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ASYMMETRIC DEMOGRAPHIC TRANSITIONS AND NORTH-SOUTH CAPITAL FLOWS

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Abstract

This paper studies demographic differences between lower-income, less developed countries (the "South") and higher-income developed countries (the "North"). The specific objective is to analyze the implications of demographic asymmetries for aggregate saving-investment imbalances, exchange rates, and the resulting net capital flows between North and South. An optimistic view of asymmetric demographic transitions among Southern and Northern economies suggests that the North can run a current-account surplus sizable in relation to the Northern economy, thereby transferring large net amounts of financial capital to the South. The analysis here argues that the optimistic view is a plausible summary of demographic influences on North-South capital flows in the historical period between 1950 and the mid-1970s. For historical decades after the 1970s and for the initial decades of the 21st century, however, the analysis argues instead that demographic forces considered by themselves are likely to *diminish* rather than augment the flow of Northern saving to the South as a fraction of the Southern economy. The fundamental causes of these effects are shifts in *relative* demographics between the South and the North. The qualitative conclusion about North-South capital flows holds regardless of whether the demographic transition in Southern economies is somewhat faster and sooner or somewhat slower and delayed, regardless of whether growth in Southern total factor productivity is vigorous or weak, and regardless of whether cross-border goods substitutability is modest or strong.

Demographic changes alter macroeconomic outcomes. When demographic evolutions are asymmetric across countries, the cross-border transmissions resulting from demographic forces alter exchange rates and external imbalances. The cross-border effects alter countries' welfare.

Earlier research in this project addressed these global dimensions of demographic change by focusing on interactions among similarly structured developed economies.[1] This paper changes the focus to demographic differences between developing and developed ("Southern" and "Northern") economies. The specific objective is to analyze the implications of demographic asymmetries for aggregate saving-investment imbalances, exchange rates, and the resulting net capital flows between North and South.[2]

The paper starts with some background in section 1A, identifying issues about Southern economic growth and transfers of Northern savings to Southern economies. Section 1B summarizes alternative views about the influence of demographic transitions on North-South capital flows. Sections 2A and 2B provide an overview of the general-equilibrium model and the demographic data used in the paper. Section 2C identifies key analytical characteristics of Southern and Northern economies as incorporated into the model. Section 3 presents a benchmark analysis of demographic effects on saving, investment, and capital flows. Section 4 reports a variety of sensitivity experiments designed to test the robustness of the benchmark analysis. Section 5 summarizes conclusions and implications for government policies.

1. BACKGROUND AND ISSUES

1A. World Economic Growth and the Transfer of Northern Savings to Southern Economies

In a self-contained ("closed") economic system, all transactions occur between resident agents. When any one borrower has a liability on its balance sheet, a lender elsewhere in the system has a matching asset. The savings generated in such an economy

[1] The earlier research in the project is summarized in Bryant (2004a, 2004b); Bryant, Faruqee, Velculescu, and Arbatli (2004); Bryant and McKibbin (2004); and Bryant and de Fleurieu (2005). Bryant (2004b) gives references to related work carried out by other researchers.

[2] Bryant (2005) is a first effort in the Brookings components of the project to study interactions between developed and developing economies. McKibbin and Nguyen (2004), McKibbin (2005a, 2005b) and Batini, Callen, and McKibbin (2006) have addressed these issues in the ANU components of the project.

are like a pervasive fluid. The economy's financial system (financial intermediaries and financial markets) is like a reservoir for these funds. When the current-period income of households and other economic agents exceeds their consumption, the resulting savings flow into the reservoir. Businesses and others whose current-period income falls short of their spending draw funds out of the reservoir, borrowing to finance their excess spending. The existence of the reservoir permits the saving and investment decisions of individual economic agents to be taken independently, even though, when measured after the decisions have been made and inconsistencies among them have been eliminated, the flows of aggregate saving and aggregate investment are necessarily equal for the closed system as a whole.

Suppose that market imperfections do not exist (such as asymmetries in the distribution of information and in access to financial institutions); that costs are low for transactions, communications, and transportation; and that restrictions do not inhibit the movement of savings and people among regions within the system. The savings fluid in the reservoir would behave much like water: following a change in underlying circumstances in some region, the fluid in all parts of the reservoir would adjust almost instantaneously to reestablish a uniform level. Savers would move funds so adeptly from lower-return to higher-return locations, and borrowers would shift so promptly from higher-cost to lower-cost sources of financing, that market interest rates and yields on investments, adjusted for risk premiums, would speedily become equalized throughout the reservoir. Similar equalizing pressures would apply to wages, adjusted for skill levels.

More realistically, suppose instead that market imperfections are numerous and that costs for transactions (especially for adjusting capital stocks to new desired levels) are significant. The savings fluid in the reservoir then has to be described as viscous – more like thick molasses than water. Given sufficient time for adjustment to changes in underlying circumstances, a uniform level of the viscous fluid would eventually prevail. If in one region of the reservoir the withdrawals during any particular short run substantially exceed or fall short of new deposits, however, the level in that region can be temporarily lower or higher than elsewhere in the reservoir. Suppose, for example, that investment opportunities become more favorable in a particular region. Before information about the new opportunities become widely available and all plans are

correspondingly adjusted, the region would have an excess demand for savings (and labor). Desired withdrawals from the reservoir by the residents of, or owners of assets in, the favored region would be temporarily larger than planned inflows. The region would pull savings from other parts of the reservoir as investors in the projects with higher than average expected returns successfully bid funds away from investors whose projects in other regions were less promising. During the transitional period, there might be little relation between the investment and saving of that region's residents. If one could calculate balance-of-payments accounts for the favored region, one would observe a net savings inflow (a current account deficit). Eventually, rates of return on investment adjusted for risk premiums and wage rates adjusted for skill levels would converge throughout all regions. But as long as perceived rates of return were unusually high in the favored region, the reservoir would not have a uniform level, and funds would flow from the rest of the reservoir to the favored region.

The greater the heterogeneities across regions and the greater the extent to which access to financial institutions differs—more generally, the more viscous is the flow of savings from one part of the reservoir to another—the more important would be geographical variations in the intensity of investment activity and its financing. Regional variations in financial activity would tend to be closely associated with regional variations in real economic activity.

The world economy is, formally, a closed system. Each liability position in the world is somewhere matched by a corresponding asset position. But of course there are huge political, economic, and social differences among the world’s regions and nation states. Restrictions inhibit some cross-border transactions. Even in the absence of border restrictions, economic transactions within nations are much more dense than transactions that cross national borders. The metaphor that best describes financial activity in the world economy is, rather than a single global reservoir, a collection of national reservoirs partially—but only partially—linked together.

During the years immediately following World War II, national financial reservoirs were separated nearly completely. Only limited scope existed for net capital flows and corresponding imbalances in current account transactions. Even the cross-border shipments of goods and services—but especially the net ladling of savings from

one national reservoir to another—were modest relative to the sizes of national outputs. The reconciliation between savings and investment necessarily proceeded largely independently, individual nation by individual nation, with little scope for aggregate national investment to differ from aggregate national saving.

The financial structure of the world economy underwent a sea change in the second half of the twentieth century (in part returning the world to where it had been in the first decade of the century). The economic distances between nations' financial systems shrank markedly. National savings reservoirs that had been nearly autonomous became less so. Today, to a greater extent than before, the levels in national reservoirs tend to be pulled together toward a common level.

Even so, financial activities in many parts of the world remain segmented along national lines. The notion of a unified world financial system, implying a nearly uniform level throughout a single global reservoir, remains an inappropriate metaphor. For both financial and real-sector activity, national borders have economic influences that are large, pervasive, and durable. The financial systems in Southern, less developed economies are typically less differentiated and flexible than those of Northern industrialized economies. For a realistic analysis of North-South financial interactions, one should not presume that Southern and Northern regions are parts of an integrated global financial reservoir.

The levels of output, and output per worker, in most Southern economies are far below the levels in most Northern economies.[3] Why? Why has there not been greater convergence between poorer countries in the South and richer countries in the North?

Under the extreme assumptions of a fully integrated global reservoir, economic theory would predict virtually complete convergence. If the capital-labor ratio were initially lower and hence the marginal product of capital higher in the poorer South, financial capital—a portion of Northern savings—would flow to the South and investment would exceed saving in the South until the Southern capital-labor ratio, and hence capital returns and wages, were eventually equalized with the North. If superior technologies were invented in the North, the ideas and then financial capital would flow to the South, again inducing an eventual equalization of returns. The workings of the

[3] For a survey, see Temple (1999).

global reservoir, in sum, would ensure an eventual convergence of the South with the North after a transitional period in which Northern domestic investment was less than Northern savings and Southern domestic investment exceeded Southern saving.

Which features of the world economy inhibit the convergence predicted under the extreme assumptions of a global reservoir? Growth-accounting explanations of why output is so much lower in the South than the North focus proximately on factor inputs to the production process. North aggregate output is not higher because there are more workers in the production process in the North than in the South. Quite the contrary: people and workers are much more numerous in the South than the North! Debates have thus focused on output per worker (or per capita).

Should proximate explanations of inferior Southern performance emphasize smaller inputs of physical and human capital, or should they primarily emphasize lower levels of total factor productivity (TFP for short)?[4] The empirical literature on economic growth contains prominent examples of both views. The so-called "neoclassical revival," typified by Mankiw, Romer, and Weil (1992) or Alwyn Young (1994, 1995), emphasizes the accumulation of physical and human capital. Mankiw-Romer-Weil argued that differences in physical and human capital account for as much as 80 percent of the observed international variation in income per capita. The alternative view focuses on growth in TFP and contends that the neoclassical revival goes "too far" in emphasizing capital accumulation. Typical illustrations of this alternative view include Klenow and Rodriguez-Clare (1997a, 1997b), Hall and Jones (1999), and Easterly and Levine (2001). Klenow and Rodriguez-Clare argue that TFP growth accounts for some 90 percent of the cross-national variation in growth rates.

Bosworth and Collins (2003) show that most of the differences between these two views of growth accounting can be explained by measurement issues, including a conceptual difference on how to identify the contribution of capital accumulation to growth.[5] They defend a middle view that both capital accumulation (physical and human) and improvements in economic efficiency are central to the growth process.

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[4] On definitions and alternative measures of total factor productivity, see for example Hulten (2001) and Barro and Sala-i-Martin (1995). Definitions are also discussed further below.

[5] Bosworth and Collins (2003, p.125) summarize the reasons for the divergence in views as follows: "First some researchers rely on the share of investment in GDP to proxy changes in the capital stock, whereas

The deeper questions about why output per worker in Southern economies is so low relative to the North cannot be tackled merely by examining the quantities and rates of growth of factor inputs and total factor productivity. Accounting decompositions of growth in terms of factor inputs indicate the *proximate sources* of growth but cannot shed much light on the *fundamental causes* of growth.[6] The *qualities* of measured inputs (true effectiveness in contributing to output) need attention. And one has to dig into the myriad of considerations underlying the level and rate of growth of total factor productivity. In the empirical research on growth, beginning with Solow (1957) and Denison (1962), TFP is computed as the "residual" input in the production function. The calculated index of TFP thus captures not merely increases in the technological efficiency of factors, but virtually everything else that can influence output. For example, the TFP index reflects unmeasured factors such as natural resources and variations in the utilization of capital. And it reflects the effects on output of the quality of private and public institutions, political turbulence, changes in government policies, legal processes such as the enforcement of contracts and the protection of property rights, the presence or absence of tropical diseases, the degree of openness to the rest of the world and the effects of external shocks, and most broadly of all social infrastructure and social norms.

Most economists and noneconomists agree that some, perhaps even all, of these multiple causes explain the failure of output per worker in Southern economies to catch up with the North. Agreement does not exist, however, on which are the most important, either in general or for particular developing countries.

Whatever the weight given to various explanatory factors, the differences between South and North in outputs, and output per worker, continue to be great. For many developing countries, evidence is slight or non-existent that convergence is occurring. (That absence of convergence contrasts with evidence supporting convergence among

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others construct a direct measure of the capital stock. Second, some value investment in terms of domestic prices, whereas others use an international price measure. Finally, some measure the contribution of capital by the change in the capital-output ratio, instead of by the change in the capital-labor ratio." On this last point, the growth accountings of Mankiw-Romer-Weil (1992) and Bosworth-Collins (2003) define the contribution of TFP in terms of the capital-labor ratio, hence more conservatively than Klenow and Rodriguez-Clare (1997A) and Hall-Jones (1999). Mankiw-Romer-Weil and Bosworth-Collins therefore do not give greater "credit" to TFP growth just because capital increases when output grows because of a positive change in TFP. The issue is stated clearly in Barro and Sala-i-Martin (1995, p. 352). Temple (1999) is another survey of the issues.

[6] Bosworth and Collins (2003).

units of more homogeneous regions, such as states within the United States or industrial nation members of the OECD.[7]) Net flows of capital from Northern higher-income nations to Southern lower-income nations have, at times in some countries, assuredly contributed to convergence. But they have not been sufficient to greatly diminish the average North-South gap or to stimulate a broad-based sustained trend toward equalization of returns and factor prices.

The constraints on North-South capital flows can be classified into three groups. First, probably least important, restrictions on cross-border transactions are still prevalent in many Southern economies. Restraints on trade in *goods and services* have fallen somewhat on average, although probably less than in the North. But restrictions on cross-border *transfers of financial funds* remain pervasive in many developing nations.[8] Restraints also remain high on the ability of foreign investors to make direct investments. (Emerging-market larger Southern economies have made more progress in reducing financial separation fences at the border than other Southern economies.)

A second category of explanations for why savings do not flow net from rich countries to poor countries includes a variety of financial-system frictions not specifically related to national borders and not experienced by foreign investors alone. The financial risks of investing in most Southern economies are typically higher than the corresponding risks in the North. The Southern-economy risks, moreover, are especially salient for Northern investors. Higher financial-system risks are of course partly related to the perceived risks of underlying real-sector investments in the South.

