WP/00/151

IMF Working Paper

Population Aging and Global Capital Flows in a Parallel Universe

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INTERNATIONAL MONETARY FUND

 WP/00/151

IMF Working Paper

Research Department

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August 2000

Abstract

This paper explores the global impact of population aging, using a calibrated overlapping generations model of eight world regions to simulate the effects of historical and projected demographic trends on international capital flows. The simulations show that there will be a turning point in regional savings – investment balances between 2010 and 2030 when the European Union and North America will experience a substantial decline in savings relative to investment as their populations age rapidly. This shift will be financed by capital flows from less developed regions which are projected to become capital exporters.

JEL Classification Numbers: E21, F21

Keywords: population aging, international capital flows

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[1] Special thanks are due to Richard Hemming for the main idea behind this paper, to examine the global dimension of population aging using a model of large open economies, and for continued encouragement. I am grateful to Orazio Attanasio, Tam Bayoumi, Luis Cubeddu, Richard Disney, Hamid Faruqee, Peter Isard, Michel Juillard, Douglas Laxton, Eswar Prasad and Steve Symansky for many helpful discussions. Any errors are mine.

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I. Introduction

This paper explores the macroeconomic impact of population aging on a global level. It draws on historical and projected population data to examine demographic trends, finding that while population aging is projected worldwide over the longer-term, there are important regional differences in the medium-term. For example, youth dependency in North America rose to a peak of 52 percent in 1960, up from 42 percent 10 years earlier. By 2015 youth dependency is projected to be as low as 29 percent. This pattern illustrates the impact of the baby boom – baby bust, a post-war surge and subsequent decline in fertility throughout much of the industrialized world. In contrast youth dependency in Africa was 78 percent in 1950, rising to a peak of 87 percent in 1990 before projections have it declining to 68 percent by 2015. The paper explores the macroeconomic effects of these regional differences over the medium term, focusing especially on international capital flows. It also takes a broader view, asking how population aging will affect the world economy in the very long run. How much capital deepening will be associated with the projected decline in fertility, and what will be the effects on factor returns?

To address these issues the paper develops an overlapping generations model in which the representative agent lives for four periods: childhood, young working-age, old working-age, and retirement. The model treats fertility as exogenous, and children as depending on their parents for consumption. Workers supply labor inelastically, feed their household, and save for retirement. Retirees simply consume down savings, there being no bequests. This framework provides the basis for a model of large open economies. Each economy has identical preferences and generates output using a common Cobb-Douglas technology with an economy-specific total factor productivity. Under the assumptions of perfect capital mobility and perfect foresight, international capital flows equate the return on capital across regions. The region-specific productivity parameters are calibrated to match income per capita in eight global regions: North America, the European Union, Japan, Latin America and the Caribbean, China, Africa, the FSU countries, and a region representing the rest of the world. This framework is used to simulate the global demographic transition over the period 1770 to 2230. This is done by moving the model from a high to a low population growth equilibrium, with population dynamics over the transition calibrated to match historical and projected data. The simulation yields a "parallel universe" in which there is a significant shift in regional savings – investment balances between 2010 and 2030. At this time the European Union and North America is forecast to experience a substantial decline in savings relative to investment as their populations age rapidly. Of course these regions switch to importing capital precisely because they previously exported capital to developing regions such as Africa. They are simply running down their foreign assets.

The parallel universe differs from the real world in some important respects. First, capital around the world has the same risk-return characteristics (it is riskfree since investors have perfect foresight) so that workers saving for retirement are indifferent between holding North American or African equity for example. Because the parallel universe does not control for risk, capital flows from the developed world to emerging markets are too large. This deficiency of the model is exacerbated by the assumption of perfect capital mobility. There is no gradual removal of capital controls, nor is there heterogeneity in this regard across regions. The parallel universe should therefore be thought of as providing an upper bound on the effects of demographic change.[2] Second, the model assumes that agents accumulate wealth purely for consumption in retirement. There are no unexpected medical expenses or layoffs, and as a result no precautionary saving. Similarly there are no adjustment costs to investment so that capital adjusts instantaneously to its optimal level. For a region with high population growth relative to the rest of the world this means that the capital stock expands rapidly with the labor supply, to keep the capital-labor ratio in line with the global return on capital. In short, global capital flows in the parallel universe are driven exclusively by the interaction of life cycle factors with demographic change. Finally, the paper focuses only on the direct effects of demographic change. It abstracts away from the labor supply decision and ignores possible interactions of demographic change with technological progress.

The parallel universe does however control for one important feature of reality: differences in size, both across economies and over time. Intuitively size matters because the parallel universe is a model of open economies. The larger an economy relative to the world the greater its impact on the global interest rate for a given shock. The greater its effect on the world interest rate, the closer domestic savings supply and investment demand must move together in equilibrium. The smaller an economy relative to the world the more it will take the world interest rate as given, with domestic investment largely independent of the domestic supply of capital. Differences in size matter over time because the EU countries and Japan have grown substantially relative to North America since the end of World War II. The simulated demographic shift will control for differences in size across economies and over time by calibrating the model to match regional trends in GDP per capita.

Against this background the parallel universe generates international capital flows that match historical trends. It generates a path for the North American current account that goes from a surplus of 3.9 percent of GDP around 1950, when North America is financing economic recovery in the EU countries and Japan, to a deficit of –0.5 percent of GDP around 1990. The parallel universe projects that the North American current account will then recover to 2.1 percent of GDP around 2010 as aging baby boomers invest their retirement savings abroad. Around 2030 the situation will be reversed as retired baby boomers dissave and liquidate their foreign assets. The EU current account is in deficit around 1950, to the tune of –2.3 percent of GDP, as the postwar recovery attracts capital from abroad. By 1990 the current account

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[2] Adding uncertainty to the model would allow capital in emerging markets to be riskier than in developed economies. Such an extension would generate risk premia such that the risk-adjusted returns across regions would be equalized. Greater risk in emerging markets could reflect technological, political or institutional factors. Lucas (1991) argues that adjusting for lower levels of education in the developing world would reduce the scale of international capital flows. In the context of the model this would involve scaling down the effective labor supply in developing regions, thereby bringing capital-labor ratios in emerging markets up towards those in developed economies.

registers a surplus of about 0.7 percent of GDP. Driven by the savings of aging European baby boomers the current account is projected to rise to around 1.5 percent of GDP by 2010, before deteriorating to –1.5 percent of GDP as retired boomers dissave around 2030. Although population aging in Japan is more pronounced than in either of the above regions, past economic growth will continue to drive current account surpluses. In 1990 the model generates a current account surplus of 3.7 percent of GDP, with capital exports deteriorating gradually to about 2.2 percent of GDP by 2030.

Why does all of this matter? At its core this paper models the regional savings – investment balances as a function of demographic change and economic growth. It provides estimates of current account balances that are consistent with these fundamentals, key inputs in a model of equilibrium exchange rates. But the projected turning point in the global savings – investment balance between 2010 and 2030 has implications that go beyond exchange rate policy. The parallel universe uses international capital flows as a summary statistic for the stresses imposed by population dynamics. As such the global turning point is an important policy indicator for fiscal policy and beyond.

II. The Paper vis-a-vis the Literature

Juillard et. al. (2000) present a six region model of overlapping generations economies that is calibrated to represent Europe, North America and Japan, in addition to three regions with countries grouped according to their demographic characteristics. Their paper is closest in spirit to this exercise, in that it explicitly models the general equilibrium effects of changing youth and old-age dependency and accounts for differences in economic size, across regions and over time. Indeed it goes beyond this analysis in that it features an unfunded pay-as-you-go pension system with replacement rates calibrated to match regional characteristics. Perhaps the only shortcoming of the paper is that some regions do not correspond to meaningful economic units, making it hard to translate its results into policy implications. Attanasio and Violante (2000) present an overlapping generations model of two open economies, with one calibrated to match a region called North (representing North America and Europe) and another calibrated to match Latin America. They proceed to simulate the macroeconomic effects of a demographic transition that is based on actual and projected population data. The key advantage of their framework is that it incorporates mortality risk, which allows them to simulate a demographic shock composed of changes in fertility and life expectancy.[3] They main shortcoming of their approach is that it accounts for only two stages of the life cycle:

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[3] Life expectancy in the model used here is exogenous, since all agents live for four periods regardless of when they are born. Higgins and Williamson (1996) argue that changes in fertility, and resulting changes in youth dependency, are responsible for large swings in savings, investment, and foreign capital dependence in Asia during the post-war period. There is certainly more cross-sectional variation in youth than old-age dependency rates, so that this deficiency of the model is perhaps second-order.

working-age and retirement. There are no children, and hence no youth dependency, because agents are born as functioning workers.[4] A further disadvantage of their approach is that they do not allow for convergence in GDP per capita over time. But as this paper shows, size matters not only in the cross-sectional but also in the time-series dimension. Finally, this paper provides a more comprehensive analysis by focusing on the global impact of historical and projected population trends. On the downside, this paper makes the crucial assumption that labor is immobile. This amounts to using global capital flows to measure the effects of population dynamics. A recent paper by Storesletten (2000) looks explicitly at immigration in the context of Social Security reform. Storesletten quantifies the effects migration could have on the sustainability of Social Security. In a sense this paper complements his study by modeling capital rather than labor mobility.

