
	0.011
Labor Market Reforms	0.002
	0.008
Labor Market Reforms*Age Dependency	0.0003
	0.014
Financial Depth	-0.001**
	0
Financial Depth*Age Dependency	0.003**
	0
Constant	1.278***
	0.279
Significance of Fixed Effects	
P-value of F-statistics	0.001
Number of observations	361
Number of Countries	67
R^2	0.68
F Statistic	43.22***

Robust standard errors are reported below the coefficients.

*** indicates significance at 1 percent level, ** indicates significance at 5 percent and * indicates a significance at 1 percent level

Table 5.4A: 2SLS Estimations Second Stage

Dependent Variable: Labor Productivity Growth

	1	2
Age Dependency	-0.083***	-0.088**
	0.017	0.043
Change in Participation	-0.687***	-0.720***
	0.038	0.044
Initial Level of Labor Productivity	-0.022***	-0.029***
	0.006	0.007
Inflation	-0.111***	-0.081***
	0.007	0.009
Change in Gross Capital Formation	0.001***	0.001***
	0	0
Gross capital Formation*Age Dependency		0.001
		0.002
Number of observations	1895	1465
Number of Countries	107	75
R^2	0.396	0.383
Kleibergen-Paap rk Wald F Statistics	96.21	18.24
Stock-Yogo Critical Value	11.98	8.11
Hensen J statistic (p-value)	0.67	0.22
Davidson-MacKinnon test of exogeneity (p-value)	0.218	0.482

*significant at 10%,**significant at 5%,*** significant at 1 percent. Age dependency in model 1 is instrumented by second lag of child dependency and 5th lag of population growth. In model 2, age dependency and its interaction term are instrumented by 5th lag value of capital stock per worker, population growth and child dependency. Henson J statistic test for instrument validity, high p value reflects that instruments are valid (uncorrelated with error term and correctly excluded from second stage regression). Davidson test computes a test of exogeneity for a fixed-effect regression estimated via instrumental variables, the null hypothesis for which states that any endogeneity among the regressors would not have deleterious effects on OLS estimates. High p value suggests that there is no endogeneity problem in model.

Table 5.5A: Impact of demographics on labor productivity for high income OECD countries

	Direct Model				Interactive model			
	1	2	3	4	5	6	7	8
Age Dependency	-0.018	-0.856	1.003**	0.282	0.044	-1.399	1.125**	0.044
	0.296	1.907	0.46	0.32	0.318	1.887	0.448	0.335
Age Dependency*Age Dependency	-0.002	0.724	-0.973**	-0.309	-0.059	1.835	-0.819*	-0.158
	0.274	1.957	0.412	0.28	0.287	1.989	0.405	0.282
Change in Participation	-0.490***	-0.330***	-0.294***	-0.199***	-0.491***	-0.326***	-0.293***	-0.194***
	0.058	0.106	0.084	0.064	0.06	0.109	0.083	0.064
Initial Level of Labor Productivity	-0.024***	-0.024	-0.037***	-0.034***	-0.024***	-0.029	-0.039***	-0.035***
	0.006	0.032	0.01	0.009	0.006	0.033	0.01	0.009
Inflation	-0.094***	-0.220*	-0.183***	-0.159***	-0.095***	-0.216*	-0.199***	-0.155***
	0.033	0.112	0.054	0.035	0.033	0.11	0.059	0.037
Change in Gross Capital Formation	0.001***				0.002**			
	0				0.001			
Gross Capital Formation*Age Dependency					-0.002			
					0.003			
ICT Expenditure		0.009**				0.048*		
		0.004				0.026		
ICT Expenditure*Age Dependency						-0.081		
						0.05		
Labor Market Reforms			0.002				0.025	
			0.002				0.018	
Labor Market Reforms*Age Dependency							-0.048	
							0.037	
Financial Depth				-0.005				-0.038
				0.006				0.028
Financial Depth*Age Dependency								0.061
								0.054
Constant	0.284**	0.461	0.15	0.320**	0.265**	0.517	0.071	0.412***
	0.116	0.538	0.167	0.145	0.125	0.573	0.184	0.147
Number of observations	607	150	229	608	607	150	229	608
Number of Countries	27	25	27	27	27	25	27	27
R^2	0.366	0.154	0.162	0.153	0.367	0.171	0.174	0.158
F Statistic	39.380***	9.589***	14.768***	14.565***	37.575***	10.805***	12.535***	13.111***

Robust standard errors are reported below the coefficients.
Coefficient of financial depth is multiplied with 100 to make results presentable.
*** indicates significance at 1 percent level, ** indicates significance at 5 percent and * indicates a significance at 1 percent level