Because the Southern investment climate is seen as less hospitable by both Northern and Southern investors, investors require higher risk premiums. These higher premiums are proximately determined by market forces and perceptions. But in a deeper

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[7] Bosworth and Collins (2003) find a strong and statistically significant negative association between initial income and subsequent income growth in their large sample of developed and developing countries. They follow other researchers in interpreting this association as providing "very robust support for a process of conditional convergence" (p. 170). Note, however, that this convergence is *conditional* (that is, dependent on all the other determinants of economic growth being favorable). Conditional convergence is very different from absolute convergence. Temple (1999, p. 134) remarks that convergence conclusions are characterized by uncertainty and that "it is just not very easy to disentangle the convergence rate from other aspects of growth." A vast literature exists about the presence or absence of convergence in growth economics. For convergence of states within the United States, see for example Barro and Sala-i-Martin (1992). Mankiw, Romer, and Weil (1992) discuss convergence within the OECD.

[8] Even in many Northern economies, restrictions on cross-border capital movements lingered until the 1980s or 1990s.

sense the elevated premiums in part reflect less efficient operation of the financial reservoirs in Southern economies. Frictions, asymmetries in information, and market imperfections inhibit financial intermediation even more than in the North. Transactions and communications costs are higher.

Given that the savings fluids in Southern reservoirs are more viscous on average and that market imperfections are more prevalent, even the least risky rates of return in Southern reservoirs are typically greater than in the North. Still more consequential, investing firms and individuals in the South typically have to pay more than Northern firms and individuals to obtain external finance. (To use the terminology of Bernanke and Gertler (1995), Southern borrowers pay a higher external finance premium.) Gertler and Rogoff (1990), in a paper focusing on capital-market relationships that inhibit North-South lending, usefully emphasize the relationships among agency costs, capital-market efficiency, and the effects of financial activity on growth. They discuss how the relative wealths and outputs of nations can influence capital flows. For example, increased wealth can mitigate agency problems in lending, enhance the efficiency of a country's financial reservoir, induce savings transfers from abroad, and thereby facilitate more robust growth. Gertler and Rogoff also explain why the spread between the interest rate charged to ultimate borrowers and a relatively riskless rate of return will be systematically higher in poorer countries.[9]

The third and probably most important constraints on North-South capital flows are the numerous fundamental causes, already referred to above, contributing to inferior economic growth in many Southern economies. Some of these features of the economies and polities of Southern nations directly influence the operation of financial markets and financial intermediaries. Others are only indirectly related to Southern financial reservoirs. But all inhibit the net absorption of foreign saving.

Macroeconomic management of Southern economies, for example, is frequently even less sound than the counterpart management of Northern economies. The prudential supervision and regulation of financial institutions and financial markets may be

[9] Gertler and Rogoff (1990) observe that, in a general-equilibrium setting, investment in poor countries may suffer as rich countries get richer. The improved efficiency of foreign capital markets could cause investment funds to be siphoned away from poor-country entrepreneurs. Lucas (1990) also asks why financial capital fails to flow from rich to poor countries but gives only passing attention to capital-market imperfections.

inadequate. Business contracts and property rights may sometimes be less secure than in Northern economies. Political turmoil may be more prevalent. More broadly, the quality of institutions, social infrastructure, legal processes, and collective governance may be weaker on average in developing countries than they are in the higher-income countries of the North.[10]

The constraints on North-South capital flows do not bind so tightly as to inhibit any sizable transfers of savings between North and South. The financial-sector impediments and the deeper forces restraining improved growth in the South have diminished somewhat in many countries. Several larger emerging-market economies such as China, India, and Brazil grew robustly in the last decade or two. The much-discussed correlation between national saving and domestic investment evident in cross-section data for countries, initially emphasized by Feldstein and Horioka (1980) and subsequently studied by scores of researchers, has fallen somewhat as cross-border integration has continued to increase in the last several decades. The evidence is most clear for Northern countries.[11] But the correlation between regional saving and regional domestic investment has probably even weakened somewhat for the South and the North as a whole. That weakening in turn means that current-account imbalances between the South and the North can now be somewhat larger and more variable than in earlier decades.

Unfortunately for clear analysis, the old cliché about whether the glass is partly empty or partly full is pertinent here. The obstacles to large-scale North-South capital flows remain highly significant. Yet they have weakened through time, and could well weaken further if Southern nations make better progress in facilitating their growth and development.

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[10] Enormous heterogeneity exists within the South (as within the North). Nonetheless, the broad generalizations in the text capture widely held views. The World Bank's (2002, 2004) *World Development Reports* for the years 2002 and 2005 emphasize issues about institutions and the investment climate in developing countries. Social infrastructure issues are emphasized in Hall and Jones (1999). Holzmann (2000) discusses the obstacles to investment in Southern economies by Northern investors. See again Gertler and Rogoff (1990) on financial-system issues, the Bosworth and Collins (2003) discussion of institution issues, and the survey by Temple (1999).

[11] Blanchard and Giavazzi (2002), for example, show that the correlation has fallen sharply within the European Union as economic integration has risen (lowering of border barriers, and increases in both goods substitutability and financial substitutability within the European Union). Alan Greenspan (2004) cites Federal Reserve staff calculations that the correlation has declined recently for OECD countries, especially if the United States is excluded.

1B. Demographic Influences on North-South Capital Flows

This paper analyzes demographically-induced influences on North-South capital flows. Demographic forces were not specifically highlighted in the preceding overview. But no less than other influences, demographic changes are fundamental determinants of whether and how transfers of savings take place between the North and the South. In principle, demographic influences can have either facilitating or restraining effects on such transfers.

Views about prospective demographic influences range along a spectrum. Toward one end, the presumption is that asymmetric demographic evolutions will *increase* the extent to which the South collectively runs a current-account deficit, thus importing a fraction of Northern savings into Southern economies. This view is relatively optimistic: it presumes North-South macroeconomic interactions will be mutually beneficial, permitting asset owners in the North to earn higher returns on their savings than would otherwise be possible and simultaneously permitting investment within the South to be higher, thereby promoting Southern economic development. Attanasio and Violante (2000) and Brooks (2003) are examples of papers that suggest this relatively optimistic perspective.

Views toward the other end of the spectrum are skeptical about the direction in which prospective demographic trends will influence net capital flows. Demographic influences could, according to these views, move saving-investment imbalances in the North and the South in the opposite direction from what would be required for the optimistic outcome. Hence demographic trends might *reduce* the degree to which Southern economies run a current-account deficit and sustain a higher level of domestic investment relative to Southern savings.

The analysis below supports this less optimistic view. This section provides an introduction to the issue and identifies some relevant previous research. Later sections of the paper provide simulation evidence generated by a general-equilibrium model.

Analysts agree that demographic changes tend to influence saving and investment differently. Hence demographics also alters the saving-investment balance of an economy. The effects on saving stem from individuals smoothing consumption over

their lifetimes while the age distribution of their income follows a hump-shaped profile. This life-cycle behavior by individuals means that changes in the age composition of the population affect aggregate personal saving. In particular, a demographic transition initially reduces saving when children are numerous relative to adults. Later it increases household saving as it reduces the number of young dependents and child consumption, increases the number of working adults, and frees resources for adults to save as well as consume more. Eventually, a demographic transition reduces saving as a larger portion of the population reaches old age, begins to consume out of accumulated wealth, and has low or negative saving. Workers who are not yet elderly may anticipate the greater need for retirement saving in economies where elderly ratios are expected to rise further. Higher saving by workers at the middle and end of their working lives may increase saving more than the consumption of the rising numbers of elderly may reduce it.[12]

Changes in the age composition of the population influence aggregate investment, but with different timing. Empirical research generally finds that investment is positively related to the share of the young in the population. Countries with higher youth dependency ratios (youths as a share of the working age population) face a relatively higher demand for investment related to the development of human capital (for example, schools) and to a growing labor force (for example, expanded infrastructure). As a population ages, however, the labor force grows more slowly and the level and composition of investment shift with the needs of a more elderly population (for example, medical facilities).

The net effects on the saving-investment balance tend therefore to vary during the different stages of a demographic transition. Countries with a relatively young population experience current account deficits, as investment demand outstrips domestic saving. As children age, fertility rates decline, and life expectancy rises, the ratio of

[12] Some uncertainties remain about saving behavior in the later stages of the life cycle. Studies based on macroeconomic data generally support the predictions of life cycle approaches (for example, an increase in the elderly dependency ratio reducing saving). Studies based on microeconomic data, however, have cast some doubt on the extent to which the elderly dissave (Poterba, 2004). This may be because simplified applications of the life cycle approach do not adequately take into account the desire of the elderly to leave bequests, or their uncertainties about their lifespan after retirement, and the financial support they will need. Some empirical studies based on household survey data do not adequately incorporate the public-pension portion of elderly incomes; this is why they may appear at odds with life cycle behavior (Meredith, 1995; Miles, 1999).

active workers to the total population increases, which in turn tends to cause saving to rise faster than investment. Hence, as economies go through the middle stages of a demographic transition, they tend to experience current account surpluses. Eventually, as the aging of the population continues, the net impact on the saving-investment balance becomes ambiguous, reflecting statistical uncertainty about the relative effects of rising elderly ratios on saving and investment.

Researchers such as Higgins (1998), Lührmann (2003), Bosworth and Keys (2004), Helliwell (2004), and International Monetary Fund (2004) have studied these effects empirically with partial-equilibrium reduced-form regressions.[13] The empirical regressions confirm that demographic shifts influence saving and investment differently. Countries with high and rising youth ratios and high and rising elderly ratios tend to have saving fall relative to investment; such countries therefore become larger net importers (or smaller net exporters) of financial capital. High dependency ratios, in other words, weaken a country's current-account balance (move it toward larger deficits or smaller surpluses).[14] Conversely, countries with high and rising ratios of working-age adults to the total population tend to have increases in saving relative to investment and thus to become larger net exporters (or smaller net importers) of capital. The regression evidence has been interpreted, for example by Bosworth and Keys (2004), as supporting the relatively optimistic view of demographic effects on North-South capital flows.

Two sets of considerations, however, caution against the optimistic view that population aging in the North will be associated with large transfers of financial capital from the North to the South. The primary reasons for caution have already been discussed in the preceding section: the economies and polities of many developing nations have features that restrain their net absorption of saving from the rest of the world. Southern economies can provide substantially larger investment opportunities at the margin for Northern investors only if the constraints that inhibit faster Southern growth can be eased. In practice the South might not be able to absorb enough Northern savings to alter significantly the saving-investment balance for the North. Most analysts

[13] See also International Monetary Fund (2005).

[14] Although higher elderly dependency is often associated with an excess of investment over saving, and hence a current-account deficit, this partial correlation has lower statistical reliability, and may not be a robust guide to the effects of rising elderly dependency ratios on current account balances (Higgins, 1998; Bosworth and Keys, 2004).

agree that investments in the South by Northern owners of financial capital, if feasible, could bring advantages to both the North and South through enhanced risk diversification and higher rates of return. For Southern economies to capture those potential gains, however, the frictions and impediments – economic, political, and legal – that inhibit Northern investment in the South must not be too severe.

The second reasons for caution stem from a closer examination of the likely demographic influences on the saving-investment balances in the South and the North. Independently of the absorptive capacity of Southern economies for foreign saving, the net effect of asymmetric demographic influences in the two regions may well work in the "wrong" direction.

Northern youth ratios have declined in recent decades to considerably lower levels than youth ratios in most Southern economies. Northern elderly ratios, to be sure, have risen to much higher levels than elderly ratios on average in the South. Nonetheless, the current level of total dependency ratios (youths plus elderly as a proportion of either the total or the working-age population) tend to be markedly higher in the South than the North. Considered in isolation, the current differences in dependency ratios between the North and the South thus might be thought to support the hypothesis that savings will be weak in the South and stronger in the North, thereby leading the North to be a net exporter of savings to the South, for at least the near-term future.

For the medium and long runs, however, the demographic transition for the South as a whole, and certainly the transitions of important individual developing economies, will move just as fast or faster than the continuing demographic transitions within the Northern economies. The higher youth ratios in the South will continue to fall rapidly. Most of the higher-income advanced countries, in contrast, have already experienced the larger part of their fertility declines and hence have already seen the larger part of the decline in their youth ratios. Northern youth ratios, in fact, are projected to change relatively little in the future. Increases in Northern elderly ratios will be dramatic for several more decades. Thus total dependency ratios may well rise in the North relative to the South. The large prospective Southern declines in fertility will permit reductions in expenditures for children's consumption and child-related investments (relative to what they would be with higher youth ratios), thereby freeing resources for adults to raise adult

consumption, saving, or some of both. The so-called demographic dividend in Southern economies (large numbers of children becoming adults and entering the work force, raising the labor force and output) that has already been prominent in Asia—see Higgins and Williamson (1997)—will continue for several more decades. These considerations suggest that, over the medium run, demographic factors could cause Northern saving to fall relative to Northern investment while Southern saving rises relative to Southern investment.

Again, the levels of total dependency ratios today are higher in the South than the North. But the effects of demographic transitions depend not only on the absolute *levels* of dependency ratios, and hence on the levels of the underlying birth rates and mortality rates, but also on the sizes of incremental *changes* in dependency ratios and underlying demographic rates. If one focuses on the changes rather than the levels, the demographic transitions in Northern economies are beginning to slow down while transitions within Southern economies are just now picking up speed. The gap between Southern and Northern demographic experiences will gradually diminish through time. Alternatively stated, because of declining fertility rates and their effects on youth ratios as well as changes in elderly dependency ratios, Southern economies will prospectively experience demographic change *more rapidly* – not less rapidly – than Northern economies.

In the analytical world of two identical developed regions studied in Bryant (2004a, 2004b), asymmetrically larger fertility declines and asymmetrically larger adult-mortality declines in one of the regions lead that region to run a current-account *surplus* with the rest of the world. The direction of movement of the exchange rate for asymmetric fertility declines differs from the direction of movement for asymmetric declines in the adult mortality rate. For both cases, however, the region with the larger demographic shocks runs a current-account surplus and builds up a positive net-foreign-asset position with the rest of the world in the shorter and medium runs. That analysis leads one at least to ponder the possibility that prospective demographic developments could cause the North to run *smaller* rather than larger current-account balances (*diminished* surpluses or even *deficits*) vis-à-vis the South in the shorter and medium runs.[15] Rather than net "excess" Northern saving flowing to the South to facilitate

[15] This possibility is also discussed in Taylor (1995).

growth and development in the South, might the tendency to net "excess" savings arise more strongly in the South, with the result that reduced inward capital flows to the South could diminish Southern domestic investment relative to what it might otherwise be?