A variety of papers approach the relationship between demographic change and macroeconomic variables from an empirical angle. Higgins and Williamson (1996) find that much of the rise in Asian savings rates since the 1960s can be explained in terms of the decline in youth dependency burdens. Heller and Symansky (1997) argue that aging in emerging Asian economies will depress savings rates as a growing elderly population begins to dissave. Higgins (1998) examines the relationship between age distributions, national savings, and the current account balance. Using data for a large cross-section of countries, he finds evidence of substantial demographic effects, with increases in youth and old-age dependency associated with lower savings rates. He also finds evidence of differential effects on savings and investment, and thus a role of demography in determining the current account balance. Chinn and Prasad (2000) find that measures of relative youth and old-age dependency are negatively related to current account balances of industrial and developing countries, though the relationship is not consistently significant at conventional levels.

III. The Overlapping Generations Model

This section describes the overlapping generations framework, which is the foundation for the multicountry model. The discussion describes the life-cycle problem for the representative agent in country j, surpressing the country index. The representative agent lives for four periods: childhood, young working-age, old working-age and retirement. In childhood the agent is not a decision maker. Consumption c_t^0 is determined by the parent who is endowed with e_1 efficiency units of labor. Childrearing requires λ units of time per offspring, with time not devoted to childrearing inelastically supplied to the labor force. Young workers make a standard consumption-saving decision, consuming $c_t^1 + (1+n_t)c_t^0$ for the household and saving s_t^1. The budget constraint of a period t young worker is thus:

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[4] This paper incorporates the effects of youth dependency by allowing consumption of children to enter parents' utility. Both papers treat fertility as exogenous.

$$(1+n_t)c_t^0 + c_t^1 + s_t^1 = e_1 w_t [1-\lambda(1+n_t)] \tag{1}$$

In old working-age agents are endowed with e_2 efficiency units of labor, which they again supply inelastically. Wage income is supplemented by interest on wealth accumulated in the previous period. Children drop out of the budget constraint, having joined the workforce and become self-sufficient. The budget constraint of a period $t+1$ old worker is then:

$$c_{t+1}^2 + s_{t+1}^2 = e_2 w_{t+1} + (1+r_{t+1})s_t^1 \tag{2}$$

Here r_{t+1} is the return on capital held from period t into period $t+1$. Retirees are endowed with e_3 efficiency units of labor, which they inelastically supply to the labor force. Since there are no bequests retirees simply consume down wealth. This amounts to a decision rule for consumption, so that like children they are not active decision makers. The budget constraint of a period $t+2$ retiree is simply:

$$c_{t+2}^3 = e_3 w_{t+2} + (1+r_{t+2})s_{t+1}^2 \tag{3}$$

Preferences are described by an additively separable utility function. The lifetime utility of an agent born in period $t-1$ is:

$$V_t = \alpha(1+n_t)^{1-\varepsilon}\gamma_0 \frac{(c_t^0)^{1-\theta}}{1-\theta} + \gamma_1 \frac{(c_t^1)^{1-\theta}}{1-\theta} + \beta\gamma_2 \frac{(c_{t+1}^2)^{1-\theta}}{1-\theta} + \beta^2\gamma_3 \frac{(c_{t+2}^3)^{1-\theta}}{1-\theta} \tag{4}$$

The parameter $\alpha < 1$ gives the rate at which parents discount the utility of their children. The weight per child in the parental utility function is declining in the number of children so long as $\varepsilon > 0$. The relative importance of consumption while in childhood, young working-age, old working-age and retirement is given by γ_0, γ_1, γ_2 and γ_3. The subjective discount factor is given by β, where $0<\beta<1$, while θ is the coefficient of relative risk aversion. The substitutability of consumption over time is described by $1/\theta$, the elasticity of intertemporal substitution. When $1/\theta$ is greater than one, higher interest rates lead to increased savings, while the opposite is the case when $1/\theta$ is less than one. When $\theta=1$ the income and substitution effects of changes in the interest rate cancel out.

The age distribution in period t consists of N_{t-1} young workers, N_{t-2} old workers, and N_{t-3} retirees. The period t cohort of children is determined according to $N_t=(1+n_t)N_{t-1}$ where n_t is the period t cohort growth rate, which is exogenous. Table 1 describes the evolution of the age distribution over time:

Table 1: The Age Distribution over Time

Period	Children	Young Workers	Old Workers	Retirees
t	N_t	N_{t-1}	N_{t-2}	N_{t-3}
$t+1$	N_{t+1}	N_t	N_{t-1}	N_{t-2}
$t+2$	N_{t+2}	N_{t+1}	N_t	N_{t-1}
:	:	:	:	:

Output is generated according to a constant returns to scale neoclassical production function. Factors markets are efficient so that capital and labor are rewarded their marginal products:

$$r_{t+1} = \phi \pi_{t+1} K_t^{\phi-1} \left(X_{t+1} L_{t+1} \right)^{1-\phi} - \delta \qquad (5)$$

$$w_{t+1} = (1-\phi) \pi_{t+1} K_t^{\phi} X_{t+1}^{1-\phi} L_{t+1}^{-\phi} \qquad (6)$$

where $L_{t+1} = e_1(1-\lambda(1+n_{t+1}))N_t + e2N_{t-1} + e3N_{t-2}$ represents the aggregate labor supply measured in efficiency units. Exogenous technological progress is assumed to occur at a constant rate g, so that $X_{t+1} = (1+g)X_t$. π_{t+1} captures level differences in total factor productivity in the multicountry setting, while δ is the depreciation rate of capital. The capital stock entering period $t+1$ production is dated as of period t because it is generated by savings and investment decisions made in period t. The optimal consumption profile of the representative agent is given by:

$$c_t^0 = \left(\frac{\alpha \gamma_0}{\gamma_1} \right)^{1/\theta} (1+n_t)^{-\varepsilon/\theta} c_t^1 \qquad (7)$$

$$c_t^1 = \Phi_t^{-1} \left[e_1 w_t [1 - \lambda(1+n_t)] + \frac{e_2 w_{t+1}}{(1+r_{t+1})} + \frac{e_3 w_{t+2}}{(1+r_{t+1})(1+r_{t+2})} \right] \qquad (8)$$

$$c_{t+1}^2 = \left[\frac{\gamma_2 \beta (1+r_{t+1})}{\gamma_1} \right]^{1/\theta} c_t^1 \qquad (9)$$

$$c_{t+2}^3 = \left[\frac{\gamma_3 \beta^2 (1+r_{t+1})(1+r_{t+2})}{\gamma_1} \right]^{1/\theta} c_t^1 \qquad (8)$$

$$\Phi_t = 1 + \left(\frac{\alpha\gamma_0}{\gamma_1}\right)^{1/\theta}(1+n_t)^{\frac{\theta-\varepsilon}{\theta}} + \frac{\left[\frac{\gamma_2\beta(1+r_{t+1})}{\gamma_1}\right]^{1/\theta}}{(1+r_{t+1})} + \frac{\left[\frac{\gamma_3\beta^2(1+r_{t+1})(1+r_{t+2})}{\gamma_1}\right]^{1/\theta}}{(1+r_{t+1})(1+r_{t+2})} \quad (9)$$

Equation (7) shows that an increase in the number of children leads to a fall in consumption per child relative to consumption of young workers. But for $\theta > \varepsilon$ the consumption of the child cohort relative to that of young workers is increasing in n_t.