Table 5.6A: Impact of demographics on labor productivity for developing countries

	Direct Model				Interactive model			
	1	2	3	4	5	6	7	8
Age Dependency	-0.530***	-1.074	-0.539	-0.709***	-0.507***	-0.678	-0.47	-0.717***
	0.157	0.655	0.468	0.23	0.16	0.688	0.44	0.224
Age Dependency*Age Dependency	0.295***	0.503	0.263	0.402***	0.282***	0.32	0.376	0.401***
	0.095	0.421	0.325	0.142	0.097	0.422	0.289	0.142
Change in Participation	-0.757***	-0.497***	-0.659***	-0.621***	-0.777***	-0.496***	-0.665***	-0.621***
	0.062	0.166	0.179	0.089	0.059	0.164	0.178	0.089
Initial level of Labor Productivity	-0.032***	-0.180***	-0.077**	-0.070***	-0.032***	-0.191***	-0.085**	-0.070***
	0.01	0.048	0.033	0.016	0.009	0.047	0.035	0.016
Inflation	-0.102***	-0.180**	-0.109***	-0.121***	-0.099***	-0.184**	-0.113***	-0.121***
	0.024	0.078	0.036	0.021	0.025	0.078	0.036	0.021
Change in Gross Capital Formation	0.001***				0.002**			
	0.00				0.001			
Gross Capital Formation*Age Dependency					-0.001*			
					0.001			
ICT Expenditure		0.011*				0.034**		
		0.005				0.015		
ICT Expenditure*Age Dependency						-0.035*		
						0.019		
Labor Market Reforms			0.002				0.026**	
			0.004				0.01	
Labor Market Reforms*Age Dependency							-0.038***	
							0.012	
Financial Depth				-0.007				-0.011
				0.014				0.034
Financial Depth*Age Dependency								0.006
								0.048
Constant	0.527***	2.109***	0.970**	0.950***	0.515***	2.040***	0.957**	0.955***
	0.133	0.623	0.414	0.198	0.132	0.594	0.419	0.194
Number of observations	1504	269	392	1773	1504	269	392	1773
Number of Countries	83	46	79	88	83	46	79	88
R^2	0.41	0.277	0.276	0.275	0.417	0.288	0.288	0.275
F Statistic	61.066***	11.132***	8.429***	19.906***	51.889***	12.850***	7.542***	17.148***

Robust standard errors are reported below the coefficients.
Coefficient of financial depth is multiplied with 100 to make results presentable.
*** indicates significance at 1 percent level, ** indicates significance at 5 percent and * indicates a significance at 1 percent level