Helliwell (2004) argues that, other things equal, *demography-induced* capital movements in the future are likely to flow toward the OECD nations, not away from them. Even Bosworth and Keys (2004), who interpret their empirical work as suggesting that net capital flows will initially run from high-income regions to lower-income regions, project in their time-series analysis that after the year 2020 the current-account balance in higher-income Northern economies moves away from surplus to deficit.[16]

Reduced-form empirical regressions in which demographic ratios help to explain savings, investment, and current-account balances, such as those studied by Higgins, Lührmann, Bosworth-Keys, Helliwell, and the IMF staff, may not be adequately robust. To be sure, those researchers have investigated alternative specifications and carried out extensive sensitivity analyses of their results. Nonetheless, the statistical significance of some of the coefficients on dependency ratios is low, especially for some estimates of the effects of elderly dependency. The values of the coefficients vary, depending sensitively on the sample of countries and the time period. The variability of current-account data tends to be markedly higher for Southern than for Northern economies (so that the correlation between national savings and domestic investment is lower for the developing economies). But that result, as Helliwell asserts, is almost surely not attributable to greater capital mobility among the non-OECD countries than within the OECD. The quality of current-account, saving, and investment data for developing economies is poorer than data for the OECD economies.

Even if reduced-form empirical correlations were reliable, they might not be a satisfactory foundation for drawing conclusions about the dynamic effects of demographic changes on saving-investment balances. The dynamic effects of

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[16] The Bosworth-Keys cross-national analysis reports significant effects of demographic change on national saving but not on investment; overall, they conclude, "the cross-national analysis suggests that aging has a larger negative impact on national saving than on investment, pushing aging societies toward substantial trade deficits." When incrementally higher life expectancy in introduced into their time-series analysis, Bosworth and Keys project that high-income countries would experience even larger current-account deficits in the longer run. They project that middle-income regions would have sizable and continuing current-account surpluses, though these are projected to be smaller under the assumption of an accelerated rate of improvement in life expectancy.

demographic shocks on youth ratios and elderly ratios, and of course more broadly the dynamic effects on key macroeconomic variables, depend on whether the underlying shocks are declines in birth rates or declines in mortality. The reduced-form empirical regressions cannot capture such differences. The regressions estimate the effects on savings and on current-account balances of a decline in youth ratios or an increase in elderly ratios, for example, as invariant to why the ratios change.

The further into the future one looks, the more the asymmetric demographic transitions in high-income and lower-income countries, taken in isolation, may operate to reduce rather than increase the net flow of capital from the North to the South. That hypothesis is the focus of the research described in the rest of this paper.

2. ANALYTICAL FRAMEWORK, DATA, INITIAL CONDITIONS

2A. Overview of the Two-Region General-Equilibrium Model

The analytical framework in this paper is a world composed of two regions with cross-border flows of goods and capital. The exchange rate linking the currencies and economies of the regions adjusts to ensure that the *global* (algebraic sum of both regions) current-account balance and net-foreign-asset position are always zero. All other flow and stock identities are carefully enforced, for each region and the world economy as a whole, ensuring the framework's internal consistency. Within each region's economy, optimizing firms produce a single composite good, determined by an aggregate production function with capital and productivity-augmented labor as its arguments. The composite goods from each region are imperfect substitutes; some production in each region is exported; import demands are a function of regional incomes and relative prices.

Households in each region are assumed to have identical preferences over foreign and domestic goods. The treatments of household consumption, saving, and wealth accumulation build on the overlapping generations framework of Blanchard (1985), P. Weil (1989), and Yaari (1965) as extended by, among others, Faruqee, Laxton, and Symansky (1997) and Faruqee (2002) to incorporate age-earnings profiles and a more realistic determination of labor income. Population growth and structure are endogenous.

The population contains working adults, youth dependents (children for short), and elderly dependents who receive public pension benefits.

This analytical framework permits a focus on the cross-border effects of region-specific changes in demography. One of the papers in the project's previous research highlighted modifications in the treatment of consumption, saving, and wealth accumulation that are associated with youth dependency and the economic linkages between the child and adult populations. Another paper emphasized elderly dependency and the implications of various public pension arrangements for region-specific and world levels of saving, investment, and interest rates. The regions in those earlier studies were identical in size and structure.[17]

This paper amends the analytical framework so that the two regions are demographically and economically different. Most fundamentally, the regions differ in the sizes and compositions of their populations and in the sizes of their outputs and capital stocks. One of the regions, the South, incorporates rudimentary efforts to represent the features of economies and polities in developing countries that dampen investment prospects, inhibit growth and development, and therefore limit the net absorption of foreign saving.

The strength of the framework is that it permits analysis of the co-evolution of Southern and Northern economies in a manner that fully allows for the general-equilibrium macroeconomic interactions that determine the outcome of the demographic pressures differing across the regions. Analysis cannot avoid the fundamental difficulty that the macroeconomic effects at issue are inherently general-equilibrium in nature. Notably, the saving-investment imbalance and hence the current-account imbalance in the North obviously cannot change without an associated change in the saving-investment and current-account imbalance in the South, and vice versa. The only analytical frameworks capable of dealing adequately with the issues are general-equilibrium models.

Key features that differentiate the behavior of the South and North regions in the model are described in section 2C. First, however, the discussion turns to differences in

[17] Bryant, Faruqee, Velculescu, and Arbatli (2004) and Bryant (2004a).

demographic trends between Southern and Northern economies and summarizes the aggregated demographic series used as inputs to the analysis.

2B. Demographic Transitions in the South and the North

The Population Division of the United Nations publishes biannual statistical volumes on world and national demographic trends. The detailed data in recent editions are presented for quinquennial averages, beginning with the period 1950-55 for historical data and ending with 2045-2050 for forward-looking projections.[18] The demographic trends described below and the inputs used in this study are derived from these UN data.

Prior to a typical demographic transition, fertility (birth) rates are high and mortality rates are very high. In the early stages of a transition, infant mortality falls, perhaps sharply, and overall mortality begins to decline. Children become more numerous relative to adults; the youth dependency ratio rises. With a lag, families respond to higher numbers of surviving children and higher longevity in general by beginning to have fewer births.

In later stages of the transition, the large numbers of children age and the country enters a period where the working-age population and the labor force grow faster than the population as a whole. The youth dependency ratio falls, total dependency (youths plus elderly) is low, and an increasingly larger fraction of the population move into their years of maximum life-cycle productivity. This development, a marked rise in the active ratio (the proportion of adults of working age in the total population), is often labeled a demographic "dividend" or "bonus." The bonus occurs in the form of increased economic production accompanied by higher levels of aggregate saving.

In the final phases of a demographic transition, mortality rates continue to decline, raising life expectancies still further. Fertility rates typically stop falling further. Increasing numbers of the earlier bulge of working-age adults approach retirement years. The elderly dependency ratio thus starts a sustained rise; total dependency also rises from its earlier nadir. Elderly adults produce less output and must either consume out of accumulated savings or be supported by younger family members or government pension programs.

[18] For example, United Nations Population Division (2001, 2003, 2005).

Western European countries began their transitions at the beginning of the 19th century. Those countries, along with many other industrial countries, are now in the later stages of their transitions. Fertility rates tend to be low, well below the so-called replacement level of 2.1 lifetime births per woman. Life expectancies are high and increasing still further. Old-age dependency ratios are rising rapidly. For example, during the 2000-2005 quinquennium Japan and Germany had birth rates of only 1.32 and 1.33 births per woman; the U.S. rate was 2.04, close to the replacement rate. Life expectancies at birth in Japan, Germany, and the United States were, respectively, 81.9, 78.6, and 77.3 years. Elderly ratios (the proportion of the population age 65 and over) in Japan and Germany were 19.7 and 18.8 percent and expected to climb to near 30 percent by mid-century; the U.S. elderly ratio was 12.3 percent and predicted to increase quickly in future decades.

At the other extreme, demographic transitions in some least developed countries (Mali and Tanzania are examples) have started only in recent decades. Other Southern nations, including the largest emerging-market economies, are already in or will soon enter the middle demographic stages, thus beginning to experience the period of demographic dividend. For example, India's fertility rate dropped from 5.43 to 3.07 births per woman between the 1970-1975 and 2000-2005 quinquenniums. China's fertility rate dropped even more dramatically, from 4.86 to 1.70 births per woman. Active ratios in India and China between 1970-1975 and 2000-2005 rose, respectively, from 0.46 to 0.53 and from 0.45 to 0.62.

For the purposes of the analysis here, we prepared "North" region and "South" region demographic series. The North is defined as the aggregation of the "more developed countries" classified by the UN (Northern America, Europe, Japan, and Australia/New Zealand). Our South region corresponds geographically to the UN's "less developed" regions (the sum of the "least developed" and "other less developed" countries, comprising all the countries of Africa, Asia except for Japan, Latin America and the Caribbean, as well as Melanesia, Micronesia and Polynesia).[19]

Youth cohorts in our analytical framework are assumed to be wholly dependent on adults for the first 18 years of life. At the beginning of their 19th year, they enter

[19] The UN classifies all of Europe as developed, including Russia, Eastern Europe, and Southern Europe.

adulthood, begin supplying labor input, and no longer receive any support payments from older adults. Elderly are defined as adults 65 years and older.[20]

The framework uses the simplifying assumption of Blanchard (1985) and Yaari (1965) that mortality rates are age-invariant rather than age-specific. This simplification has the marked advantage that macroeconomic aggregation across individuals and age cohorts is straightforward. As is well known, however, the assumption departs seriously from reality. Age-invariance of the model's adult mortality rate has the undesirable consequence that the numbers of elderly in the model's regional populations are overpredicted relative to the actual-life situation in which death rates increase sharply for adults older than middle age. Because of the age-invariance assumption, the model's demographic equations cannot reproduce in every detail the actual-life combination of birth rates, mortality (inverse-of-life-expectancy) rates, and population growth rates contained in the UN Population Division's time series.[21]

The UN's demographic projections do not extend beyond 2050. To carry out sensible model simulations, one defines a consistent steady state for the world economy as a whole in which demographic growth rates for regions eventually converge. (Without such convergence, one part of the world would continue to increase *permanently* in demographic size relative to other parts.) The requirement for ultimate convergence requires demographic projections that extend well beyond 2050. Accordingly, we extrapolate the UN projections, assuming that regional populations and hence the world population eventually stabilize at a growth rate of zero. The assumption of ultimately stationary populations means that the age structures of regional populations also stabilize

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[20] The age brackets in the UN data do not correspond exactly with the model's age definitions. We sum the available UN brackets from ages 0 through 19 years to derive a model series for youth; the UN data are not available for ages 0 through 18. Working-age adults are derived from the sum of the UN's age brackets for 20-64 years (though the model's definition of working ages is 19-64 years). The UN and model age brackets for elderly correspond exactly.

[21] Earlier papers in the project discuss in more detail the advantages and disadvantages of the Blanchard-Yaari assumption that the probability of death is age-invariant. Blanchard (1985) himself pointed out that the evidence on mortality rates suggests low and approximately constant probabilities of death from, say, ages 20 through 40; thereafter mortality rates in real life do rise with age – sometimes modeled by "Gompertz's Law" suggesting that mortality rates after puberty rise in geometric progression as in Wetterstrand (1981), reaching mortality rates (in the United States) in the neighborhood of 16 percent by age 80 and 67 percent by age 100. Faruqee (2003) modifies the simplifying assumption that all adults are subject to the same age-invariant probability of death. With that modification, however, it is no longer straightforward to achieve the macroeconomic aggregation across individuals and age cohorts that is the marked advantage of the Blanchard-Weil-Yaari theoretical framework.

and converge in the very long run. Birth rates and mortality rates converge to rates that are consistent with the zero growth rates for youth, adult, and total populations.

To create regional demographic aggregates for the model based on the UN data, we first derive growth rates for the regions' adult populations for the 1950-2050 period that closely match the UN data. Next we make plausible assumptions about age-invariant mortality rates for the model that broadly capture the trends in life expectancy as published by the UN. A benchmark for the relative sizes of regional adult populations is set for the year 2000 based on the UN's actual data for that year. These inputs are then used to derive model-consistent series for birth rates, population levels, dependency ratios, and other demographic variables. Because of our procedures, the model's demographic variables are an approximation to the historical and projected UN data. The approximation is close, however, and the qualitative conclusions derived from model simulations do not appear to be significantly affected by the approximation.[22]

The panels of Figure 1 summarize key aspects of the demographic inputs into the model. Each panel begins with the historical data for 1950-2005; the UN-projection data for 2005-2050 are lightly shaded; the darkly shaded parts for years after 2050 indicate how the UN projections are extended to produce eventual convergence to a steady state with stationary populations in all parts of the world.

Growth rates for the adult populations of the two regions are shown in Figure 1a. Growth in the South is always faster than in the North until long-run convergence. The growth-rate gap widens in the last decades of the 20th century before gradually beginning to narrow during the projections. The UN demographic projections include not only paths based on medium projected fertility, but also ones based on lower and higher fertility assumptions. Figure 1a accordingly shows not only the "medium" UN projections for the regions' growth rates but also the alternatives, labeled here as *faster convergence* and *slower convergence* for the South and *largest decline* and *smallest decline* for the North. (The faster-convergence and largest-decline cases correspond to the

[22] One source of the approximation stems from our derivation of year-by-year data from the UN quinquennial series, smoothing out kinks that are evident in the UN's quinquennial series. More important, as discussed above, the assumption that mortality rates are age-invariant leads to a skewness in the numbers of elderly in the model relative to real life. We initially developed North and South demographic series using the 2000 and 2002 Revisions of the UN Population Division (United Nations, 2001, 2003); those series were used in Bryant (2005). The 2004 Revision (United Nations, 2005) became available in the fall of 2005 and we have now incorporated those updates in our demographic inputs.

UN's "Low Variant" projections, the slower-convergence and smallest-decline cases to the UN's "High Variant.")

Mortality trends used as inputs to the model are plotted in Figure 1b. For this paper we develop and use just a single projected path for each region's adult mortality rate and youth mortality rate.