IV. The Large Open Economy Model

The world economy is assumed to consist of m regions, which differ in the level of total factor productivity π. This parameter permits the model to have economies that vary in size and therefore in their impact on the world interest rate. Countries with low total factor productivity resemble small open economies that take the world interest rate as given, while countries with high productivity are larger and behave more like closed economies. The productivity parameter is time dependent to allow for convergence in GDP per capita over time. Capital is assumed to be perfectly mobile so that agents in country j receive the same return whether they invest in domestic or foreign capital:

$$r_{t+1} = \phi\pi^j_{t+1}\left(K^j_t\right)^{\phi-1}\left(X_{t+1}L^j_{t+1}\right)^{1-\phi} - \delta = \phi\pi^i_{t+1}\left(K^i_t\right)^{\phi-1}\left(X_{t+1}L^i_{t+1}\right)^{1-\phi} - \delta \quad (10)$$

This no arbitrage condition implies a relationship between the capital stock in country j and country i that must hold in equilibrium:

$$K^i_t = \left[\frac{\pi^i_{t+1}}{\pi^j_{t+1}}\right]^{\frac{1}{1-\phi}}\left[\frac{L^i_{t+1}}{L^j_{t+1}}\right]K^j_t \quad (11)$$

Wages across countries are related by a factor measuring relative productivity:

$$w^i_{t+1} = \left[\frac{\pi^i_{t+1}}{\pi^j_{t+1}}\right]^{\frac{1}{1-\phi}} w^j_{t+1} \quad (12)$$

The restriction that the production technology is identical across regions except for differences in total factor productivity means that the capital-output ratios are equal across economies:

$$\frac{K^j_t}{Y^j_{t+1}} = \frac{\phi}{r_{t+1}+\delta} \quad (13)$$

The advantage of imposing a common production technology is that it keeps the model tractable. Global equilibrium in capital markets requires that demand for capital equal supply, or equivalently that net saving equal net investment at the world level:

$$\sum_{j=1}^{m} K_t^j = \sum_{j=1}^{m} \left[N_{t-1}^j s_t^{1j} + N_{t-2}^j s_t^{2j} \right] \tag{14}$$

Expanding this expression by substituting in for savings by young and old workers and using equations (11) and (12) to express capital stocks and wage levels in terms of the capital-labor ratio of the first region yields a non-linear difference equation in the capital-labor ratio of the first region, the only state variable of the model:

$$k_{t+1}^1 \left[\frac{(1+g)L_{t+1}^1}{(1-\phi)} \right] \left[\sum_{j=1}^{m} \left[\frac{\pi_{t+1}^j}{\pi_{t+1}^1} \right]^{\frac{1}{1-\phi}} \left[\frac{L_{t+1}^j}{L_{t+1}^1} \right] \right] = \tag{15}$$

$$\left[\sum_{j=1}^{m} N_{t-1}^j \left[\left[\frac{\pi_t^j}{\pi_t^1} \right]^{\frac{1}{1-\phi}} e_1 \pi_t^1 (k_t^1)^{\phi} \left[1 - \lambda(1+n_t^j)\right] - \Psi_t^j (\Phi_t^j)^{-1} W_t^j \right] \right] +$$

$$\left[\sum_{j=1}^{m} N_{t-2}^j \left[\left[\frac{\pi_t^j}{\pi_t^1} \right]^{\frac{1}{1-\phi}} e_2 \pi_t^1 (k_t^1)^{\phi} + (1+r_t) \left[\left[\frac{\pi_{t-1}^j}{\pi_{t-1}^1} \right]^{\frac{1}{1-\phi}} \frac{e_1 \pi_{t-1}^1 (k_{t-1}^1)^{\phi}}{(1+g)} \left[1 - \lambda(1+n_{t-1}^j)\right] - \Psi_{t-1}^j (\Phi_{t-1}^j)^{-1} W_{t-1}^j \right] \right] \right] -$$

$$\left[\sum_{j=1}^{m} N_{t-2}^j \left[\frac{\gamma_2 \beta (1+r_t)}{\gamma_1} \right]^{1/\theta} (\Phi_{t-1}^j)^{-1} W_{t-1}^j \right]$$

where $k^1_{t+1} = K^1_t / (X_{t+1} L^1_{t+1})$ and

$$\Psi_t^j = 1 + \left(\frac{\alpha \gamma_0}{\gamma_1} \right)^{1/\theta} (1+n_t^j)^{\frac{\theta-\varepsilon}{\theta}} \tag{16}$$

$$W_t^j = \left[\frac{\pi_t^j}{\pi_t^1} \right]^{\frac{1}{1-\phi}} e_1 \pi_t^1 (k_t^1)^{\phi} \left[1 - \lambda(1+n_t^j)\right] + \left[\frac{\pi_{t+1}^j}{\pi_{t+1}^1} \right]^{\frac{1}{1-\phi}} \frac{e_2 \pi_{t+1}^1 (1+g)(k_{t+1}^1)^{\phi}}{(1+r_{t+1})}$$

$$+\left[\frac{\pi_{t+2}^{j}}{\pi_{t+2}^{1}}\right]^{\frac{1}{1-\phi}}\frac{e_3\pi_{t+2}^{1}(1+g)^2\left(k_{t+2}^{1}\right)^{\phi}}{(1+r_{t+1})(1+r_{t+2})} \tag{17}$$

$$W_{t-1}^{j}=\left[\frac{\pi_{t-1}^{j}}{\pi_{t-1}^{1}}\right]^{\frac{1}{1-\phi}}\frac{e_1\pi_{t-1}^{1}\left(k_{t-1}^{1}\right)^{\phi}}{(1+g)}\left[1-\lambda\left(1+n_{t-1}^{j}\right)\right]+\left[\frac{\pi_{t}^{j}}{\pi_{t}^{1}}\right]^{\frac{1}{1-\phi}}\frac{e_2\pi_{t}^{1}\left(k_{t}^{1}\right)^{\phi}}{(1+r_t)}$$

$$+\left[\frac{\pi_{t+1}^{j}}{\pi_{t+1}^{1}}\right]^{\frac{1}{1-\phi}}\frac{e_3\pi_{t+1}^{1}(1+g)\left(k_{t+1}^{1}\right)^{\phi}}{(1+r_t)(1+r_{t+1})} \tag{18}$$

Assuming that cohort growth is constant over time and equal across regions, and dropping time indices from all other variables, yields an equation in the steady state capital-labor ratio of the first region:

$$k^1\frac{(1+g)\left[e_1[1-\lambda(1+n)](1+n)^2+e_2(1+n)+e_3\right]}{(1-\phi)\pi^1}= \tag{19}$$

$$(1+n)\left[e_1\left(k^1\right)^{\phi}[1-\lambda(1+n)]-\Psi\Phi^{-1}W\right]+$$

$$\left[e_2\left(k^1\right)^{\phi}+(1+r)\left[\frac{e_1\left(k^1\right)^{\phi}}{(1+g)}[1-\lambda(1+n)]-\Psi\Phi^{-1}W_{-1}\right]-\left[\frac{\gamma_2\beta(1+r)}{\gamma_1}\right]^{1/\theta}\Phi^{-1}W_{-1}\right]$$

The steady state capital-labor ratio is independent of relative productivity levels and depends only on factors relating to the first economy. This result is quite general and holds for other level differences, for example level differences across economies in effective labor supply.

V. Model Calibration

The model is parameterized to reflect the fact that each period corresponds to roughly 20 years. The subjective discount rate β is set at 0.6, which corresponds to a pure rate of time preference ρ of about 2.5 percent per year where $\beta=1/(1+\rho)^{20}$. The discount factor applied to the utility of children α is set at 0.6, equivalent to an annual discount factor of 0.975. The coefficient of relative risk aversion θ is set at 2 so that the elasticity of intertemporal substitution is 0.5. ε is set at 0.5 so that $\theta > \varepsilon$. Consumption in childhood, young working-age, old working-age and retirement carries the same weight in lifetime utility so that γ_0, γ_1, γ_2 and γ_3 each equal one. Agents are endowed with one efficiency unit of labor in each working-age period, while they have a zero labor endowment in retirement. The parameter which describes the time cost of childrearing λ is set at 0.1 so that young workers devote $\lambda(1+n_t)$ percent of their time endowment to this task. The share of output rewarded to capital ϕ is set at 0.3, while depreciation is assumed to occur at a rate of 5 percent per year so that $\delta = 1\text{-}0.95^{20} = 0.65$. Exogenous technological progress is assumed away so that $g = 0$.[5]

This choice of parameters represents a baseline specification and should not be regarded as the only relevant parameterization. Indeed the choice of parameters should be seen in terms of the main hypothesis underlying the model, that life cycle factors are a key determinant of the current account balance. Since the effects of youth and old-age dependency figure so prominently in this hypothesis, the parameter choices for α, ε, λ, γ_0, γ_1, γ_2, γ_3, e_1, e_2 and e_3 are significant because they determine the relative importance of youth and old-age dependency effects for a given demographic shift. From the point of view of robustness of the results a key question is then: are the results of the model qualitatively unchanged for reasonable values of these parameters? Table 2 presents steady state capital labor ratios for the baseline parameterization of the model, assuming that $\pi = 1$ and that $n^* = 0.71$ so that steady state population growth is about 2.7 percent per annum.