Figure 5.1A: Child dependency and old age dependency by income group

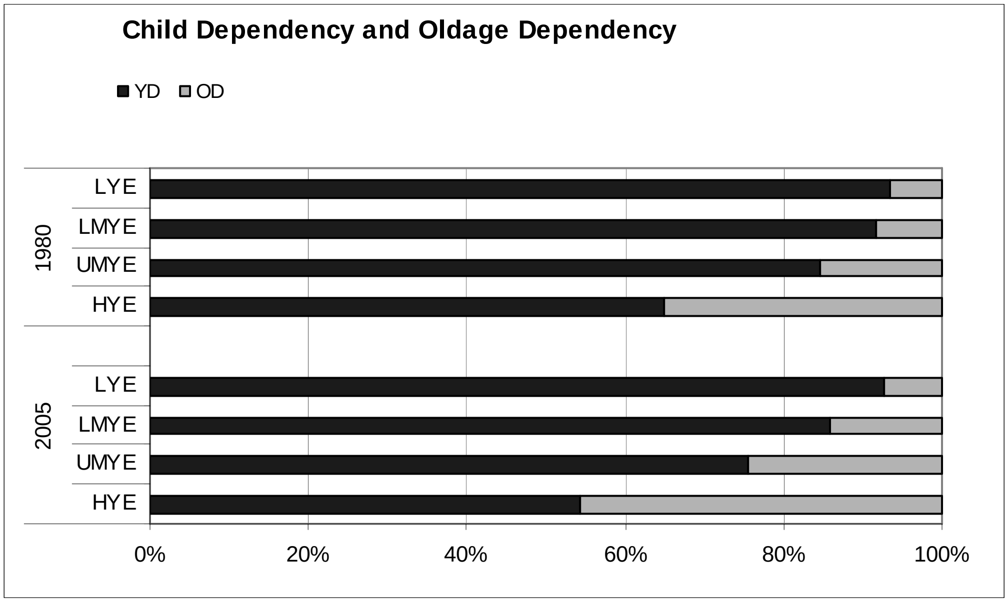
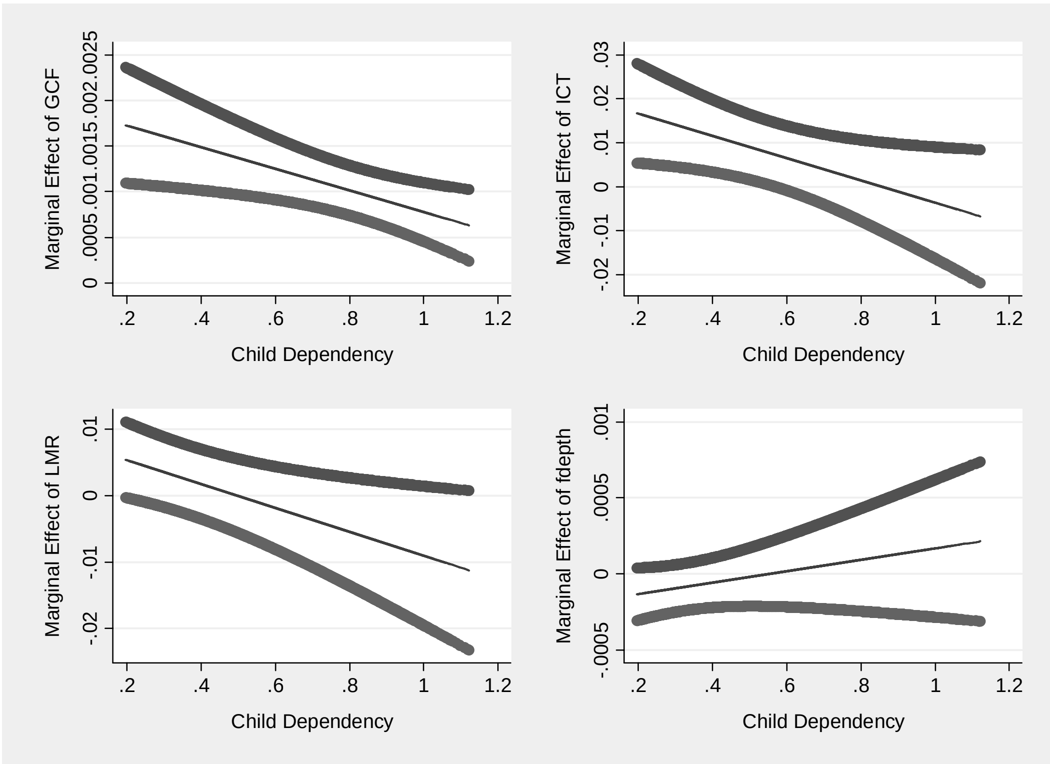
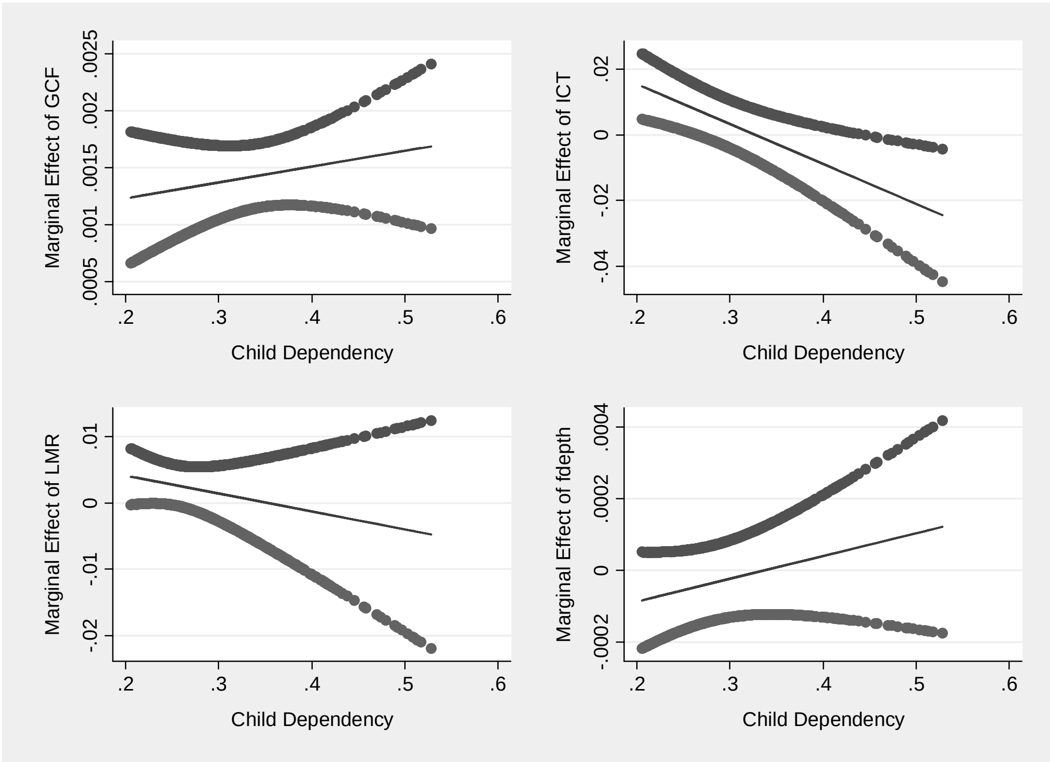