Combination of the growth rates for adult populations in Figure 1a with the mortality rates in Figure 1b generates the model-equation series for fertility rates shown in Figure 1c. As in Figure 1a, the alternative paths for fertility rates are identified as faster convergence and slower convergence for the South and largest decline and smallest decline for the North.[23]

Trends over time in the Southern and Northern dependency ratios (Figure 1d) exhibit the differences in levels and in rates of change described verbally above. Youths are a much higher proportion of the population in the South than in the North. Although declining already by the 1980s, the projected level of the Southern youth ratio still remains above 35 percent until the 2030s and only declines to the assumed long-run steady-state level of 18 percent in the beginning of the 22nd century. The Northern youth ratio, by contrast, has already completed much of its eventual decline by 2005; it is even projected to fall briefly below the long-run steady-state level before finally rising to that level.

The levels of the elderly ratios for the regions differ greatly, of course in the opposite direction. The Northern elderly ratio of some 27 percent as of today is more than 4 times higher than the Southern elderly ratio of 6 percent. The Northern ratio is projected to rise persistently to well over 60 percent in the 2060s before eventually falling back to the long-run ratio of 47 percent. In contrast, the Southern elderly ratio is only

[23] Perceptive readers will note that the model fertility rates in the ultimate steady state (where the demographic growth rates are all zero) are below the value of the "replacement" fertility rate (approximately 2.1) typically associated with stationary populations. This lack of correspondence is again attributable to the Blanchard (1985)-Yaari (1965) assumption that mortality rates are age-invariant. For the model's demographic series, one cannot match both mortality rates and fertility rates to actual data – given that the model is to reproduce exactly the actual data for the growth rate of the adult population. The compromise embedded in Figures 1a through 1e, 2, and 3 is to assign more weight to actual mortality rates than to actual fertility rates when constructing the model demographic series. (We could raise the level of fertility rates in the model to better match actual fertility rates but only at the expense of lessening the correspondence between the model's mortality rates and those in actual data.) This technical problem in the model does not significantly affect the substantive conclusions generated in the project's research.

beginning its long rise as of today and by the 2060s is still projected to be no higher than 20-22 percent.

Throughout the historical period 1950-2005, the Northern active ratio lies well above the Southern ratio (Figure 1e). But already by the 1980s, the gap between the two ratios was narrowing. The Northern ratio peaked a little after the turn of the century while the Southern ratio had been rising strongly. In the UN medium projections, the Southern active ratio will exceed the Northern ratio after about 2010 and will keep rising until it reaches a level of around 54 percent in the 2040s. The Northern ratio will continue to fall and will be below 40 percent by the 2040s.[24]

2C. Analytical Characteristics of Southern and Northern Economies

This section summarizes features of the model governing the relative sizes of the Southern and Northern regions and differences in their macroeconomic behaviors. Most characterizations of the behaviors and structures of developing economies are controversial. Some details of the calibration choices used here are stylized assumptions or rough approximations. Furthermore, actual data are not readily available for macroeconomic variables for aggregates of developing Southern economies. As the research progresses, we continue to review and amend these calibration choices and try to compile better data. In addition, when we know that substantive conclusions generated with the model are sensitive to calibration choices, we identify alternative choices that bracket the plausible range.

Developing countries in the aggregate have a much larger total population than developed countries. Despite their larger size in terms of numbers of people, as discussed in the first section of the paper, the aggregates of developing countries' outputs and their physical capital stocks are markedly smaller than aggregates of outputs and capital stocks in developed economies. The South's share of the total world population in recent years, for example, is in the range of 80 to 85 percent. Yet measured at market prices and at market exchange rates, the GDPs of Southern economies in recent years account for only about one fifth to one quarter of world GDP. Even if output is measured at purchasing-

[24] To make the broad trends clearer, Figures 1d and 1e show the ratios only for the medium UN projections for each region.

power-parity prices, the share of Southern economies in world output is not more than one half. Our calibration of the model's variables for Southern and Northern regions reflects such broad facts about relative size.[25]

Relative Populations and Effective Labor Forces. The total population in the model's South region in the year 1950 was some 2-1/4 times the North's population. Because of the South's faster demographic growth, in the earliest years of the 21st century the multiple is now slightly more than 4 times. Figure 2 plots this ratio for the time horizon of the model simulations. By the time both regions eventually settle into a long-run steady state with demographic growth rates at zero, the South's population is simulated to be 7.6 times larger than the North's.

Effective labor forces in the model represent not just the number of workers but, in effect, the number of labor "efficiency units." Thus the model's levels for the effective labor force in a region are significantly greater than the level of that region's adult population, reflecting the calibration of the labor forces with their incorporation of the age-specific, relative productivities of different workers. In principle, it would be desirable to estimate – or if not estimate, then at least assume – different age-earnings profiles for the South and the North. Because of data difficulties, however, we have not yet tried to do so. For the time being, we assume that age-earning profiles are the same in the South and the North.[26]

During the historical period 1950-2005, the ratio of the South's effective labor force to the North's, also shown in Figure 2, is somewhat smaller than the ratio of populations. Eventually, in the ultimate steady state, the South's effective labor force, like its population, gets to be 7.6 times that of the North. Notice in the 2005-2050 UN projection period, however, that the South's effective labor force grows much more

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[25] Bryant (2004c, Appendix Table) provides data for the distribution by nation of key macroeconomic variables such as GDP (at market prices, and at purchasing-power-parity prices), cross-border trade, international reserves, population, and IMF quotas. For another source of nation-by-nation and world data, see World Bank (2005), Table 1 of the Appendix on Selected World Development Indicators. When making our calibration choices, we have also checked our results against the data set used by Bosworth and Collins (2003), which in turn relies in part on the Penn World Tables (Summers and Heston, 1988, 1991).

[26] As discussed in earlier project papers, the age-earnings profiles are normalized to unity at the time a youth enters adulthood and the labor force. Hence on average all workers supply more labor input in efficiency units than suggested by the number of workers in the labor force. U.S. data were the basis for estimation of the age-earning profile used in earlier project papers. That same profile is used in this study (for both regions).

rapidly than the North's. By the 2070s, it rises to be some 12 times larger, before eventually falling back to the steady-state multiple. The different behavior of the total-population and the effective-labor-force ratios is attributable to the operation of the age-earnings profiles. The effective labor force in the South rises so rapidly relative to the North's effective labor force not just because the number of working-age adults is rising faster but also because, as the additional Southern workers move through the age-earnings profile, they supply larger amounts of labor input measured in terms of efficiency units.

The level of human capital embodied in an average Southern worker (as conventionally estimated) is markedly lower than that in an average Northern worker.[27] For the purposes of the model, as explained below, we lump human capital per worker together with all the other factors which cause output per worker (labor productivity) to be lower in the South than the North. The model's series for effective labor forces, and hence their relative size, do *not* reflect human-capital differences between the regions. The level of the ratio of effective labor forces *adjusted for human-capital differences* would of course be substantially lower than the ratio shown in Figure 2.

The ratio of the effective labor force to the adult population, shown for each region in Figure 3, is another demographic variable with analytical significance. The level of the North's ratio is well below the South's during the decades after 1950, in part because there are already more elderly in the Northern adult population. The Northern ratio begins a decline by the 1990s that persists throughout the first half of the 21st century. The South ratio, though in the 1950s above that of the North, declines modestly through 1975 and then rises somewhat through the first decade of this century as the South enters the years of demographic dividend. Declines in the Southern ratio do not begin until the 2020s. The much earlier decline in the Northern than the Southern ratio reflects the fact that Northern economies are in a much more advanced stage of their demographic transitions.

Relative Levels of Labor Productivity. The outputs, capital stocks, and effective labor forces of the regions are key endogenous variables in the regions' aggregate

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[27] See, for example, Krueger (1968), Klenow and Rodriguez-Clare (1997a), and Bosworth and Collins (2003)

production functions (and elsewhere in the model). The other variables in the aggregate production functions are indexes of "total factor productivity" (TFP) or "technological progress." In empirical research, as section 1A emphasized, TFP is computed as a "residual" input in the production function and represents not merely changes in the technological efficiency of factors, as is often assumed, but everything else that can influence output. As a reminder of their complex nature, such indexes might be labeled "TFP-plus" were it not for the awkwardness of the term.

The levels and rates of growth of the TFP indexes in the model are specified exogenously. As in other augmented-Solow growth models, the growth rates of these indexes together with demographic growth rates are the critical determinants of long-run growth rates for the economies as a whole. The indexes appear in the production functions as "labor-augmenting."[28]

More specifically, the aggregate production functions take the form:

$$Y = K^{\alpha}(A \cdot H)^{1-\alpha} \tag{1}$$

where Y is real output, K is the physical capital stock, H is the human-capital augmented stock of labor, and A is a broad index of "total factor productivity plus." This specification is the so-called Cobb-Douglas form for which the elasticity of substitution between labor and capital is unity. The parameter α is the elasticity of output with respect to capital, assumed to be equal to the share of returns to capital in output.

The stock of human capital, H, may be thought of as the effective labor force, L, multiplied by an index of human-capital adjustments, E:

$$H = E \cdot L\,. \tag{2}$$

Given the function (1) and this specification of H, the indexes A and E might just as well be combined:

$$Y = K^{\alpha}(A \cdot E \cdot L)^{1-\alpha} = BK^{\alpha}(L)^{1-\alpha} \tag{3}$$

where $B = (A \cdot E)^{1-\alpha}$. Alternatively, equation (3) can be written with the left-hand side as output per member of the effective labor force:

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[28] "Technological progress plus" in the production functions must be labor-augmenting (so-called "Harrod neutral") if this type of model is to generate balanced-growth equilibrium paths with well-specified long-run steady states. This property of balanced-growth models is well understood in the literature on growth economics; see, for example, Obstfeld and Rogoff (1996, pp. 191-192, 430-431) or David Romer (2001, pp. 9-12).

$$\frac{Y}{L} = B\left(\frac{K}{L}\right)^{\alpha} . \qquad (4)$$

The specification (3) does not separate the effects of human-capital efficiency, *E*, from all the other elements of TFP as embodied in the index *A*. It simply combines the two groups of effects into a single index, *B*. We experimented with developing separate indexes *E* and *A* but in the end decided not to do so because we did not have good empirical grounds for the specification of *E*. Indeed, we do not have solid empirical grounds for estimating a level for either the *A* or the combined *B* index.

When economists speak of TFP or "technical progress" indexes, they sometimes draw a distinction between the advancement of technological progress in the sense of movements upward in the best-practice (presumably worldwide) frontier of knowledge versus changes in technological efficiency at a regional or local level. The second, local component could be either positive or negative, depending on whether the locality is catching up to the best-practice frontier or losing ground with respect to it. If the local component is sufficiently negative, the TFP index as a whole for a locality could decline for an extended period.[29]

The single most important determinants of the initial relative sizes of regional outputs and capital stocks in our model simulations are the assumptions made about the initial values of the TFP indexes, the *B* for each region. Subsequent evolution of the relative sizes of the outputs and capital stocks through time is increasingly governed by the assumed rates of change for the *B* indexes. The *B* index for the South can fall as well as rise through time.

Figures 4a and 4b summarize the inputs for the model's TFP indexes. We assume that the South's index at the outset, in the year 1950, is one third the level of the North's. In the absence of clear evidence favoring a different assumption, the pre-1950 rates of growth of the *B* indexes in both regions are taken to be identical, at 1.5 percent per year. For simplicity, the growth rate for the North index is kept unchanged at 1.5 percent per year over the entire simulation horizon. We define four alternative paths for the growth rate of the Southern index.

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[29] The World Bank *East Asian Miracle* study (1993) makes use of this distinction.

For the benchmark-case simulation, the growth rate of the South's TFP index climbs steadily from its initial 1950 rate of 1.5 percent; the growth rate reaches 2 percent per year in the first years of the 21st century and rises further to a rate of 2-1/4 percent by the 2020s; the rate remains at that higher rate for most of the rest of the century and then gradually declines until it eventually reaches the same long-run steady-state rate of 1.5 percent that the Northern economy is assumed to follow throughout (Figure 4a). With these growth rates, the level of Southern productivity relative to the North's reaches 50 percent around 2050 and in the long run settles at 80 percent.

Issues about the gap between productivity levels in the developing and developed countries and how fast the gap may be closing are controversial among development economists. We cannot be confident that the benchmark assumptions about levels and growth rates of the TFP indexes are more plausible than others. We have thus experimented with a variety of alternative assumptions. Figure 4a shows three alternative paths for Southern growth rates, and the implications for the Southern index level relative to the North's are plotted in Figure 4b. One alternative, labeled "more vigorous," is substantially more optimistic about Southern productivity than the benchmark. The two other alternatives, "less vigorous" and "weak," are decidedly more pessimistic. The less vigorous path and even more so the weak path postulate a *decline* in Southern productivity growth relative to the North in the early decades of the simulations.

Large emerging-market economies such as China and India, where growth in output and output per worker has been rapid in the last decade, represent a significant fraction of the South, however defined. Because of their sizes, such countries can strongly influence the aggregate behavior of a Southern region. A focus on nations such as China and India could point toward selecting the more vigorous path in Figure 4, or an even higher growth path, as best approximating prospective Southern prospects for productivity advances. A focus on nations in Africa or Latin America, in contrast, could point toward the "less vigorous" or "weak" paths.[30]

Section 4C conducts sensitivity tests with these alternative paths.

Investment Climate in the Southern Region. When calibrating the model, we introduce three differences between the South and North regions that are aimed at

[30] See again Bosworth and Collins (2003).

differentiating the regions' investment climates. Each source of difference is motivated by a class of effects that could explain why investment in Southern economies may be more difficult or less profitable than in the North. These model-calibration differences do not adequately reflect the deeper differences between South and North identified in section 1A above. The model is not complex enough to capture those deeper differences. But these model features are a start in the right direction.

First, we force a larger risk-premium wedge on capital in the South economy. The model contains an exogenous risk premium that is analogous to an equity premium, the difference between a low-risk government bond rate and the riskier return on equity claims on physical capital. Other factors held equal, a larger risk premium makes it less attractive for investors to hold physical capital rather than other forms of wealth. In the Northern economy, this risk-premium wedge between bonds and equity capital is set at 200 basis points. For the results reported in this paper, the risk-premium wedge in the Southern economy is set at 500 basis points, two and one-half times higher than in the North.[31]

Second, we assume that the adjustment costs of making new investments are substantially higher in the South than the North. The model follows much of the literature on investment in specifying that firms incur adjustment costs as they shift from one investment-to-capital ratio to another. Optimal long-run investment is a function of Tobin's *q* variable (defined as the ratio of the market value of a marginal unit of capital to its current replacement cost). If adjustment costs were assumed absent, the value of *q* would remain near unity so that the value of the capital stock would always remain close to its replacement cost. In contrast, when adjustment costs must be incurred, it is not preferable for firms to keep their capital stock at its optimal equilibrium level period by period. Higher adjustment costs slow firms' adjustment from a past balanced-growth equilibrium path to a new path now deemed appropriate.[32] To dramatize the possibility that investment spending in the South is more difficult, in our initial exploration of this

[31] This specification is consistent with the general point in section 1A that Southern financial reservoirs are saddled with more frictions, asymmetries in information, and market imperfections that inhibit financial intermediation. Gertler and Rogoff (1990, p.250) observe that the spread between the marginal product of capital and the world riskless interest rate will vary across countries and, in particular, will be larger the poorer the country.