Table 2: Steady State Capital-Labor Ratios

α	0.2	0.6	1
$k^*(\alpha)$	0.0168	0.0103	0.0078
ε	0	0.5	1
$k^*(\varepsilon)$	0.0089	0.0103	0.0118
λ	0	0.1	0.2
$k^*(\lambda)$	0.0129	0.0103	0.0076
n^*	0	0.23	0.71
$k^*(n)$	0.0435	0.0253	0.0103
θ	0.5	1	2
$k^*(\theta)$	0.0752	0.0404	0.0103

As α falls the capital-labor ratio increases because youth dependency becomes relatively less important for a given rate of population growth. As ε rises away from zero the capital-labor

[5] These parameter choices are consistent with the recent overlapping generations literature. Higgins (1994) chooses ϕ=0.33, β=0.54, δ=0.72, and θ=0.77 in the context of a 3 period model. For this choice of θ the elasticity of intertemporal substitution is 1.3, so that higher interest rates lead to a moderate increase in saving. Higgins and Williamson (1996) appear to have the same parameterization, with the exception of θ, which is set at 1, making savings unresponsive to changes in the interest rate. Attanasio and Violante (2000), in a model with mortality risk, set ϕ=0.36, β=1.011 per annum, δ=0.05 per annum, with θ=2 such that higher interest rates reduce savings slightly.

ratio increases as the weight per child in the parental utility function declines. As λ increases agents devote a greater amount of time per unit of offspring so that for a given n the effective labor supply falls. Nonetheless the capital-labor ratio declines as λ increases because the impact on capital accumulation outweighs the effect on the labor force. As cohort growth declines towards zero the capital-labor ratio increases due to capital deepening associated with lower fertility. Capital deepening is also associated with lower values for θ.

The productivity parameter π^j takes on a special significance in the model because it determines the size of economy j. The parallel universe is assumed to consist of eight global economies: Canada and the US (NA), the 15 member countries of the European Union (EU), Japan (JAP), Latin America and the Caribbean (LAC), China and Taiwan (CHI), Africa (AFR), the countries of the former Soviet Union (FSU), and a region representing the rest of the world (ROW). Table 3 lists real GDP per capita in these regions relative to that in NA, using data from Maddison (1991) and the Penn World Tables Mark 5.6:[6]

Table 3: Ratio of Real GDP per Capita to NA (in %)

	EU	LAC	CHI	JAP	AFR	FSU	ROW
1870	77						
1890	70	21	13	28			15
1910	60	19	9	24			12
1930	60	20	7	28			9
1950	42	16	4	16	8	25	7
1970	64	21	6	57	8	32	7
1990	70	17	10	79	8	42	7

Table 3 tells a story of different and evolving economic fortunes. Prior to World War II real GDP per capita relative to NA deteriorated in the EU countries, falling to a low of 42 percent in 1950. The war had a similar effect on Japan, though real GDP per capita was only around 30 percent that of NA around 1900. The postwar period has seen convergence in both regions towards real GDP per capita in NA, with the EU and Japan around 70 and 80 percent respectively in 1990. Meanwhile real GDP per capita relative to NA has remained stable in other regions, at around 20 percent in LAC, 10 percent in CHI, AFR and ROW, and 30 percent in the FSU.

[6] The data from Maddison (1995) give GDP per capita in 1985 US dollars and the total population for a range of countries starting in 1870. This data is reproduced in Barro and Sala-i-Martin (1995). For the AFR and FSU economies the POP series, which is population in thousands, and the RGDPCH series, which is GDP per capita in constant dollars, were used from the Penn World Tables Mark 5.6 to construct the ratios.

It is clear from Table 3 that size matters, both across regions and over time. The simulations that follow calibrate the regional total factor productivities to match the historical evolution of per capita income, both across regions and over time.

VI. Historical and Projected Population Trends

Figures 1 and 2 plot youth and old-age dependency ratios in the eight global regions for the period 1950 to 2150.[7] There exists a wide dispersion in 1950 in both youth and old-age dependency ratios. The EU and North America are substantially "older" than other regions, having lower youth dependency and higher old-age dependency. Africa and LAC are at the other extreme, with the highest youth and lowest old-age dependency ratios. Japan is somewhere in the middle. Its youth dependency ratio in 1950 is near 60 percent, roughly halfway between the EU and Africa, while its old-age dependency ratio also occupies the middle ground. Looking forward this underscores the dramatic decline in fertility that has transformed Japan's age distribution.

From Figure 1 it is clear that historical and projected trends in fertility are quite different across regions. Japan sees a dramatic decline in youth dependency from 60 percent in 1950 to a projected 23 percent in 2000. The EU sees a slight increase in youth dependency, which peaks in 1970 at 39 percent, before the baby bust pushes youth dependency to a projected minimum of 24 percent in 2010. The effects of the post-war baby boom are most pronounced in North America where youth dependency rises to a peak of 52 percent in 1960. Thereafter the baby bust brings youth dependency down to near 30 percent by 1980, close to the projected long run level. The picture is quite different in developing regions. In Africa youth dependency is projected to remain above 80 percent until 2000, before it declines to an assumed long run equilibrium of 30 percent. LAC sees an earlier and more precipitous drop in youth dependency, while CHI sees a substantial drop in youth dependency from a peak of 72 percent in 1965 to around 30 percent in 2010. Figure 1 illustrates an important property of the World Bank projections: assumed convergence in population growth in the very long run. Youth dependency across regions converges at 30 percent by 2075, for population growth near zero. This feature of the projections is better interpreted as an "equilibrium condition" rather than as

[7] For the period 1950 to 1990 the data are taken from the United Nations "World Population Prospects: The 1992 Revision," which provides data on the age distribution (in 5 year age-groups) for a large cross-section of countries. The demographic data from 1995 onward are imputed using country-specific cohort growth rates (for the same 5 year age-groups) from the World Bank "World Population Projections: The 1994-95 Edition," using the United Nations data as a base. This data splice is necessary because the United Nations projections extend only to 2025, while the World Bank data go back only to 1990. In 1990, the base year for the projections used in this paper, the age distribution data from both sources are very similar in most cases.

a forecast. From the point of view of the simulations this aspect of the projections is helpful since cohort growth must be equal across regions for there to be a steady state.

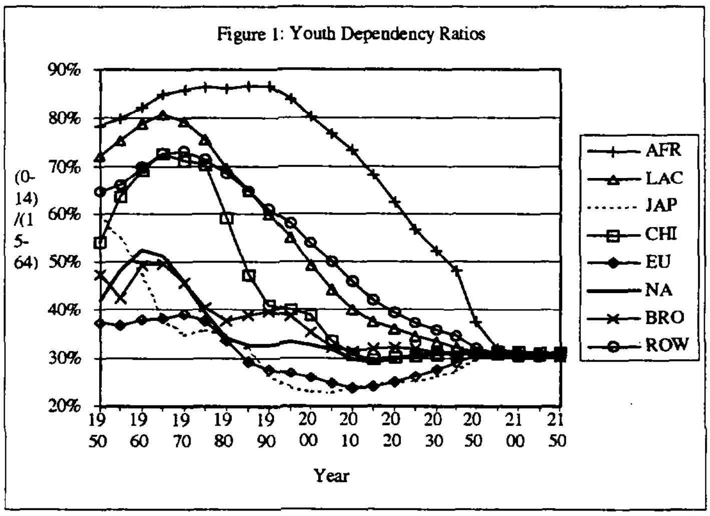
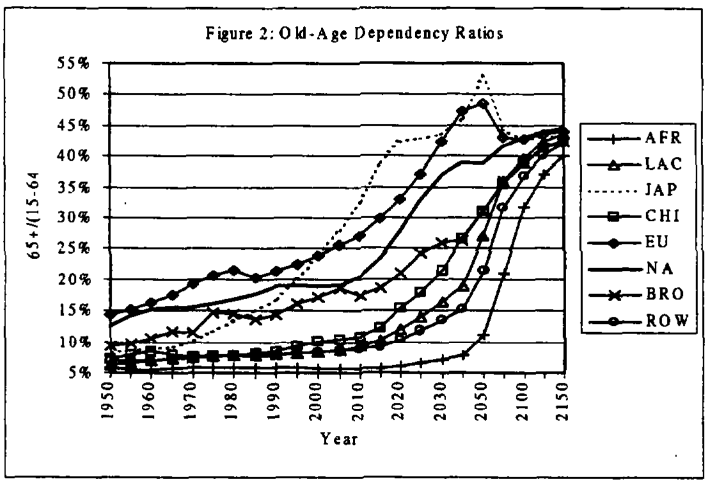
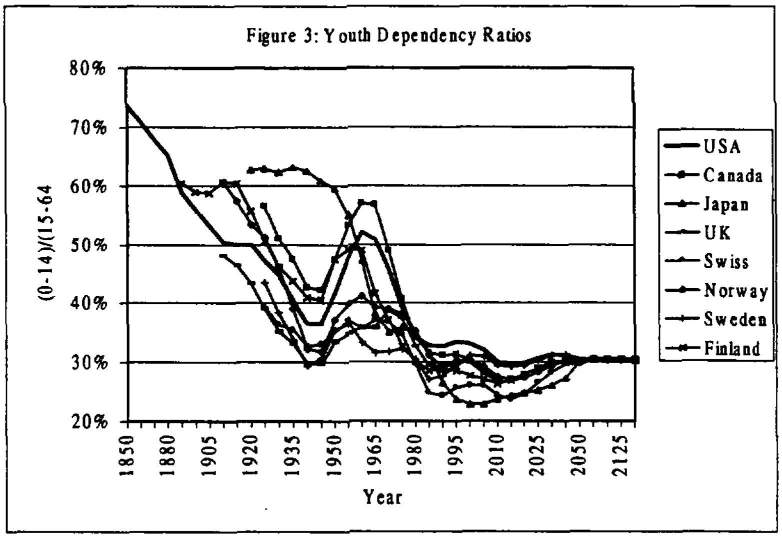
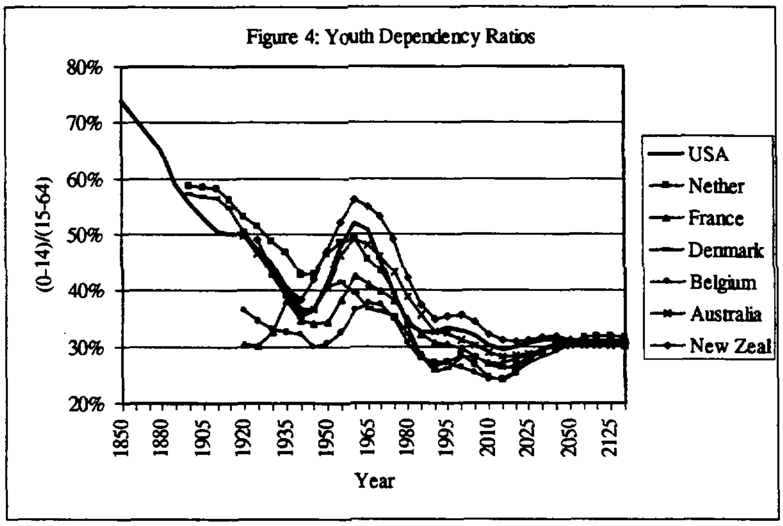