Figure 5.2A: Marginal impact of gross capital formation, ICT expenditure, labor market reforms and financial development on labor productivity at different levels of child dependency-complete sample



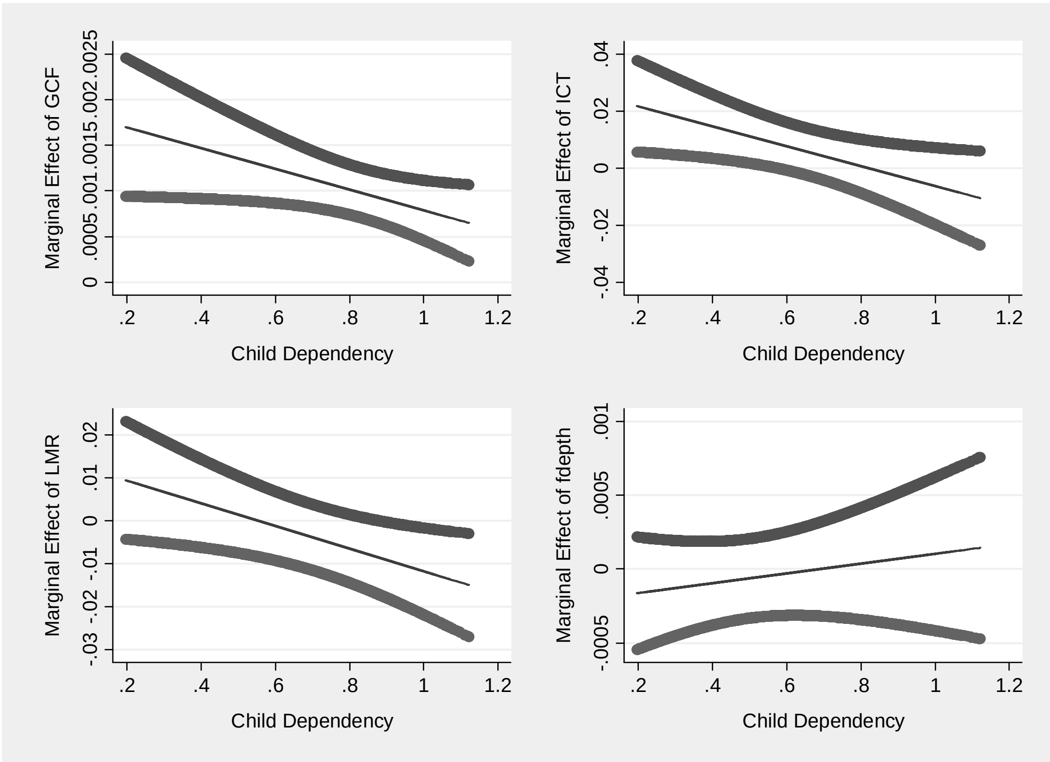
This figure examines the impact of gross capital formation, ICT expenditure, labor market reforms and financial development on labor productivity growth at different levels of child dependency. The upper panels show the marginal effect of Gross Capital Formation (GCF) and ICT expenditure (ICT) and the lower panels show the marginal effect of Labor Market Reforms (LMR) and Financial Development (fdepth) at different levels of child dependency.

Figure 5.2.1A: Marginal impact of gross capital formation, ICT expenditure, labor market reforms and financial development on labor productivity at different levels of child dependency- developed countries