[32] Adjustment costs influence how quickly adjustment occurs from one path to another, but are assumed not to influence the nature of the equilibrium balanced-growth paths themselves.

effect we set the parameter determining the size of adjustment costs in the South at an extreme value ten times greater than the Northern value.

Third, we assume that the depreciation rate on physical capital in the South is higher than the Northern rate. (Depreciation rates on capital are exogenous in the regional models.) Northern capital depreciates at a fixed annual rate of 4.25 percent. Capital in the Southern region depreciates at 6.50 percent.[33]

Intertemporal Smoothing of Consumption. For this paper, we implement two asymmetries between the North and South regions. Both stem from a presumption that consumers in the South are less able than Northern consumers to intertemporally smooth their consumption spending.

The macroeconomic theory underpinning our analytical framework emphasizes the forward-looking behavior of agents and presupposes that both firms and households engage in intertemporal optimization. When implementing the theory, however, the empirical model allows for a fraction of consumers whose consumption is constrained by an inability to borrow and hence are unable to smooth their consumption intertemporally. These constrained consumers can only consume out of their current income. The framework also allows for alternative assumptions about the intertemporal elasticity of substitution in consumption. This behavioral parameter can have powerful effects on macroeconomic outcomes.[34] The net response of consumption to changes in the real interest rate depends on the relative strength of substitution and income effects. With a low rather than high value of intertemporal elasticity of substitution, consumers act less strongly to shift their consumption intertemporally; the substitution effect is smaller relative to the income effect. With a low intertemporal elasticity of substitution, moreover, consumers respond absolutely less to interest-rate changes.

Earlier research in the project assumed a value of one third for the fraction of consumers unable to borrow to smooth their consumption intertemporally. In the current study this one-third value is retained for Northern consumers. In the South, however, we double this fraction so that two-thirds of consumers are assumed unable to borrow. This

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[33] This assumption about relative depreciation rates can be challenged. Some might argue that the depreciation rate on physical capital in Northern economies could be as high or even higher than the rate in Southern economies.

[34] See, for example, Appendix 3 in Bryant, Faruqee, Velculescu, and Arbatli (2004).

difference between South and North is suggested in part by the fact that superior credit institutions and financial markets exist in the North. In addition, many more consumers in the South than the North may not be able to smooth intertemporally because their consumption spending is at or close to the minimums necessary to sustain survival.

For the benchmark case in this paper, the South and the North are both assumed to have values of 0.5 for the intertemporal elasticity of substitution. In sensitivity experiments conducted for this paper, we have also postulated values different from the benchmark case. For example, we have examined scenarios in which the parameter has a smaller value in the South than the North. And we have examined the effects of varying the level of the parameter equally in both regions.[35]

External-Sector Imbalances. Demographic transitions have consequences over very lengthy periods. In the analytical context of the model, moreover, the world as a whole cannot reach a sustainable steady state except in the very long run. Model simulations in this study are accordingly conducted over very long-run horizons, typically for more than 500 years. Because the time scale of policy interest is the next several decades, we have not emphasized results for the very long run in any of the papers for this project. We do regard the long-run results, however, as a helpful analytical benchmark.

In this paper we interpret model outcomes for the year 1950 as the "initial conditions" for simulations. The choice of 1950 is dictated by the typical beginning year for the UN demographic data (Figures 1 through 3). Changes in other key (non-demographic) exogenous variables, such as the growth rates for the TFP indexes, also begin in the year 1950. It is often most revealing, therefore, to examine *changes* in the model's variables from the values in the initial conditions of 1950.[36]

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[35] The marginal propensity to consume out of wealth in the general case of the CRRA utility function depends, as is well known, on the elasticity of intertemporal substitution and on the entire sequences of future interest rates and future adult mortality rates. In contrast, when the intertemporal substitution elasticity is assumed to be unity (the case of logarithmic utility) and when the adult mortality rate is assumed to be constant rather than time varying, the marginal propensity to consume out of wealth reduces to the simple form of a constant, the sum of the time preference rate and the mortality rate. Cases where the intertemporal substitution elasticity takes on a value markedly less than unity are more consistent with the available empirical evidence; for example, plausible estimates appear to be as low as 0.5 or even 0.3.

[36] We frequently start actual model simulations in a year well before 1950, to be sure that the model generates a plausible set of initial conditions for 1950 (with key exogenous variables *not* changing prior to 1950).

The model generates a 1950 outcome for the world economy in which the South region runs a current-account deficit while the North has the counterpart equivalent current-account surplus. The South's 1950 current-account deficit is a large 6 percent of its nominal GDP. The ratio of the North's current-account surplus to the North's nominal GDP is roughly 3 percent. Under these initial conditions, the South pays a large net amount of investment income to the North, a situation that is sustainable because the South simultaneously runs a large trade *surplus* with the North.

The model simulations are calibrated such that the pattern of Southern current-account deficits matched by Northern current-account surpluses has persisted for many years prior to 1950. Hence the South, with a large net foreign *liability* position, is a debtor region. Because of the global balance-sheet identities enforced in the model, the North has a correspondingly large net foreign asset position vis-à-vis the South.

In the 1950 initial conditions with which simulations begin, therefore, the South region has domestic investment that is higher than national saving, in effect importing part of Northern savings through its current-account deficit. The North in the model has the reverse condition. National saving in the North is higher than domestic investment, with a part of Northern gross saving exported to the South through net capital outflows.

Relative Levels of the South's Outputs and Capital Stocks. Given the combinations of benchmark assumptions summarized above, the model generates a gross national product (GNP) for the South in the early 1950s that is some 38 percent of the North's. The South's early-1950s capital stock is about 41 percent of the North's capital stock.[37]

By the year 2005, the South's GNP as simulated in the model is still only about one half of the North's GNP. Similarly, the 2005 ratio of the physical capital stock in the South relative to that in the North is only higher by some 6 percentage points.

Because the initial conditions for calibrating the model cause the South to run continuing current-account deficits for the historical period 1950-2005, and hence to have a large net foreign liability position, it should be emphasized that the value of the South's

[37] These ratios adjust the two regions' real GDPs and capital stocks to a common currency, using the real exchange rate. The South's relative percentages in 1950 would be marginally higher in the absence of this adjustment for the real exchange rate.

gross domestic product (GDP) is considerably higher than its GNP throughout the historical period.

3. BENCHMARK ANALYSIS OF DEMOGRAPHIC EFFECTS ON SAVING, INVESTMENT, AND CAPITAL FLOWS

The analysis of demographic-induced effects begins here by describing outcomes in the South and North resulting from a benchmark simulation. The emphasis is on understanding the dynamic effects on macroeconomic variables in the regions, in particular on savings and investment and the balance between them. "Benchmark" is shorthand for the combination of calibration assumptions summarized in section 2C. The demographic paths in the benchmark case are the UN medium fertility paths shown in Figures 1c, the mortality rates in Figure 1b, and the demographic ratios plotted in Figures 1d and 1e.[38]

An overview of the causal processes captured in the model can be outlined as follows. Changes in fertility and life expectancy alter the sizes and compositions of populations. Changes in the regions' working-age populations and their relative sizes are critical determinants of changes in the sizes of effective labor forces. The sizes of effective labor forces reflect not just demographic shifts but also the humped age-earning profiles associated with the life-cycle behavior of individuals and the employment practices of firms. The macroeconomic aggregates of labor incomes, human wealths, and private savings are determined as demographic shifts pass through the age-earning profiles. The endogenous determination of other key macroeconomic aggregates, such as a region's capital stock and its output, is driven by a combination of changes in the effective labor force and changes in the region's rates of growth of labor-augmenting TFP. The size of a region's output relative to output in the rest of the world, determined in part by the relative sizes of the regions' effective labor forces, is a key driver of cross-border goods transactions, exchange rates, and the saving-investment imbalances, and hence external-sector imbalances and interregional capital flows.

[38] Some of the empirical results here and in the following sections are similar to, and the substantive conclusions basically the same, as those in the earlier paper, Bryant (2005). Many detailed aspects of the inputs and calculations, however, have been revised since that earlier paper was completed.

To gain intuition about the effects of demographics on macroeconomic variables, remember that when individuals first enter the labor force, they have relatively low productivity, have relatively low labor incomes, and are relatively low savers. Younger adults on average have lower savings in the early working years in part because of children and child-support expenses. Then as these workers gain experience and seniority and have higher productivity, their effective labor input increases over time; in effect, they ascend the left side of the hump of the economy's age-earning profile. Individuals tend to reach their years of peak earnings and high savings when they are in their forties, fifties, and early sixties. Saving is high in the middle years not only because of higher labor incomes but also because of savings in anticipation of retirement and augmented savings stemming from lower payments for child support. Eventually, workers start to descend the right side of the humped age-earning profile so that their labor incomes and saving decline. At that point, their consumption must be increasingly financed out of their privately accumulated financial wealth as supplemented by pension transfers from the government.

Changes in the age composition of the population together with the hump-shaped profile of earnings by age influence both the supply side and the demand side of macroeconomic behavior. On the supply side, the earnings profile is an indicator of the changes in a cohort's relative productivity and its supply of labor over its lifetime. The number of workers in each cohort, summed by productivities across working cohorts, directly influences the aggregate supply of output. On the demand side, the anticipated path of labor income determines the saving plans of consumers over their lifetimes.[39]

Incentives for investment also change in response to changes in demographics and labor productivity. As the effective labor force adjusts and the relative scarcity of labor and capital are altered, previous levels of the capital stock and output are no longer economically appropriate. Variables such as real interest rates are pressured to adjust to reflect the new conditions. Investment flows, occurring promptly or sluggishly depending

[39] The hump shape for an economy's aggregate age-earnings profile reflects both of two types of effects: (i) changes over time in the relative productivities of age cohorts (initially, increases caused by rising seniority and experience and then subsequently, decreases towards the end of working life); and (ii) changes by age in the rates of participation in the labor force of cohorts. For further discussion and a graph illustrating the humped age-earnings profile for the Japanese economy for various years in the period 1970-1997, see Bryant and McKibbin (2004, p. 363).

on the size of the changed incentives and the adjustment costs to be paid, alter the capital stock and key macroeconomic variables such as the capital-output and the capital-labor ratios.

For the benchmark simulation, Figure 5a plots the evolutions of saving and investment relative to economic activity in the Southern and Northern regions. The variables are measured as changes from the initial-conditions values of the ratios prevailing in 1950.[40]

To interpret the changes through time of the saving and investment ratios, one can derive analytical clues from a comparison of changes in the North and South active ratios (Figure 1e) and in the North and South ratios of the effective labor force to adult population (Figure 3). Remember also that the level of the South's effective labor force relative to that of the North increases sharply and persistently (Figure 2).[41]

For the first few decades after 1950, the level of the active ratio was much lower in the South than the North and declined markedly. The Southern ratio of the effective labor force to the adult population, higher than the North's, also declined appreciably in the first decades after 1950. These declines in the Southern ratios reflected the large number of children entering the South population in those years and the lesser productivity relative to older workers of the increasingly numerous youths just entering the labor force. In association with these demographic changes, Southern saving in relation to Southern GDP declined significantly (by close to a percentage point of GDP) and did not begin to increase strongly until the active ratio and the ratio of effective labor force to adult population began rising several decades later (Figure 5a). In contrast, the ratio of Southern investment to economic activity rose strongly from the outset but then began a gradual deceleration after the 1970s; the investment ratio fell after the mid-1980s for several decades.

Demographic influences on saving and investment in the North during the first decades after 1950 were roughly the opposite of those in the South. The North had a high

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[40] The denominators of the ratios in Figures 5a and 5b are Southern nominal GDP for the Southern ratios and Northern nominal GDP for Northern ratios. Saving is nominal national saving, the sum of nominal private saving and nominal government saving or dissaving.

[41] The effective labor force in the North rises gradually from 1950 through the first decade of the 21st century but then begins a gradual protracted absolute decline. The South's effective labor force grows vigorously from the outset and only peaks by the middle of the 21st century.

and initially climbing active ratio. The ratio of the effective labor force to adult population in the North had not yet begun the long decline that would start about 2005. Northern saving was buoyant and Northern investment was relatively weak during the early decades when the North active ratio was rising strongly.

The savings-investment balances in the benchmark simulation move dramatically in the reverse direction, however, once the Northern active ratio peaks and begins to decline and as the Southern active ratio begins to increase strongly. The gap between the Southern and the Northern active ratios was already narrowing by the 1980s (again see Figure 1e). In the medium UN projections, the Southern active ratio exceeds the Northern ratio after 2010 and does not peak until the 2040s. The Northern active ratio and ratio of effective labor force to adult population continue their sharp fall. The saving ratio in the South, now influenced by the demographic bonus of a fast-increasing effective labor force, begins a persistent upsurge that continues into the middle of the 21st century. In contrast, net demographic influences in the North contribute to a peaking of the saving ratio and then a subsequent decline. The demographic evolutions of the two regions thus contribute to a progressive strengthening of Southern saving and a relative weakening of Northern saving.

The saving-investment imbalance in each region is, by the national income accounts identities, the current-account balance of that region and its net inflow or outflow of capital. Each region's external imbalance in the benchmark simulation, measured as a ratio to the region's nominal GDP, is plotted in Figure 5b. These current-balance ratios are implicit in Figure 5a, but Figure 5b makes it easier to focus on how dramatically the saving-investment balances change over time. Figure 6 reports the associated path of the real exchange rate.[42]

The South's currency depreciates gradually for several decades after 1950 and then depreciates more strongly over a period that continues for more than 100 years. In

[42] A downward movement in the exchange rate represents a depreciation of the South's currency (appreciation of the North's). The variables in Figures 5b and 6 are again measured as changes from the values prevailing in 1950. The Southern (Northern) ratios in Figure 5b express the region's current-account imbalance as a proportion of the South's (North's) GDP. The identity which requires the South's current-account imbalance to be equal, with opposite sign, to the North's current-account imbalance does not require the two current-account ratios to be identical in absolute value (because the denominators are of course not equal).

the steady state reached by the world economy in the very long run, the real (and also the nominal) exchange rate settle at a level far below the original initial-conditions value.