Figure 2 shows that the aging of Japan's population is remarkable compared with other regions. Old-age dependency rises from 8 percent in 1950 to a projected 24 percent in 2000, the same level as in the EU, which has old-age dependency of 14 percent in 1950. Old-age dependency in Japan then accelerates to the highest projected level of any region in 2050 at 53 percent. In the same year old-age dependency is also projected to peak in the EU at 49 percent. Meanwhile old-age dependency remains at comparatively sedate levels in North America, reaching 39 percent in 2050 before converging to a long run equilibrium near 45 percent. Old-age dependency ratios in developing regions remain extremely low until they are driven up by the long-run "equilibrium condition" around 2050.



Figures 3 and 4 plot youth dependency ratios for a selection of countries over the period 1850 to 2150. They raise three important points. First, the world was not in a demographic steady state prior to 1950. Population data for developed economies suggest these regions experienced a dramatic decline in fertility leading up to 1950. For example youth dependency in the US declined from 74 percent in 1850 to 36 percent in 1945, a decline similar to that experienced by other developed countries. Second, the degree of comovement between the series is striking, suggesting that fertility trends across the developed world are dominated by a global factor that loads on events such as the two world wars and the Great Depression. Third, Japan is a notable exception to the global fertility decline prior to 1960. Youth dependency in Japan remained stable around 60 percent until 1950. Unlike the rest of the countries plotted here, Japan was in a high fertility equilibrium, which in part explains the severity of aging in Japan today.





VII. THE SIMULATED DEMOGRAPHIC TRANSITION

The simulated demographic transition takes into account the fact that across many developed countries fertility declined in the period leading up to 1950. Figure 5 plots annualized cohort growth for the eight global regions over the simulation period, which extends from 1770 to 2230.[8] Before the transition the world economy is assumed to be in a high fertility equilibrium with cohort growth about 2.7 percent per annum ($n^* = 0.71$).[9] The demographic transition begins in 1870 when cohort growth in NA, the EU and the FSU falls steadily to around 1 percent per year in the model period centered around 1950. Cohort growth remains near the high fertility equilibrium for all other regions of the model. Beyond 1950 cohort growth rates replicate historical and projected population trends, rising in the period centered around 1970 in NA, the EU and the FSU because of the baby boom and declining rapidly thereafter as the baby bust takes hold. Beyond 1950 cohort growth in developing regions such as CHI, LAC, AFR and ROW surges above the initial equilibrium rate before eventually declining. Japan follows an entirely different path. It transitions from the initial high fertility equilibrium to an equilibrium with zero cohort growth in the space of just one model period (between 1950 and 1970). The simulated transition ends around 2070 when cohort growth in all regions stabilizes at close to zero ($n^* = 0.02$). The transition from a high to a low fertility equilibrium is complete.

Figures 6 and 7 plot youth and old-age dependency ratios for the simulated demographic shift. Youth dependency falls from about 110 percent in the pre-transition equilibrium to just above 50 in the post-transition steady state when the global population is basically stable. Old-age dependency rises from an initial level of around 20 percent to a long run equilibrium level of 50 percent. Both charts demonstrate that the simulated demographic shift reproduces the key features of observed demographic trends, both across regions and over time.

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[8] Cohort growth rates for the model are computed by aggregating the16 5-year age groups in the data into 4 20-year age groups that span 0-19, 20-39, 40-59, 60+. The cohort growth rate is then the "child" cohort divided by the "young worker" cohort minus one, calculated in 20 year intervals.

[9] Under the assumption of perfect capital mobility cohort growth must be equal across regions in the steady state. The level of cohort growth in the pre-transition steady state is important because it will impact the extent to which the transition will produce capital deepening. The simulated transition will produce substantial capital deepening as cohort growth declines from initially 3 percent per year to zero. A second transition scenario that begins in 1950 and starts from an initial steady state with cohort growth around 1 percent per annum produces less capital deepening but qualitatively unchanged transitional dynamics beyond 1990.

Figure 5: Annualized Cohort Growth Rates

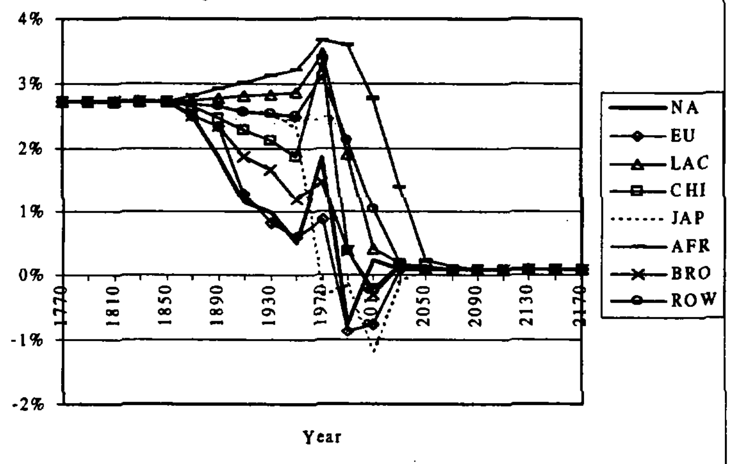


Figure 6: Youth Dependency Ratios

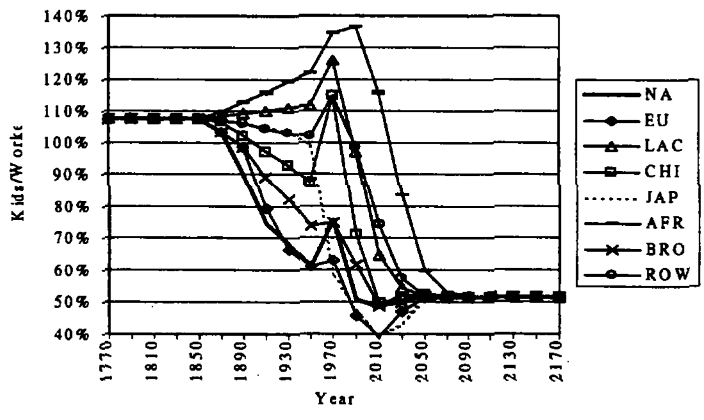
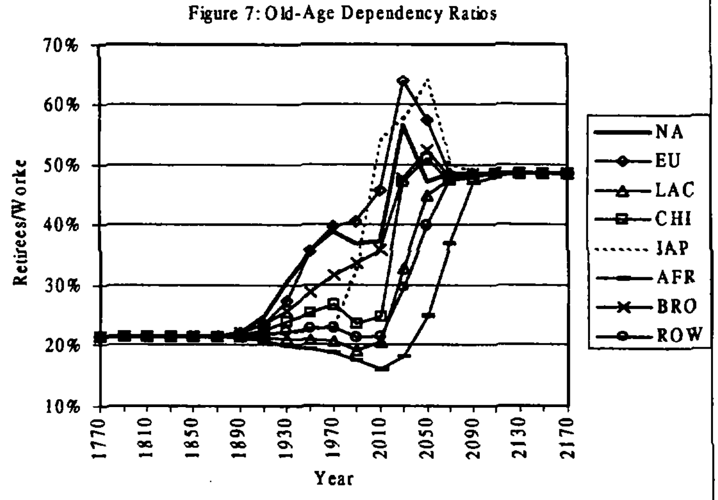


Figure 7: Old-Age Dependency Ratios



VIII. Simulating the Effects of Demographic Change

Figures 8 through 13 plot the current account over the transition for some of the regions.[10] The charts are three dimensional for a simple reason. Each region's productivity parameter π is held constant over the simulation period, to focus only on the effects of demographic change. But GDP per capita in the EU and Japan has converged significantly towards that in NA since 1950, so that for purposes of calibration it is unclear how large to make both regions relative to NA. This problem is addressed by simulating the demographic shift ten times, progressively increasing the productivity parameter assigned to the EU and Japan from 0.1 to 1 in increments of 0.1. Table 4 gives the steady state ratio of income per capita in both regions relative to that in NA.