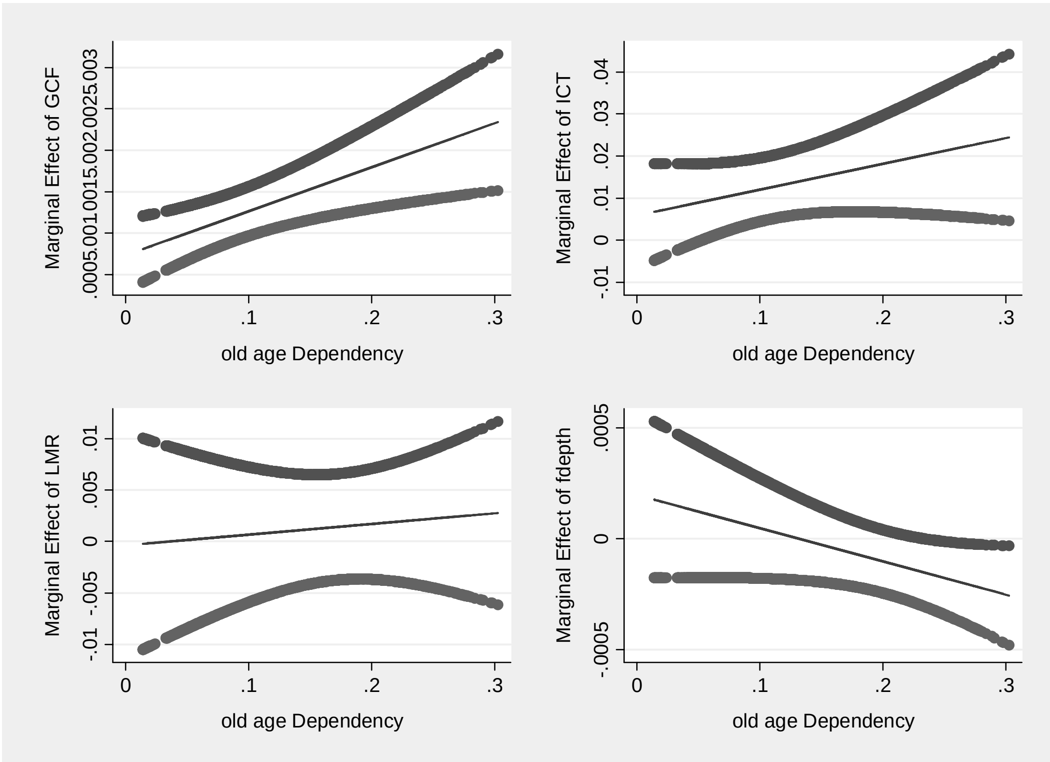
This figure examines the impact of gross capital formation, ICT expenditure, labor market reforms and financial development on labor productivity growth at different levels of child dependency. The upper panels show the marginal effect of Gross Capital Formation (GCF) and ICT expenditure (ICT) and the lower panels show the marginal effect of Labor Market Reforms (LMR) and Financial Development (fdepth) at different levels of child dependency.

Figure 5.2.2A: Marginal impact of gross capital formation, ICT expenditure, labor market reforms and financial development on labor productivity at different levels of child dependency – developing countries



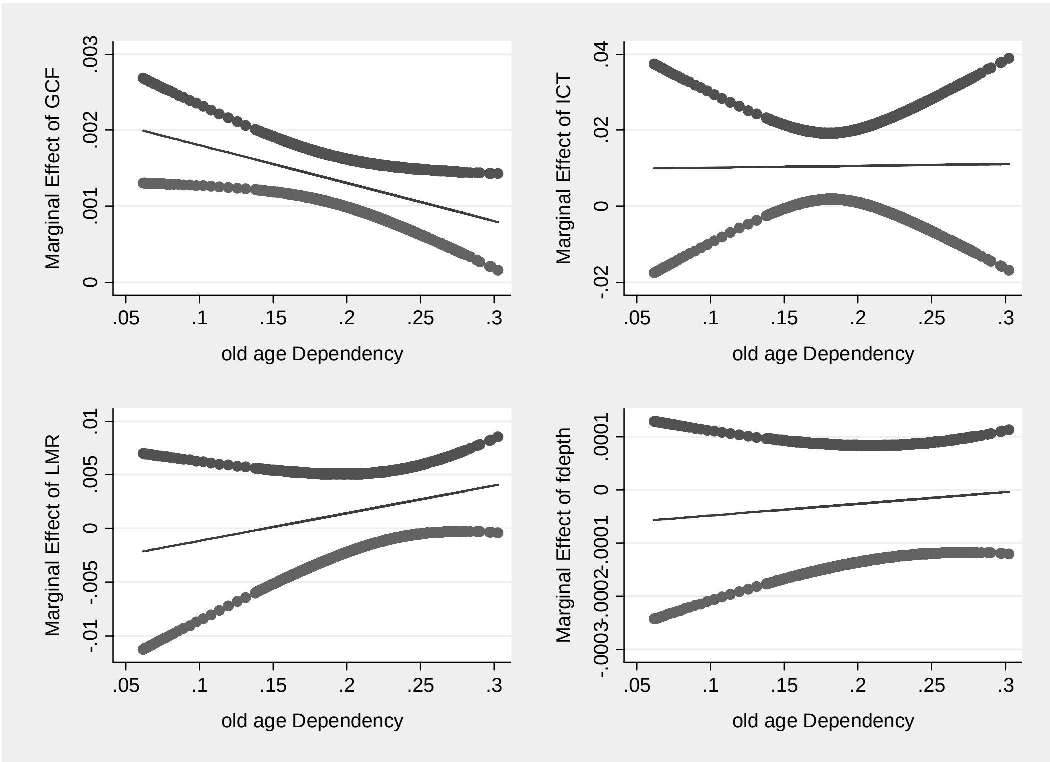
This figure examines the impact of gross capital formation, ICT expenditure, labor market reforms and financial development on labor productivity growth at different levels of child dependency. The upper panels show the marginal effect of Gross Capital Formation (GCF) and ICT expenditure (ICT) and the lower panels show the marginal effect of Labor Market Reforms (LMR) and Financial Development (fdepth) at different levels of child dependency.