The changes in the real exchange rate are traceable to changes in the relative size of the regions' outputs, which in turn depend on changes in the relative sizes of the regions' populations and effective labor forces. The demographic shifts studied here are transitory in terms of differences between the regions' demographic *rates of growth* (Figure 1a) but cause permanent changes in the *relative levels* of demographic variables (Figure 2). The South's population and effective labor force relative to the North's have increased greatly by the time both regions settle down to the same rates of growth in the long-run steady state. Correspondingly, macroeconomic aggregates such as the capital stock and goods output become larger in the South relative to the North.[43] The quantity of South-produced goods available for sale and consumption in the world thus increases relative to the quantity of North-produced goods. In the absence of changes in the preferences of each region's consumers for the two types of goods, relative prices in the world economy have to change to reflect the now relatively more abundant South-produced goods. A real depreciation of the South's currency, representing an improvement in the Northern economy's real terms of trade, is an integral part of the required change in relative prices. The size of the required depreciation of the South's currency depends on the degree of price sensitivity of South and North consumers, in particular on the price elasticities of the regions' import demands.[44]

Recall that in the benchmark initial conditions, the South in 1950 starts out as a debtor region, running a current-account deficit large in relation to the size of its economy. Thus at the outset some part of Northern savings flows to the South as the financing for the South's current-account deficit. This pattern of large capital inflows to the South in proportion to the Southern economy continues in the benchmark simulation for two and one-half decades after 1950. Hence the shifts in relative demographics

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[43] The increase in relative size of the Southern region's economy is considerably smaller measured in terms of the ratio of real GDPs than when measured by the ratios of populations or effective labor forces; this difference is primarily due to differences in the levels of total factor productivity between the South and the North, .

[44] The fundamental explanation for exchange-rate changes summarized here is highlighted in earlier papers; see especially the extended analysis in Bryant and de Fleurieu (2005), who emphasize the dependence of the size of exchange-rate changes on the degree of price elasticity of import demands. See section 4E below for further discussion.

contribute to a major increase in the gap between the South's investment and national savings ratios, and hence to a further widening in the current-account deficit.

However, the gaps in the regional saving-investment ratios – the current-balance deficit ratio in the South and the North's current-account surplus ratio – begin to move in the opposite direction around the mid-1970s. Thereafter, for the final two decades of the 20th and the first four decades of the 21st centuries, the South's current-balance ratio improves steadily and persistently. (The degree of improvement slows down for the first few years after the 1990s but then picks up again through the 2030s.) By the decade of the 2030s the South runs a current-balance ratio more than 1.5 percentage points of GDP stronger than at the outset in 1950.

The key feature of the benchmark simulation that warrants emphasis here is the dramatic reversal after the 1970s of savings-investment imbalances in relation to the sizes of the regional economies. Demographic inputs in the model, mirroring history up to the present, are a major contributor to this reversal. Prior to the mid-1970s, demographic asymmetries between the Southern and Northern regions increase the net flow of capital from the North to the South, as postulated by the relatively optimistic view identified in section 1B above. Beginning in the mid-1970s, however, the relative demographics operate in the reverse direction. As a percentage of their regional economies, Northern saving falls relative to Northern investment while Southern saving increasingly rises relative to Southern investment. Relative demographic influences progressively operate to *reduce* rather than increase the net flow of capital from the North to the South measured as a fraction of the size of the Southern economy.[45]

[45] Note again that the ratios in Figures 5a and 5b measure savings, investment, and current balances *in relation to the sizes of the regional economies* and *in relation to the initial conditions of 1950*. In the benchmark simulation, the South – even by the 2030s – is still running a current-account deficit in absolute terms; the North is still exporting a (smaller) fraction of its savings to the South. Thus the direction of net capital flows in absolute terms is still from the North to the South. The more important point analytically, stressed in the text, is that the capital flows occurring after the mid-1970s are progressively *diminished as a proportion of the Southern and Northern economies*. Note also that the outcomes for current-account ratios in Figure 5b are, by the medium and long runs, significantly influenced by the depreciation of the South's currency (Figure 6). Were it not for that exchange-rate depreciation, the South's current-balance ratio in the medium run, compared with the 1950 ratio, would have been more negative or less positive. See section 4D below.

4. SENSITIVITY ANALYSES

Are the macroeconomic consequences evident in the benchmark simulation robust? Or might they change greatly with changes in some of the input assumptions? This section reports a variety of sensitivity experiments, each highlighting a key feature of the model and exploring the degree to which alternative assumptions about that feature are capable of altering the preceding analysis.

4A. Alternative Assumptions about Demographic Evolutions

The details of the prospective demographic transitions in developing and developed economies are uncertain. An obvious question to ask is how the macroeconomic consequences would differ if the demographic transition in one or both regions were to proceed more rapidly or more slowly than in the benchmark case. Altered effects associated with alternative demographic projections are of clear interest in their own right. Studying alternative paths also helps to clarify how the model generates the macroeconomic consequences of demographic shifts.

Figures 1a and 1c show the UN Population Division's alternative projections for both the South and the North. Our research has explored various combinations of these alternative paths. The gist of these experiments can be conveyed by a comparison of two additional simulations with the benchmark case.

Each of the additional simulations differs from the benchmark only in the assumed demographic path *for the Southern region*. One assumes the South follows the "faster convergence" (UN Low-Variant) path associated with earlier and sharper reductions in fertility and hence a speedier transition to the ultimate steady state of a stationary population. The second assumes "slower convergence" (UN High Variant), smaller and later reductions in fertility, and thus a more protracted demographic transition. The North in both additional simulations follows the same "medium-decline" demographics assumed in the benchmark.

The active ratios shown in Figure 7 illustrate a key feature of the differences between the three demographic scenarios for the South. The faster-convergence scenario, with its earlier declines in fertility, causes earlier declines in the youth ratio. To a greater extent than in the benchmark, more youths leave childhood to enter the workforce than

new births add to the number of dependents; thus faster convergence produces an even more vigorous rise in the active ratio than occurs in the benchmark case. The active ratio in the faster-convergence case, however, falls more sharply and converges sooner toward the ultimate stationary population in which the elderly ratio has risen to high levels. In contrast, the slower-convergence scenario for the South with its delayed fertility reductions and higher rates of population growth generates a delayed and more gradual rise in the active ratio, a later and less elevated peak, and a more protracted convergence toward the ultimate steady state.[46]

All three simulations generate a large depreciation of the South's currency over the medium and longer runs (Figure 8) but the size of the depreciation is least large for the faster-convergence case and greatest for the slower-convergence scenario. Compared with the benchmark case, the faster-convergence outcome results in a less large increase in the South's effective labor force relative to the North's and hence a less large relative rise in the South's capital stock and output. Thus the amount of South-produced goods available for sale in the world relative to North-produced goods increases less than in the benchmark case. The "required" change in relative prices and hence the "required" depreciation of the South's currency is accordingly smaller. The converse is true for the slower-convergence case: the effective labor force in the South rises more than in the benchmark case; the larger labor force requires a larger capital stock relative to the North's and produces more output relative to the North. Relative prices thus have to change by more, and the South's currency has to depreciate by a larger amount.

Figure 9 compares the savings and investment ratios in the South for the three simulations. Differences across the three cases are relatively small for the savings ratio. The absence of larger difference might seem puzzling but is readily explained. In the faster-convergence case, the South has smaller numbers of adults and a smaller effective labor force than in the benchmark; that difference in adult population and labor input will, other things being equal, lead to *lower* aggregate saving. However, the active ratio in the faster-convergence case rises sooner and faster to a higher peak (Figure 7). Other things equal, that higher active ratio encourages *higher* saving. In effect, two offsetting

[46] Analogous differences are observed among the ratios of the effective labor force to the adult population for the three alternative Southern demographic paths (not shown in a separate chart).

forces are at work, and the net effect of the two produces an outcome for aggregate saving in the faster-convergence case that falls only a little below the benchmark. When the slower-convergence case is compared with the benchmark, offsetting forces in the opposite direction are at work; the net effect is to produce a saving ratio slightly higher than the benchmark.

Differences among the investment ratios for the three cases are larger and more readily visible. The faster-convergence simulation relative to the benchmark, because of the smaller effective labor force and lower growth in the South over the medium run, has a smaller need for capital to accompany labor inputs in the production function. Less investment in new capital is required, and the South's investment ratio is lower. An analogous argument with the signs reversed explains why the South's investment ratio needs to be higher in the slower-convergence than in the benchmark case.

Imbalances between the saving and investment ratios of Figure 9, the current-balance ratios, are shown directly in Figure 10 (again using 1950 as a base period for comparison). The consequences for current-account balances in relation to the economies differ rather little for the first few decades before and after the year 2005.[47] But thereafter the differences become significant. The gap between the Southern investment and saving ratios closes in the benchmark simulation for decades after the 1970s through the 2040s. If the South were to experience a speedier demographic transition, converging faster to the later stages already being experienced by the North, the gap between Southern investment and saving ratios would close even further and faster after 2020. Demographic influences would then work even more strongly to *reduce* rather than increase the net flow of capital from the North to the South in relation to the Southern economy. Conversely, a slower-convergence experience for the South would work in the reverse direction over the medium run. Demographic influences in the South relative to those in the North would, other things equal, *stimulate* the transfer of

[47] No major consequences can occur until the UN's projected demographic paths themselves start to differ (again see Figures 1a and 1e). The relatively small differences between the paths in Figure 10 for the years 1990 through 2015 are attributable to the forward-looking behavior of those consumers who intertemporally smooth their consumption and saving expenditures. The differences in the saving ratios caused by differences in saving behavior cannot be seen as readily in Figure 9 because of the differing vertical scales in the two figures.

savings from the North to the South, causing a larger Southern current-balance deficit in proportion to the Southern economy.[48]

The following table summarizes key qualitative points of the preceding analysis:

Table 1. Comparison of Post-2005 Effects in Simulations of Alternative Southern Demographic Paths

(Variables measured as change from 1950 initial conditions)

	Benchmark simulation (medium UN path)	***Faster Convergence (UN Low Variant: speedier Southern transition)***	***Slower Convergence (UN High Variant: more delayed Southern transition)***
South National Saving Ratio	Rises substantially through mid-century	Slightly lower than for benchmark case	Slightly higher than for benchmark case
South Investment Ratio	Falls moderately through 2030s and then recovers moderately to mid-century	Lower than benchmark from 2020s through mid-century	Higher than benchmark from 2020s through mid-century
Ratio of South's to North's Effective Labor Force	Rises persistently for first two thirds of 21st century	Lower than benchmark	Higher than benchmark
Ratio of South Output to North Output	Rises persistently through mid-century	Lower than benchmark	Higher than benchmark
Exchange Value of Southern Currency	Depreciates strongly in long-run	Depreciates less than in benchmark case	Depreciates more than in benchmark case
Ratio of South's current balance to South nominal GDP	Improves steadily through the 2030s, diminishing the net flow of capital to the South as a proportion of Southern output	Improves slightly less for first years after 2005 but thereafter improves substantially more than benchmark	Improves slightly more for first years after 2005 but thereafter improves markedly less than benchmark

We also conducted sensitivity tests with the alternative demographic paths for the North shown in Figures 1a and 1c (the "largest decline" in fertility rates corresponding to the UN Population Division's Low Variant projection and the "smallest decline"/High Variant projection). A larger and earlier decline in Northern fertility and population growth causes a larger depreciation in the exchange value of the Southern currency and leads to a modestly greater improvement in the South's current-balance ratio (relative to the benchmark case). Conversely, a smaller decline in Northern fertility and population

[48] During the period 2000-2020, improvements in the South's current-balance ratio are slightly *less* in the faster-convergence case than in the benchmark and slightly *greater* in the slower-convergence case. The further reversals in the South's current-balance ratio after the decade of the 2030s, like the reversal that occurs in the mid-1970s, are attributable predominantly to the further differences between the three demographic paths for the South after the 2030s and hence to changes in the *relative* demographics between the two regions (see again, for example, the longer-run differences in the active ratios shown in Figure 7).

growth causes a smaller depreciation of the South's currency and somewhat less improvement in the South's current-balance ratio.

The main conclusion to take away from the sensitivity tests on alternative demographic paths is that the benchmark analysis is robust to changes in the pace of Southern and Northern demographic transitions. Variations in assumptions about the demographic paths in either the South or the North do significantly alter the macroeconomic outcomes. But the differences between the UN's Low Variant, Medium, and High Variant projections do not modify the qualitative conclusion that demographic influences in coming decades will work to reduce rather than increase the net flow of capital from the North to the South measured in relation to the size of the Southern economy.

4B. Hospitality of the Southern Investment Climate; Southern Consumption Parameters

In the course of the research for the paper, sensitivity tests were carried out on the factors identified in section 2C that affect the hospitality of the Southern investment climate. Tests were also conducted on the dimensions of intertemporal smoothing of consumption identified in section 2C. To keep the paper from becoming still longer, these two sets of sensitivity tests are not summarized here.

No significant surprises were encountered in these tests. Variation in the assumptions about the risk-premium wedge on capital in the Southern economy, about the adjustment costs associated with Southern investments, and about the Southern depreciation rate for physical capital influenced the levels of investment in the expected directions. The quantitative size of effects differed substantially for alternative assumptions about the adjustment costs for investment. But in all cases the qualitative conclusion of the benchmark analysis remained intact about the influences of demographic trends on North-South capital flows.

Differences were somewhat larger among the simulations conducted with alternative assumptions about the parameters governing the intertemporal smoothing of consumption. It appears to be true for these experiments as well, however, that the tested variation in assumptions was not great enough to significantly modify the qualitative conclusions emerging from the benchmark analysis.