Table 4: Ratio of GDP per Capita in the EU and JAP relative to NA (in %)

π	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Ratio	4	10	18	27	37	48	60	73	86	100

In other words the simulated current account path for $\pi = 0.7$ assumes that GDP per capita in the EU and Japan is on average 60 percent that in NA over the simulation period. This scenario amounts to freezing relative GDP per capita in the EU and Japan at 1970 levels for the full simulation period. The other productivity parameters are held fixed such that the steady state GDP per capita ratios are 21 percent in the case of LAC, 10 percent in the case of CHI, AFR and ROW, and 25 in the case of the FSU area. In effect this approach amounts to a sensitivity analysis that examines whether the effects of demographic change are robust to convergence in GDP per capita of the EU and Japan relative to NA.[11]

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[10] Using equation (16) is possible to find the steady state capital-labor ratio for a given cohort growth rate. Using csolve.m, a non-linear equation solver for Matlab written by Christopher Sims, this is done for the pre- and post-transition steady states. These capital-labor ratios are then imposed as initial and terminal conditions in a system of non-linear difference equations, based on equation (15) that must hold over the transition. The equilibrium path of the capital-labor ratio consistent with this system of equations is then solved for numerically using csolve.m.

[11] The current account balance is derived as the difference between net saving and net investment. Net saving in period t is given by $A_t - A_{t-1}$ where $A_t = N_{t-1}s_t^1 + N_{t-2}s_t^2$ is wealth accumulated in period t and invested in period $t+1$. If $A_t - A_{t-1} > 0$ then total saving by workers exceeds dissaving by retirees in period t, while if $A_t - A_{t-1} < 0$ total dissaving by retirees exceeds wealth accumulated by working-age cohorts. Net investment in period t is given by $K_t - K_{t-1}$. In the steady state it is the case that $A_t - A_{t-1} = K_t - K_{t-1}$. Net saving equals net investment (continued...)

Figure 8 plots the current account in percent of GDP for North America. As cohort growth in North America falls below the global average beyond 1850 the underlying return on capital in NA falls also, which generates current account surpluses that persist until 1970 when the baby boom drives cohort growth in NA above that in the EU, Japan and the FSU. The baby boom raises the underlying return on capital in NA, which leads to a current account deficit for π greater than 0.4 in the case of the EU and Japan. The intuition behind this result is simple. Cohort growth in the EU and Japan is below that in NA so that as π increases they drag down the world return on capital. For π greater than 0.4 their impact is such that the underlying return on capital in NA is above the world return, producing capital inflows. The current account peaks in 2010 at around 3.4 percent of GDP (for π between 0.8 and 1), then drops sharply to –3.2 percent of GDP in 2030 before returning to zero in the long run steady state. The sharp swing in the current account from 2010 to 2030 is a product of the baby boom – baby bust and is robust to different factor productivities for the EU and Japan. The intuition behind the swing is obvious. A large cohort of baby boomers is born in 1970. The boomers accumulate savings for retirement primarily in 2010 when they are in old working-age. This drives saving above investment, generating the current account surplus. They dissave in 2030 when they are in retirement, driving the current account negative.

Figure 8: The Current Account Balance in NA (in % of GDP)

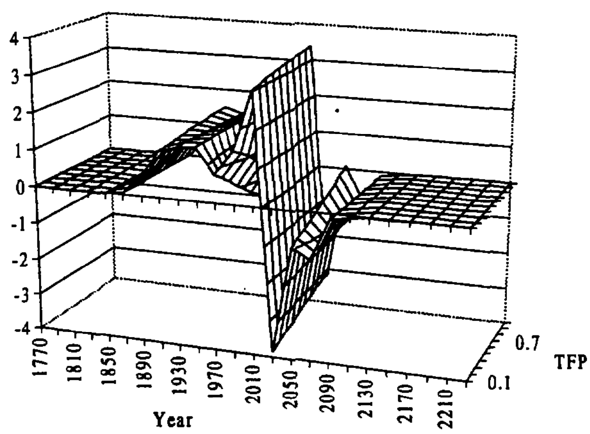

Figure 9 plots the current account balance in percent of GDP for the EU. As in NA the current account turns positive beyond 1850 as cohort growth in Europe falls below the global average. As cohort growth increases in the period centered around 1970, the model period that captures the baby boom, the surplus declines because the underlying return on capital in the EU

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just as in a closed economy. Over the transition, however, as cohort growth diverges across regions this need no longer be the case. Regions with net saving in excess of net investment are investing abroad and accumulating foreign assets, while the reverse is true for regions with net saving below net investment.

countries rises towards the world interest rate. The current account surplus peaks in 2010 (for $\pi > 0.1$), averaging about 2.8 percent of GDP for π in the range 0.8 to 1. As in NA working-age boomers born in 1970 are saving for retirement, which pushes up domestic saving supply relative to investment demand. In effect European baby boomers are accumulating retirement savings by investing in developing regions where the underlying return on capital is higher. The current account turns negative in 2030, averaging about –2.8 percent of GDP for π around 0.8, and deteriorates further in 2050 to around –3.1 percent of GDP for $\pi = 0.8$. The fact that the current account deficit worsens in 2050 is linked to the evolution of cohort growth in the EU, which unlike cohort growth in NA remains negative in 2010. The European baby bust lasts longer, and as a result the current account deficit does too. As in the case for NA the switch from surplus to deficit going from 2010 to 2030 is robust to different values for π.

Figure 9: The Current Account Balance in the EU (in % of GDP)

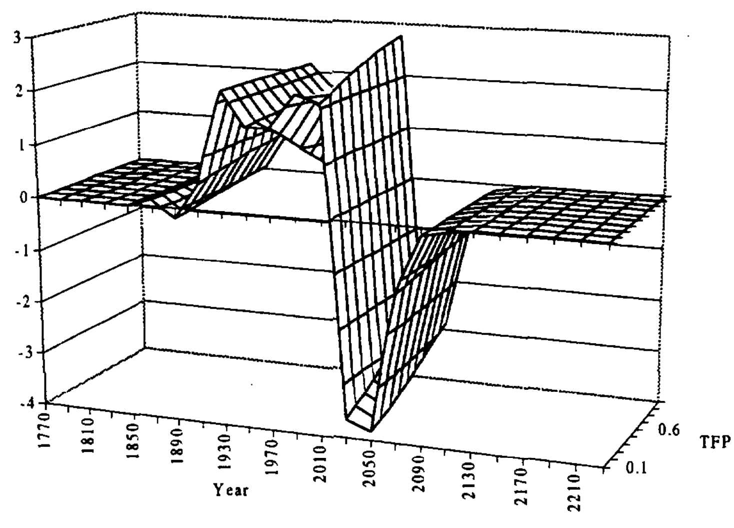


Figure 10 plots the current account balance in percent of GDP for Japan, which remains in a high fertility equilibrium until 1950. As cohort growth in NA, the EU and the FSU declines beyond 1850 this means that the underlying return on capital in Japan is above the world interest rate, which results in capital inflows. The current account deficit bottoms out at –1.8 percent of GDP in the period centered around 1930, a magnitude that is stable across different values for π. Cohort growth declines from above 2 percent per annum in 1950 to below zero in 1970. This huge shift in fertility dramatically reduces the implicit return on capital in Japan so that savers shift their holdings abroad. The current account switches from –1.2 percent of GDP in 1950 to a surplus of 3.12 percent of GDP in 1970 (for π around 0.8). The current account remains positive in 1990, rising to 4.7 percent of GDP for $\pi = 0.8$, driven by the savings of the last generation born during the high fertility equilibrium in 1950. The dissaving of this cohort drives the current account balance negative in 2010 when it averages –1 percent of GDP for values of π greater than 0.6. Japan is projected to suffer a second baby bust when cohort growth falls below –1 percent per annum in the period centered around 2010. This decline in fertility is responsible for the current account deficit of about –4.4 percent of GDP in 2050, when a relatively large cohort born in 1990 moves into retirement and dissaves. In short Japan's demographic transition produces a reversal in the current account that comes earlier and is more persistent than in the EU or NA. While the latter regions experience the post-war baby boom and bust, which produces a swing from current account surplus in 2010 to deficit in 2030, Japan's pronounced fertility decline after 1950 generates a transition from current account surplus to deficit that begins between 1990 and 2010.