Figure 5.3A: Marginal impact of gross capital formation, ICT expenditure, labor market reforms and financial development on labor productivity at different levels of old age dependency -complete sample



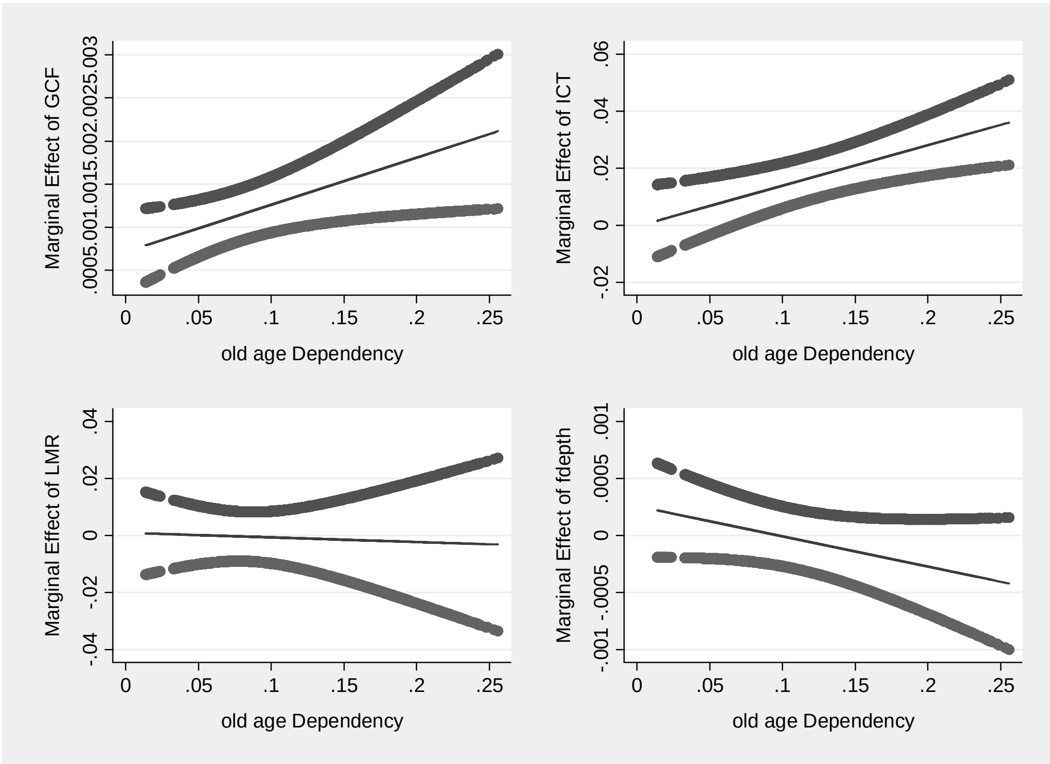
This figure examines the impact of gross capital formation, ICT expenditure, labor market reforms and financial development on labor productivity growth at different levels of child dependency. The upper panels show the marginal effect of Gross Capital Formation (GCF) and ICT expenditure (ICT) and the lower panels show the marginal effect of Labor Market Reforms (LMR) and Financial Development (fdepth) at different levels of child dependency.