4C. Productivity Convergence between North and South

Section 2C discussed alternative views about the levels and rates of growth of indexes of total factor productivity in the economies of developing nations. Our benchmark paths and three alternative paths for the Southern TFP index, the *B* of equations (3) and (4), were shown in Figures 4a and 4b. These paths reflect the broad spectrum of possible views about Southern growth performance and convergence of TFP indexes, ranging from a pessimistic "weak" scenario at one extreme to the other very optimistic extreme labeled "more vigorous." In the more vigorous scenario, the South index is 55 percent of the North's in 2050; by the time the ultimate steady state is reached, the South index catches up fully (complete long-run convergence). In the benchmark scenario, the South index reaches 50 percent of the North level in 2050 and long-run convergence is about 80 percent. The index for the "less vigorous" path is 40 percent of the North's in 2050 and 58 percent in the long run. In the weak scenario, the South's TFP index in 2050 is no higher than the 33 percent value assumed for the initial conditions of 1950; in the very long run, the index is still only 37 percent of the North's.

In this section we conduct simulations with the alternative paths for the Southern TFP indexes and compare the results to the benchmark simulation.

Because the initial level and growth rate of a region's TFP index is the preeminent driver of the region's growth, different paths for the TFP index have straightforward consequences for most macroeconomic variables. A faster (slower) growth of the index induces increased (reduced) accumulation of capital, raises (lowers) the aggregate amount of the region's output, and pushes up (down) the ratio of the region's output to output in the rest of the world. Growth in the South's TFP that is faster than in the benchmark case, by increasing the amounts of South-produced goods in the world relative to Northern-produced goods, requires a larger real depreciation of the South's currency and worsens the South's real terms of trade vis-à-vis the North. Conversely, slower than benchmark growth in the South's TFP diminishes the relative scarcity of South-produced goods and leads to a smaller real depreciation of the South's currency. Figure 11 shows these real exchange-rate outcomes.

Effects on the South's investment and saving ratios are plotted in Figure 12. With higher Southern output per unit of effective labor input, more capital needs to be accumulated; more Southern investment takes place, and the South investment ratio is modestly higher than in the benchmark case. With Southern output higher, aggregate Southern consumption and per-capita Southern consumption are also higher. The improved prospects for future growth also lead to a moderate increase in the marginal propensity to consume out of wealth and a slight increase in the Southern savings ratio. For the cases in which Southern TFP growth is less vigorous or weak relative to the benchmark, the direction of effects is reversed: the capital stock and output are lower, the investment ratio is lower, the savings ratio is somewhat lower, and the levels of Southern aggregate and per-capita consumption are reduced.

Although both the saving and investment ratio move in the same direction when TFP growth is altered, the size of the change in the investment ratio tends to be somewhat larger. As illustrated in Figure 13, therefore, the net effect of faster growth in TFP relative to the benchmark is to modestly worsen the current-balance ratio (enlarging a deficit or shrinking a surplus). Thus the South's net foreign liability position—its debtor status vis-à-vis the North—increases further relative to the size of its economy as it uses more of Northern-generated savings to support Southern investment. Less vigorous or weak growth in TFP have the opposite effects on external-imbalance variables, improving the current-balance ratio and reducing the South's net foreign liability position relative to the size of the economy.

Again we include a table to summarize:

Table 2. Comparison of Post-2005 Effects in Simulations of Alternative Paths for Growth in South's TFP Index

(Variables measured as change from 1950 initial conditions)

	Benchmark simulation (medium UN path)	***More Vigorous Growth than Benchmark Case***	***Slower Growth than Benchmark Case***
South National Saving Ratio	Rises substantially through mid-century	Slightly higher than for benchmark	Slightly lower than for benchmark
South Investment Ratio	Falls moderately through 2030s and then recovers moderately to mid-century	Modestly higher than benchmark	Moderately lower than benchmark
Ratio of South Output to North Output	Rises persistently through mid-century	Higher than benchmark	Lower than benchmark
Exchange Value of	Depreciates strongly	Depreciates more than	Depreciates less than

Southern Currency	in long-run	in benchmark case	in benchmark case
Ratio of South's current balance to South nominal GDP	Improves steadily through the 2030s, diminishing the net flow of capital to the South as a proportion of Southern output	Worsens moderately relative to benchmark (increasing South's deficit ratio)	Improves moderately relative to benchmark (diminishing South's deficit ratio)

The preceding analysis leads to two summary points. First, alternative assumptions about Southern TFP growth and the degree of Southern convergence to Northern TFP levels can generate substantial quantitative differences in estimates of the effects of demographic transitions on the direction and size of North-South capital flows. Second, the main features of the benchmark analysis appear to be robust. The most striking feature of the alternative TFP simulations, immediately evident in Figures 12 and 13, is that the broad pattern for the savings, investment, and current-balance ratios is similar. For example the South's current-balance ratio characteristically turns more negative in each simulation for the historical period 1950-1975 but thereafter undergoes a characteristic sustained improvement over many subsequent decades. The largest differences among the simulations occur in the medium and long runs. Even then, however, the differences are not large enough to cause departures from the broad pattern. Notwithstanding fairly extreme alternative assumptions about the speed of Southern TFP growth, the trend predicted by model simulations is that demographic forces in future decades are likely to diminish the flow of Northern saving to the South as a fraction of the Southern economy.

Our interest in North-South capital flows stems from their ultimate implications for economic welfare in both regions of the world. As a reminder of those more fundamental implications, it is worth stressing again that the evolution of Southern total factor productivity reflects—perhaps one should say embodies—all paramount influences on Southern economic growth, not merely growth in technological progress narrowly defined. If some set of deeper causes can raise Southern TFP growth, Southern residents will clearly be better off in welfare terms virtually regardless of the effects on net inward capital flows from the North.

The size of potential welfare gains is enormous. In the model simulations, which probably suggest the right order of magnitude, real consumption per adult in the South is more than 3 percent higher in 2025 and 9 percent higher in 2050 if TFP growth follows

the more-vigorous TFP path rather than the benchmark evolution. If one examines the extreme comparison of real consumptions per adult along the pessimistic weak and the optimistic more-vigorous TFP paths, the differences between the two trajectories amount to 28 percent in 2025 and more than 55 percent by 2050![49]

Examined from the perspective of potential welfare gains, should it be a cause for concern that higher TFP growth leads to greater transfers of saving from the North to the South? Should Southern countries worry that they could make *excessive* use of foreign saving and thereby incur unmanageably large external debt? No doubt there are examples of Southern economies borrowing too heavily from abroad and getting into debt troubles. But it seems doubtful that many of those problem cases arose because the countries experienced unusually high TFP growth. Prudent management of external debt is necessary. But when TFP growth is strong, a developing economy can afford to borrow more savings from abroad without unduly increasing risks. And—for valid reasons—Northern investors in the aggregate will typically want to increase their investments in the economy.

The North itself, moreover, is better off in welfare terms if Southern TFP growth is more vigorous. Northern output is then higher than it otherwise would be; the North enjoys a substantial improvement in its real terms of trade while its exports to and imports from the South are both higher; and Northern per-adult and per capita consumption is higher. A larger fraction of the North's higher savings will be invested in the South in a world with more vigorous Southern TFP growth. But such a scenario is the win-win outcome that has been imagined as being on balance good for both the South and the North.

4D. Demographic Evolutions and the Cross-Border Substitutability of Goods

The size of the South's output relative to output produced in the North played a key role in the preceding interpretation of model simulations. That ratio strongly influences the real and nominal exchange rates in the model. The real terms of trade of each region has major effects on regional welfares.

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[49] In real life, the presence or absence of significant border impediments to capital flows is of course relevant for the evaluation of potential welfare gains. The text comparison of the outcomes from alternative TFP paths holds the degree of border impediments unchanged across the alternative paths.

The sensitivity experiments described in this section show that the strength of those important effects depends critically on the degree of cross-border substitutability among goods produced in each region. The degree of imperfect substitutability, as embodied in the values of the substitutability parameters governing the demand for imports, can have important quantitative effects on the macroeconomic interactions between the regions.[50]

The model specifies cross-border trade using two traditional, widely used assumptions: (i) domestically-produced tradable goods in an economy are imperfect substitutes in demand for tradable goods produced abroad imported into the economy, and (ii) the preferences underlying the imperfect substitutability between home- and foreign-produced goods are unchanged over time. The substitutability margin between home-produced and foreign-produced goods is captured in the price elasticities of each region's demand for imports. Suppose goods production in one of the model's regions accounts for a larger share of world output over time. Given the traditional assumptions about import demands, that region will experience a faster increase in its imports than its exports. As explained before, the incipient imbalance in that region's trade with the rest of the world will have to be associated with a real depreciation of the region's currency. With unchanged preferences for the imperfectly substitutable home-produced and foreign-produced goods, such depreciation is required to induce the world's consumers and firms to buy the now relatively less scarce output of the faster growing region and to prevent the region's actual trade deficit from growing larger and larger.

The salience of the traditional assumptions can be illustrated by comparing the benchmark simulation with three additional simulations that vary the substitutability parameters. In the benchmark case, the price elasticities in the two regions' import equations have a value of -1.10 (values near negative unity are typically estimated in aggregate import demand equations); the benchmark puts a value of zero on so-called "varieties effects" in the import equations. For a "diminished-substitutability" simulation, the import price elasticities are lowered (for both regions) by 25 percent, to values of -0.82; varieties effects are set at zero. Two "heightened-substitutability" simulations are run. The first ("heightened substitutability 1") raises the import price elasticities in both

[50] This analytical point, treated here briefly, is emphasized in Bryant and de Fleurieu (2005).

regions to values of -1.65 (two-thirds larger than the benchmark) but keeps varieties effects set at zero. The second ("heightened substitutability 2") raises the import price elasticities to values of -1.65 and also assigns a positive value of 0.50 to the varieties-effect coefficient.[51] Apart from these parameter changes, the additional simulations use inputs identical to those in the benchmark simulation.[52]

Altering the substitutability parameters has major effects on the South's saving ratios but somewhat smaller effects on its investment ratios (Figure 14). Heightened substitutability reduces the savings ratio more than the benchmark during the historical period and keeps it lower throughout the medium and long run. Heightened substitutability dramatically cuts the size of the long-run depreciation in the real value of the South's currency, as shown in Figure 15. Adding a non-zero varieties effect in the heightened-substitutabiliy-2 simulation reduces the size of the depreciation still further. Raising the substitutability parameters enlarges the South's current-account deficit and lowers its current-balance ratio (Figure 16). If the cross-border goods substitutability is diminished, the effects on the Southern savings ratio, the real exchange rate, and the South's current-balance ratio go in the opposite direction.[53]

The key to understanding effects resulting from changes in the substitutability parameters is an appreciation of the relative importance of *quantity* adjustments relative to adjustments in *prices and price-like variables*. Heightening substitutability increases the importance of quantity adjustments relative to price adjustments. Diminishing substitutability has opposite effects: it puts even greater pressure for adjustment on prices and price-like variables. When any exogenous shocks – for example, changes to fertility rates and mortality rates – are put into an analytical economic system, real quantity variables (for example incomes, wealths, and consumptions) are required to adjust so that regional economies and the world economy as a whole can attain a new real equilibrium.

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[51] The rationale for "varieties effects" in trade equations and the way they are incorporated in the analytical model are explained in Bryant and de Fleurieu (2005).

[52] These experiments vary the substitutability parameters equivalently in the two regions. Cases also merit examination where the parameters have different values for the regions. Ideally, of course, one should have empirical estimates of these parameters. As of now, such estimates cannot be found, especially for an aggregation of developing economies.

[53] The Northern saving ratio is *increased* with heightened substitutability and *reduced* with diminished substitutability. Effects of changing the degree of substitutability on the Northern current-balance ratio of course also have the opposite sign from effects on the Southern current-balance ratio.

The necessary adjustments in key quantity variables, although not independent of what happens to price variables, are most crucially interdependent with the evolutions of other endogenous quantity variables (with all endogenous variables ultimately driven by the exogenous shocks). If shocks are asymmetric across regions, major adjustments are typically required in both the real and the nominal values of cross-border transactions. The higher is cross-border goods substitutability with respect to relative prices, the less will price variables have to adjust to achieve the necessary adjustments in real quantity variables. Greater sensitivity of behavior to prices means that quantities, both cross-border and domestic, adjust faster and possibly more smoothly to the required new equilibrium. Conversely, if cross-border goods substitutability is weak, then price and price-like variables must adjust by much larger amounts to achieve the adjustments to quantities that are ultimately necessary. Price variables in these generalizations include of course goods prices – domestic prices, import and export prices. But the relevant price-like variables also include interest rates and exchange rates (both real and nominal).

Thus in the diminished-substitutability simulation, price adjustments—including, dramatically, the real exchange rate but also the real interest rate—are larger than in the benchmark case. The underlying demographic forces which cause the South's output to rise relative to the North's require a bigger change in the real exchange rate to adjust to the new relative abundance of South-produced goods. The lower value of the import price elasticity simultaneously *increases* the size of the depreciation of the South's currency and *improves* the South's current-balance ratio (reduces the current-account deficit relative to the benchmark case).

The opposite effects occur when the substitutability parameters are larger in absolute value. The real exchange rate and real interest rate need to change less relative to the benchmark case to achieve the required adjustment to the altered demographic conditions. The higher values of the substitutability parameters thus permit a *smaller* depreciation of the South's currency and produce a *deterioration* (larger negative value) of the current-balance ratio. If a non-zero varieties effect is combined with a higher value for the import price elasticities (heightened-substitutability-2 simulation), the size of the necessary depreciation is still smaller and the South runs a still more negative current-balance ratio.

The robustness of the earlier conclusion about the direction of the demographic effects on North-South capital flows is not *qualitatively* challenged by variation in the cross-border substitutability parameters. Regardless of whether the substitutability parameters are heightened or diminished, it remains true that the South's deficit ratio increases and interregional capital inflows to the South are larger relative to the Southern economy during the historical period to the mid-1970s (Figure 16). Similarly, a persistent and decades-long diminution in the capital flows to the South begins after the 1970s whatever the degree of cross-border substitutability. Nonetheless, the levels of the post-1970s current-balance ratios produced by the alternative parameters differ quite significantly. Hence the robustness of inferences from the benchmark case is certainly affected in quantitative terms.[54]

Variation in the substitutability parameters can have dramatic implications for regional welfares. Suppose again that one gauges regional welfare by the evolution over time in levels of per-adult consumption (or per-capita consumption for the entire population). The simulations being compared here reveal that heightened (diminished) cross-border substitutability with its augmented (reduced) Southern use of Northern savings *improves* (*worsens*) per-adult consumption in the South but *lowers (raises)* per-adult consumption in the North.