Figure 10: The Current Account Balance of Japan (in % of GDP)

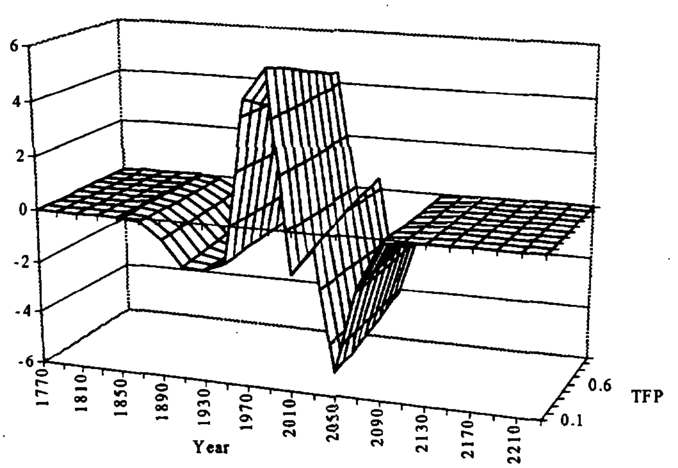


Figure 11 plots the current account balance in percent of GDP for the LAC region. Beyond 1850 cohort growth in LAC rises above that in the initial high fertility equilibrium. As a result the implicit return on capital rises above the world interest rate and the region registers large and persistent capital inflows. The period centered around 1970 illustrates how size matters in the model. In that period the current account deficit of LAC ranges from –1.5 percent of GDP for $\pi = 0.1$ to -4.75 percent of GDP for $\pi = 1$. As the EU countries and Japan converge in size to NA, low cohort growth in both regions tends to pull down the world interest rate relative to the implicit return on capital in LAC. Thus with π increasing the current account deficit becomes greater. The current account switches to surplus in 2010 when it amounts to 1.2 percent of GDP for values of π between 0.1 and 0.5. In this regard the LAC region is similar to other developing regions such as CHI, AFR or ROW where deficit turns to surplus around a similar time. Figures 12 and 13 present the evolution of the current account for CHI and AFR respectively.

Figure 11: The Current Account Balance for LAC (in % of GDP)

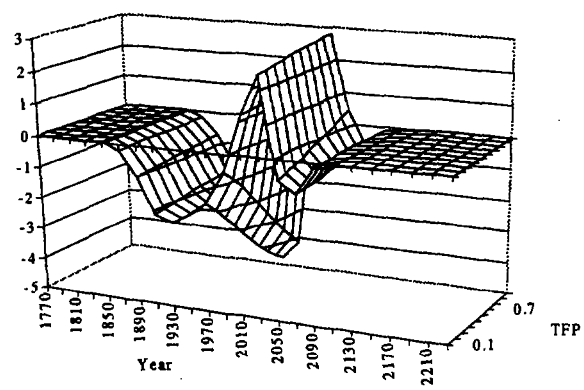


Figure 12: The Current Account Balance of CHI (in % of GDP)

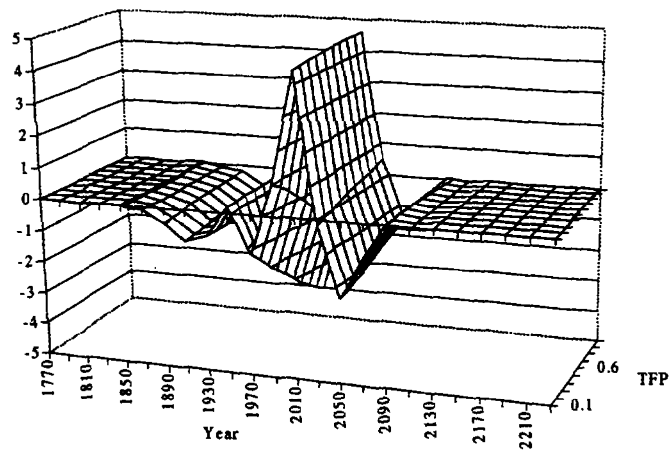
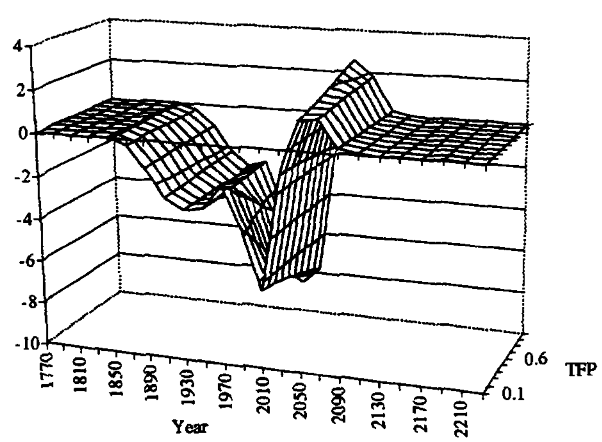


Figure 13: The Current Account of AFR (in % of GDP)

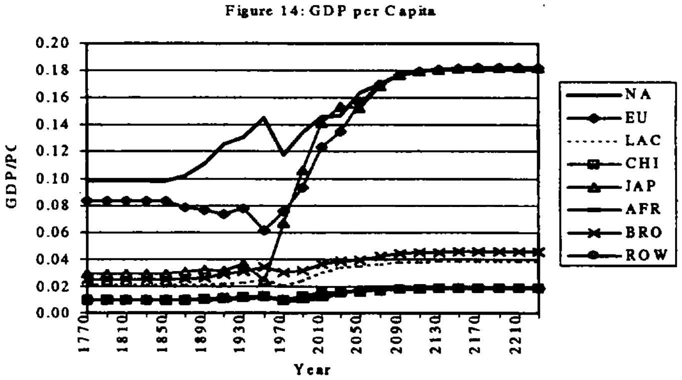


Overall a number of interesting points emerge. First, developed regions such as NA, the EU and Japan experience capital outflows from 1950 to 1990 when declining fertility relative to the rest of the world pushes down their implicit returns on capital. Beyond 2010 the situation is reversed. The developed world experiences large current account deficits as large boomer cohorts dissave in retirement, pushing net saving below investment. In effect the developed world is running down its accumulated shares in foreign capital. The picture is of course the opposite for developing regions such as AFR, CHI and LAC. Second, size matters. The magnitude of international capital flows depends on the π parameter, or the assumed size of the EU and Japan relative to NA. Importantly though, the global turning point around 2010 is robust to changes in π. The impact of the baby boom and bust on saving and investment behavior is too pronounced for π to have an effect. Third, the demographic "center of gravity" of investment demands is earlier than for savings supply, a point first made by Higgins and Williamson (1996) and documented empirically by Higgins (1998). Investment demand is more closely related to the share of children in the population, through its connection with labor force growth. In contrast, savings supply is more closely related to the share of working-age adults and retirees, through its connection with retirement needs. A shift towards a younger age distribution thus generates current account deficits and foreign capital dependence, as investment demand exceeds the domestic supply of savings.

IX. Simulating the Interactions of Demographic Change and Growth

The simulations in the previous section focus on demographic change, simulating the effects of population dynamics holding all else constant, especially economic development. Of course this is not what happened. The ratio of GDP per capita in the EU to that in NA grew from 42 percent in 1950 to 70 percent in 1990, while in the same period it grew from 16 percent to 79 percent in the case of Japan. Size matters not only across regions but also over time. In the context of the model this is important because the key driver behind international capital flows on the investment side is the implicit return on capital, which is affected by relative cohort growth and the level of π. This section simulates the demographic transition, calibrating the π^j to match the evolution of the GDP per capita ratios over time. Figure 14 plots the evolution of GDP per capita for the simulated transition.

Figure 14: GDP per Capita



Convergence in GDP per capita in the EU region and Japan matches the data in Table 3 up until 1990, beyond which it is assumed that convergence in the production technology with NA is achieved by 2010 in Japan and by 2050 in the EU. The overall increase in GDP per capita levels arises from capital deepening effects associated with lower fertility in the long run. Figure 15 plots the current accounts of Japan and the EU over the transition.