Figure 5.3.1A: Marginal impact of gross capital formation, ICT expenditure, labor market reforms and financial development on labor productivity at different levels of old age dependency- developed countries



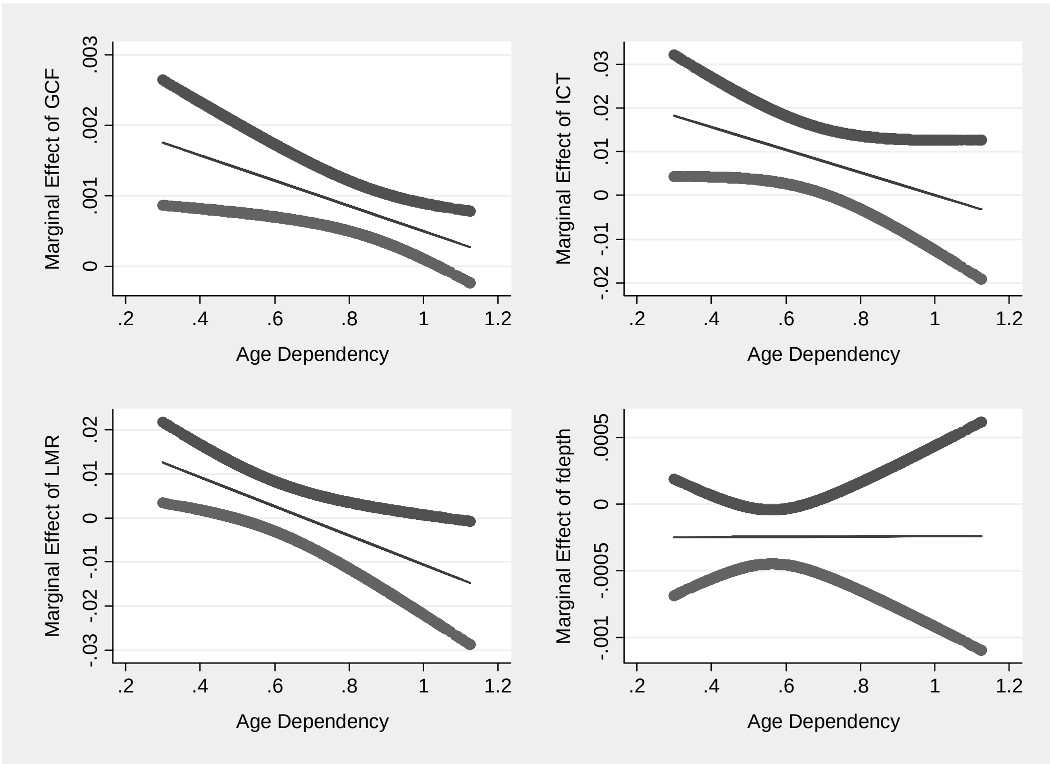
This figure examines the impact of gross capital formation, ICT expenditure, labor market reforms and financial development on labor productivity growth at different levels of child dependency. The upper panels show the marginal effect of Gross Capital Formation (GCF) and ICT expenditure (ICT) and the lower panel show the marginal effect of Labor Market Reforms (LMR) and Financial Development (fdepth) at different levels of child dependency.

Figure 5.3.2A: Marginal impact of gross capital formation, ICT expenditure, labor market reforms and financial development on labor productivity at different levels of old age dependency – developing countries



This figure examines the impact of gross capital formation, ICT expenditure, labor market reforms and financial development on labor productivity growth at different levels of child dependency. The upper panels show the marginal effect of Gross Capital Formation (GCF) and ICT expenditure (ICT) and the lower panels show the marginal effect of Labor Market Reforms (LMR) and Financial Development (fdepth) at different levels of child dependency.

Figure 5.4A : Impact of demographics on labor productivity 1995-2005 -sensitivity analysis



This figure examines the impact of gross capital formation, ICT expenditure, labor market reforms and financial development on labor productivity growth at different levels of child dependency. The upper panels show the marginal effect of Gross Capital Formation (GCF) and ICT expenditure (ICT) and the lower panels show the marginal effect of Labor Market Reforms (LMR) and Financial Development (fdepth) at different levels of child dependency.

Samenvatting

Dit proefschrift levert empirisch bewijs voor de stelling dat de verdeling van de bevolking over verschillende leeftijdsgroepen van invloed is op economische groei, de arbeidsparticipatie van vrouwen en de groei van de arbeidsproductiviteit. Tevens levert het empirisch bewijs voor de stelling dat de relatie tussen de arbeidsparticipatiegraad van vrouwen en de economische groei een U-vorm vertoont, alsook dat een toename van de arbeidsparticipatiegraad op de korte termijn gepaard gaat met een afname van de arbeidsproductiviteit.

Na motivering van dit proefschrift in hoofdstuk 1, wordt in hoofdstuk 2 een aangepast Solow-Swan neoklassiek groeimodel geïntroduceerd, uitgebreid met demografische variabelen. De parameters van dit model worden geschat gebruikmakend van data uit zeventig landen over de periode 1961-2003. De resultaten tonen aan dat het bruto nationaal product per hoofd van de bevolking positief samenhangt met het groeiverschil tussen de beroepsbevolking en de totale bevolking en negatief samenhangt met de aandelen jongeren en ouderen. Uitgaande van deze modelresultaten kan voorts worden vastgesteld dat 46 procent van de economische groei per hoofd van de bevolking in China over de periode 1961-2003 wordt verklaard door demografische veranderingen in de bevolkingsopbouw, 39 procent in India en 25 procent in Pakistan. Naar verwachting hebben demografische veranderingen in de bevolkingsopbouw eveneens een positief effect op de economische groei in India en Pakistan over de periode 2005-2050, maar een negatief effect in China.

Hoofdstuk 3 levert empirisch bewijs voor de stelling dat de relatie tussen de arbeidsparticipatiegraad van vrouwen en de economische groei een U-vorm vertoont. De aggregatie van een micro-economisch model van de arbeidsparticipatiebeslissing over individuen toont aan dat vruchtbaarheid, het aandeel van de werkgelegenheid in de landbouw, het opleidings- en het inkomensniveau van een land de belangrijkste verklarende variabelen vormen van de arbeidsparticipatiegraad in dat land over de economische ontwikkelingscyclus. Een kwadratisch functioneel verband met interactie-effecten tussen de kapitaal-arbeid ratio als proxy voor het inkomensniveau en ieder ander van de genoemde verklarende variabelen wordt geschat voor vrouwen in tien verschillende leeftijdsklassen, gebruikmakend van data van 40 landen in verschillende inkomensklassen over de periode 1960-2000. Voor elke leeftijdsgroep en voor elke verklarende variabele in het model kan een punt worden vastgesteld waarop een regime van een dalende participatiegraad omslaat in een regime van een toenemende participatiegraad. De daaraan verbonden beleidsconclusie is dat het verschil in de mate van arbeidsparticipatie van mannen en vrouwen in elk land uiteindelijk kan worden weggewerkt als het inkomensniveau maar voldoende stijgt.

Hoofdstuk 4 analyseert de invloed van een toename in de arbeidsparticipatiegraad op de arbeidsproductiviteit, met specifieke aandacht voor transitie- en ontwikkelende economieën. De analyse is gebaseerd op data van 45 landen uit verschillende delen van de wereld over de periode 1980-2005. De resultaten tonen aan dat er een afruil bestaat tussen productiviteit en arbeidsmarktparticipatie op de korte termijn. Omdat deze afruil echter na enkele jaren verdwijnt, heeft een toename van de arbeidsmarktparticipatiegraad op de middellange tot lange termijn uiteindelijk een positief effect op economische groei. Voorts tonen de resultaten aan dat de intensiteit van de afruil verschilt tussen landen en is gerelateerd aan het inkomensniveau. De afruil is het zwakst in ontwikkelde, rijke landen, waar deze binnen een periode van vijf jaar verdwijnt. In ontwikkelende en opkomende landen daarentegen is de afruil het sterkst, en verzwakt deze slechts geleidelijk over een langere tijdsduur.

Hoofdstuk 5 verschaft meer inzicht in het uiteenlopen van de arbeidsproductiviteit tussen regio’s en verschillende inkomensklassen in de wereld en levert empirisch bewijs voor de stelling dat de leeftijdsopbouw van de bevolking bepalend is voor arbeidsproductiviteitsgroei. De resultaten wijzen uit dat een groter aandeel van leeftijdsafhankelijke bevolkingsgroepen negatief uitwerkt op de economische groei, niet alleen direct maar ook doordat de impact van andere sociale, economische en infrastructurele determinanten van economische groei hierdoor indirect wordt beïnvloed. Voorts blijkt dat een bevolkingsopbouw met een groter aandeel jongeren een sterker nadelig effect heeft op de groei van de arbeidsproductiviteit dan dat van ouderen. Deze diversiteit in grootte en aard van de leeftijdsafhankelijke bevolking tussen regio's en tussen verschillende inkomensgroepen dragen aldus bij aan een betere verklaring van de verschillen in waargenomen arbeidsproductiviteit.

De behoefte om de snelheid en timing van demografische veranderingen vanuit beleidsperspectief beter te begrijpen wordt door de resultaten van dit proefschrift benadrukt, alsook de behoefte om het "demografische dividend" te kunnen vertalen in termen van economische groei. Het merendeel van de ontwikkelende en opkomende markteconomieën ondergaan nu of in de nabije toekomst een fase waarin ze de voordelen van demografische transitie kunnen benutten. Er is echter geen garantie dat het volledige kwantum van deze voordelen ook daadwerkelijk gerealiseerd zal worden. Belangrijke redenen hiervoor zijn het ontbreken van een adequaat beleidsraamwerk en onvoldoende voorbereiding.