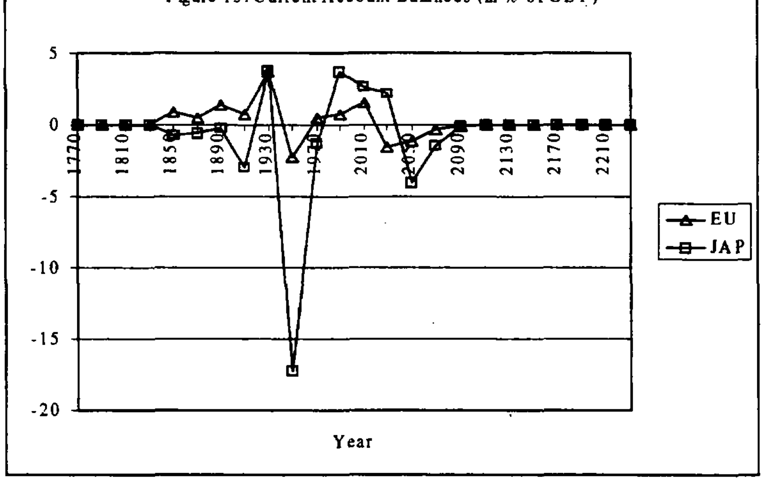


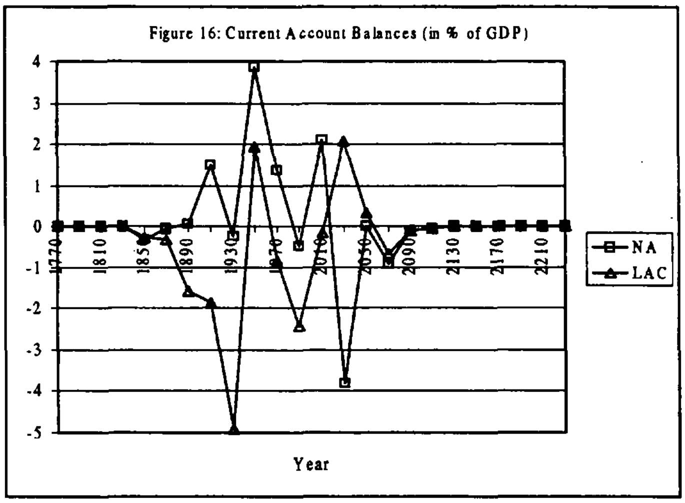
Figure 15: Current Account Balances (in % of GDP)

Both Japan and the EU experience large current account deficits in the model period centered around 1950. The postwar recovery in both regions is financed by capital flows from NA and from developing regions where the implicit return on capital, driven only by cohort growth, falls behind the underlying rates of return in Japan and Europe. As Table 5 shows the EU current account registers a deficit of –2.3 percent of GDP in the period centered around 1950, a surplus of 0.5 percent in 1970 and a surplus of 0.7 percent in 1990. In 2010 the surplus rises to 1.5 percent of GDP as aging baby boomers accumulate retirement wealth. As these baby boomers dissave in retirement the current account registers a deficit of –1.5 percent of GDP in 2030. The deficit persists into 2050 when it measures –1.1 percent of GDP. In short, accounting for economic growth leaves the implications of demographic change for the EU current account qualitatively unchanged. The turning point in the savings – investment balance going from 2010 to 2030 is unaffected. The same is not true for Japan where economic recovery following World War II is so strong that it registers a current account deficit of –17.3 percent of GDP in the period centered around 1950. Improvements in Japanese technology are such that huge capital inflows are necessary to keep the return on Japanese capital in line with the world interest rate. The magnitude of these inflows changes the subsequent path of the Japanese current account. To pay off foreign liabilities the current account switches to surplus in 1990 and remains positive through 2030. Accounting for the rapid postwar recovery in Japan has important repercussions for the evolution of the current account.

Table 5: Current Account Balances in % of GDP

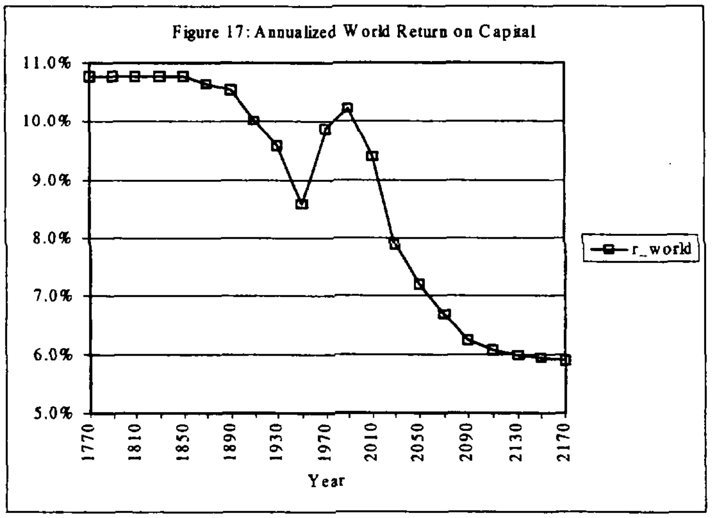
	1910	1930	1950	1970	1990	2010	2030	2050	2070
EU	0.70	3.67	-2.27	0.50	0.74	1.53	-1.52	-1.13	-0.38
JAP	-3.00	3.77	-17.28	-1.30	3.68	2.63	2.16	-4.02	-1.48
NA	1.51	-0.23	3.86	1.37	-0.48	2.11	-3.83	-0.01	-0.93
FSU	-0.08	-1.69	3.88	2.49	-0.25	0.48	-0.03	-1.53	-0.80
LAC	-1.86	-4.92	1.95	-0.83	-2.43	-0.17	2.08	0.32	-0.67
CHI	-0.70	-2.97	3.46	-0.45	-0.83	3.33	-0.23	-1.38	-0.73
AFR	-2.34	-5.74	1.32	-1.02	-5.83	-8.59	-2.20	2.20	1.77
ROW	-1.36	-4.01	2.49	-0.01	-2.74	-2.09	1.51	1.64	-0.67

Figure 16 plots the current account in percent of GDP for NA and LAC. Much of the financing for economic recovery in Japan and the EU is generated by NA, although the LAC current account also registers a surplus in 1950. As before the NA current account turns from surplus in 2010 to deficit in 2030 as the baby boomers move into retirement.[12]



[12] Going from 2010 to 2030, the turning point in the global savings – investment balance obtains for a wide range of conventional parameterizations of the model. It is however highly sensitive to different scenarios for economic growth in developing regions. A scenario where GDP per capita in CHI converges with that in NA beginning in the period centered around 2010, for example, would raise the incipient return on capital in CHI and generate capital inflows. The timing and scale of these inflows would depend on projected economic growth in CHI relative to the rest of the world.

Figure 17 plots the annualized world return on capital. The long run decline in fertility produces substantial capital deepening, raising the capital-labor ratio and pushing down the world interest rate. In the pre-transition steady state the world return on capital is just shy of 11 percent per annum, falling to 6 percent in the long run. The impact of technological destruction related to World War II can be seen in the decline of the world return on capital to about 8.5 percent per year in the period around 1950. Thereafter economic recovery in Japan and the EU and the baby boom in developed regions push the world return back above 10 percent.[13]



How do the generated capital flows match with the data? Table 6 provides current account balances in percent of GDP for the model regions.[14] It lists average current account balances for 20 year periods centered around 1970 and 1990. On the basis of two observations it is hard to say anything about the fit of the model, though it is clear that controling for the postwar economic recovery in Japan and the EU improves the fit. In both regions economic growth drives the current account negative around 1950 and the model predicts a gradual improvement through 2010. Certainly this shift is consistent with the data. Interestingly the model also matches the deterioration in the NA current account, from a surplus of 1.4 percent of GDP in 1970 to a deficit of –0.5 percent of GDP in 1990.

[13] The capital deepening effects over the very long run are conditional on the World Bank forecast, which sees cohort growth in the very long run decline to zero.

[14] The current account and GDP series are taken from the World Economic Outlook. The regional series have different lengths, because data for developing countries becomes available later than for industrial ones. For Africa the series begins in 1970, for China in 1968, for the EU and FSU countries in 1969 (this WEO category includes some Eastern European countries), for Japan in 1966, for LAC in 1968, for North America in 1961, and for the ROW region in 1980.

Table 6: Historical Current Account Balances in % of GDP

	NA	EU	JAP	CHI	FSU	LAC	AFR	ROW
1970	0.07	-0.47	0.63	0.97	0.14	-2.80	-2.82	4.27
1990	-1.89	0.20	2.44	0.78	-0.52	-2.26	-3.38	-0.41

X. CONCLUSION

This paper finds that there are important general equilibrium effects of historical and projected population trends on global capital flows. It identifies a turning point between 2010 and 2030 when North America and the EU are projected to become capital importers as rapid population aging pushes their savings below investment. This shift will be financed by developing countries that will become capital exporters.

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