These effects on per-adult or per-capita consumptions stem from changes in the terms of trade of the regions. When a region experiences a real depreciation of its currency, for example, it suffers a deterioration of its real terms of trade with the rest of the world. Other things equal, the deterioration of the terms of trade causes an adverse change in the welfare of the region's residents. In the simulations here, South residents in the benchmark case, because of the very large currency depreciation, experience a major deterioration in the relative prices at which South-produced goods can be traded for imported goods. With heightened substitutability parameters, the adverse changes from deterioration of the terms of trade are significantly mitigated. What is gained by the South when substitutability parameters are higher, however, is plainly an adverse development for Northern residents; the Northern real terms of trade is less favorable

[54] Note also that after the decade of the 2030s the alternative substitutability parameters appear to reverse the ranking of current-balance outcomes among the simulations.

than in the benchmark case and hence negatively impacts Northern per-adult consumption.[55]

This paper is not the place for a more extended discussion of inferences about the effects of demographic transitions on regional welfares. Nor is it the place to resolve which values of the import price elasticities and other substitutability parameters conform best to real-life behavior. But it should be clear from even the brief discussion here that analysis of macroeconomic interactions among different parts of the world economy needs to pay greater attention to the degree of cross-border goods substitutability. In particular, analysts and policymakers require more reliable empirical estimates of the determinants of the degree of cross-border goods substitutability than the inadequate estimates currently available.

5. CONCLUSIONS AND IMPLICATIONS FOR GOVERNMENT POLICIES

Public debate in recent years has focused prominently on the major changes in demographic trends in the world economy. In Japan, the United States, and several European nations, much of the attention has been concerned with the effects of population aging on health care, public pensions, and government budgets. Commentators have also begun to appreciate the point that demographic asymmetries among regions of the world can strongly influence macroeconomic interactions among the regions, altering exchange rates, external imbalances, and interregional capital flows. Given prospective demographic developments, these issues are certain to generate concern in future years among an even wider public audience.

The contribution of this paper is to study how global demographic change may alter regions' saving and investment and the imbalances between them, which is the reverse side of the coin of interregional capital flows. The most pronounced differences in demographic trends today are those among developing lower-income and developed higher-income nations. That fact explains the structure of this paper. I aggregate developing and developed nations into a two-region world—a Southern economy and a

[55] As always, one has to be careful when making welfare inferences to distinguish between (for example) per-adult or per-capita consumption of individual residents of a region versus aggregate adult or total consumption for the region as a whole.

Northern economy—and analyze the demographic and macroeconomic interactions between them. The strength of the analytical framework is its general-equilibrium modeling of the co-evolution of both economies.

North-South asymmetries in demographic transitions have already strongly influenced capital flows between the North and South, and will continue to do so. The paper highlights the key relationships that determine these North-South flows. A relatively optimistic view of these relationships suggests that the North can run a current-account surplus sizable in relation to the Northern economy, thereby transferring large net amounts of financial capital to the South. Such an outcome could be mutually beneficial for the South and the North, simultaneously promoting Southern economic development and permitting asset owners in the North to earn higher returns on their savings than would otherwise be possible. The analysis here argues that this view is a plausible summary of what happened in the world economy in the historical period between 1950 and the mid-1970s. But the analysis casts doubt on this optimistic view for historical decades after the 1970s. Rather, the paper reinforces the conjecture that asymmetric demography between the South and the North, other things being held equal, now operates to *reduce* rather than increase the net flow of Northern savings to the South as a proportion of the Southern and Northern economies. Alternatively stated, demographic factors for several decades into the medium-run future will cause Northern saving to fall relative to Northern investment while Southern saving rises relative to Southern investment.

The fundamental causes of these effects are shifts in *relative* demographics. Relative shifts in the age compositions of the populations, and in particular relative shifts in the numbers of active workers in the labor forces and their efficiencies, differentially affect regions' flows of savings and investments. Savings, determined in a modified life-cycle framework, are relatively high (low) in a region in which the active labor force rises (declines) in relation to the total population. Investments relative to savings are high (low) when youth and elderly dependents constitute a large (small) fraction of the population. Both savings and investment are of course higher (lower) in a region growing strongly (sluggishly). But the balance between savings and investment for a single region—and even more so net changes through time in the savings-investment

imbalances of regions interacting with each other—depend critically on the relative demographics. Other things equal, for example, financial capital tends net to flow away from a region whose active ratio (effective labor force to total population) rises relative to the active ratio abroad; the shift in relative demographics pushes up savings relative to investment in that region, with the savings-investment balance abroad influenced in the opposite direction. In the period between 1950 and the mid-1970s, the South experienced a marked fall in its active ratio; simultaneously, the active ratio in the North was rising strongly. After the 1970s, the South's active ratio was reversing its earlier decline and rising strongly while the increase in the Northern ratio was decelerating and, by the first decade of the 21st century, beginning to decline. The marked shifts in relative demographics explain the prominent reversal in the pattern of current-balance ratios before and after the 1970s.

The preceding generalizations refer to composite aggregations of developing Southern economies and of more advanced Northern economies. Disaggregated analyses would find significant differences among both groups of economies, for example between China, India, and Brazil and between the United States, Europe, and Japan. One must thus be cautious in applying the analysis here to actual economies. The goal is to summarize broad tendencies, which then can be used as a foundation for identifying refined conclusions applicable to particular developing and developed economies.[56]

During preparation of this paper, numerous sensitivity experiments were conducted to test the robustness of the analysis and in particular the conclusions about the direction of North-South capital flows. Sample results from three sets of these experiments are described in the paper. One set focuses on alternative demographic projections, examining whether outcomes would change substantially if the South experienced a faster or slower demographic transition than the medium scenario of the UN Population Division. A second set examines alternative assumptions about the growth of Southern total factor productivity. The third studies the consequences of varying the degree of cross-border goods substitutability.

[56] McKibbin (2005b) and Batini, Callen, and McKibbin (2006) present conclusions about the role of demographic factors in a more disaggregated context.

The general appraisal emerging from the sensitivity tests is that the qualitative analysis is robust to the assumptions tested. To be sure, quantitative details of the effects on savings, investment, and capital flows differ for each of the three sets of sensitivity experiments. The quantitative results are especially sensitive to big variations in the assumed substitutability between Southern-produced and Northern-produced goods (as embodied in import price elasticities and the strength of varieties effects). The broad qualitative features of the analysis, however, are affected in only modest ways. Regardless of whether the demographic transition in Southern economies is somewhat faster and sooner or somewhat slower and delayed, regardless of whether Southern TFP growth is vigorous or weak, and regardless of whether cross-border goods substitutability is modest or strong, demographic forces considered by themselves are likely in future decades to diminish rather than augment the flow of Northern saving to the South as a fraction of the Southern economy.

The research reported in this paper and the larger project of which it is a part are preliminary in a fundamental sense: inferences drawn from model simulations cannot be treated with full confidence if the model itself has features that can be challenged. The effects of demographic forces and macroeconomic interactions among countries are highly complex. Like all models, the one underlying this paper makes numerous simplifications and has problematic features. Much can, and should, be done to refine it.

One valid criticism that can be made about the model is that it undoubtedly is biased toward making cross-border capital flows seem easier than they are in real life (especially between developed and developing economies). To simplify the model's structure, the assumption is made that exchange rates are proximately determined with a variant of the uncovered interest parity condition. This assumption, as is widely acknowledged by those using multi-country models, is tantamount to presuming that assets denominated in different currencies are perfect substitutes for each other (adjusted for expected rates of return and heterogeneous risks). Substantial evidence exists that this assumption does not conform to real-life behavior. Hence the model can be accused of exaggerating the effects of demographic and macroeconomic conditions on capital flows. The accusation seems especially pertinent for this paper, given its focus on capital flows between the North and the South. It may well be, for example, that the initial conditions

generated by the model for the year 1950 are excessive in the sense that the South's current-account deficit and net foreign liability position are larger than seems plausible.

The weakness just identified, on the other hand, may also have a silver lining for the purposes of this paper. By illustrating the effects of demographic forces in a setting where restrictions and frictions inhibiting North-South capital flows are less than those in real life, the analysis here identifies the effects of the demographic forces transparently. It seems doubtful, moreover, that an analytical framework taking account of the restrictions and frictions inhibiting capital flows would overturn the qualitative predictions emphasized in this paper. The relative demographics leading to a greater net inflow of Northern savings to the South in 1950-1975 and those reducing the net inflow in 1975-2025 might be exaggerated in the model simulations here. But the conclusion about the mid-1970s reversal in the direction of the demographic-induced effects would probably survive in a more refined analysis.

A prudent judgment should take into account the likelihood that demographic influences on capital flows and other external-sector variables are just one of the influences determining North-South interactions, and probably not even the most important influence. It would be imprudent, however, to presume that the demographic forces are small enough to be safely ignored.

How should policymakers in Northern nations such as the United States and Japan react to the analysis here? One recommendation is unambiguous. Public policy concerned with demographic trends in higher-income Northern nations should recognize that demographic asymmetries with lower-income Southern economies are unlikely, by themselves, to ease resolution of Northern macroeconomic difficulties caused by population aging. In fact, the demographic asymmetries between South and North are likely to work in the "wrong" direction, reducing rather than increasing the extent to which Southern nations rely on Northern savings to facilitate their own development.

Neither Northern nor Southern governments have much of a policy handle to intervene directly to influence demographic developments. The pace and nature of demographic transitions in all nations is uncertain. Moreover, they are largely outside the control of public policy. For example, it is unclear what governmental measures might reliably alter the decline in fertility rates or manage the increases in life expectancy.

Measures such as improved health care for infants, improved availability of contraceptive devices, and enhanced delivery and better cost containment for elderly health care are desirable in themselves. But short of radical policies such as China's one-child-per-couple restriction, the scope for specific intervention in demographic trends is limited.

Southern governments aspiring to foster their nations' development should concentrate on mitigating the domestic obstacles that inhibit the faster growth of their economies. The list of such constraints, alluded to in the first section of this paper, is a long one. Improvements are needed in infrastructure capacity, education and training, macroeconomic management, prudential supervision and regulation of financial intermediaries and financial markets, the enforcement of contracts and the protection of property rights, the nurturing of social infrastructure and norms, and more broadly still in the quality and stability of many different private and public institutions. All such improvements will contribute, directly or indirectly, to raising the level or growth rate of Southern nations' total factor productivity. Merely identifying a catalogue of such improvements is of no practical help to Southern governments. But it at least points the development of policy recommendations toward the most promising areas. Much the surest recipe for improving Southern welfare, as suggested by the analysis above, is to find feasible ways of lifting the level or growth rate of Southern total factor productivity.

As the 21st century proceeds, Northern governments will likely experience heightened pressure, from both their own citizens and foreigners, to alleviate economic inequality across the nations and individuals of the world. And they *should* experience such pressure. Even from a selfish—and of course from a compassionate—perspective, no thoughtful person can justify the extreme disparities in income and wealth in the world.

How can Northern governments and international organizations best help to mitigate the disparities? The most promising course of action is to provide supportive assistance to Southern governments and to nongovernmental organizations who themselves are seeking to achieve the fundamental improvements that need to be made within Southern economies. Northern governments and international organizations should not espouse direct subsidies aimed merely at increasing flows of financial capital to Southern economies. Such intervention is likely to have poorer results than supportive

assistance intended to mitigate the deeper domestic obstacles that impede growth and development.

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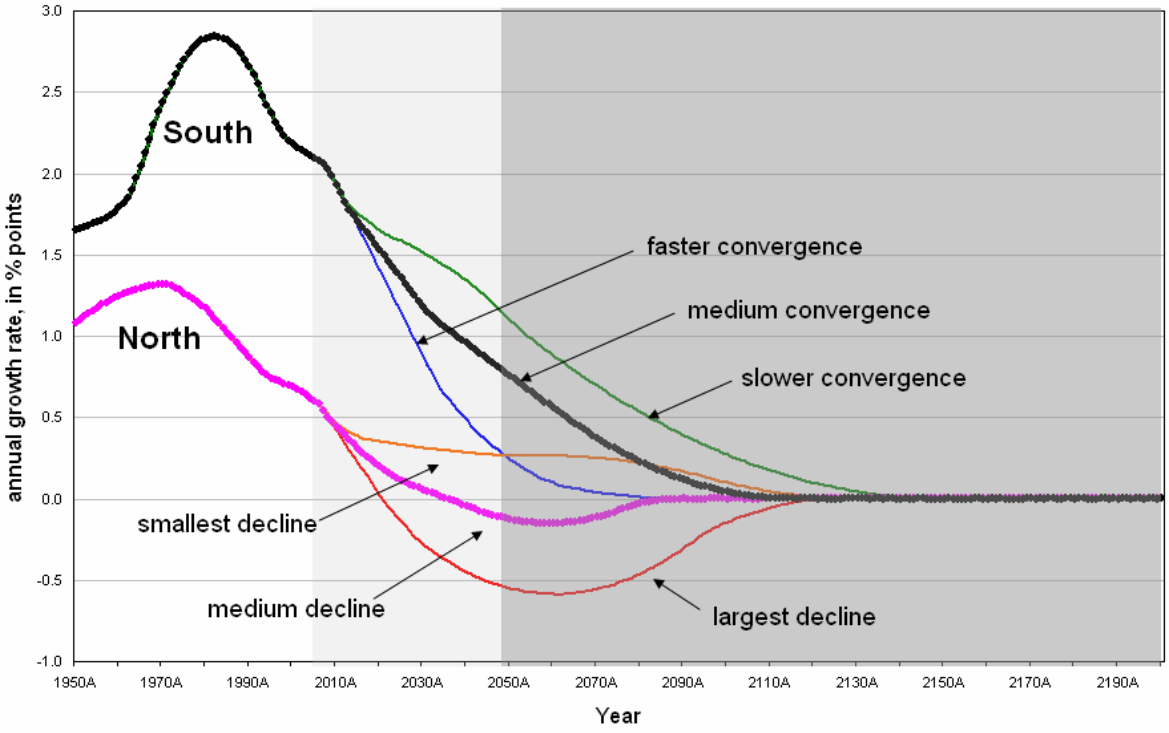
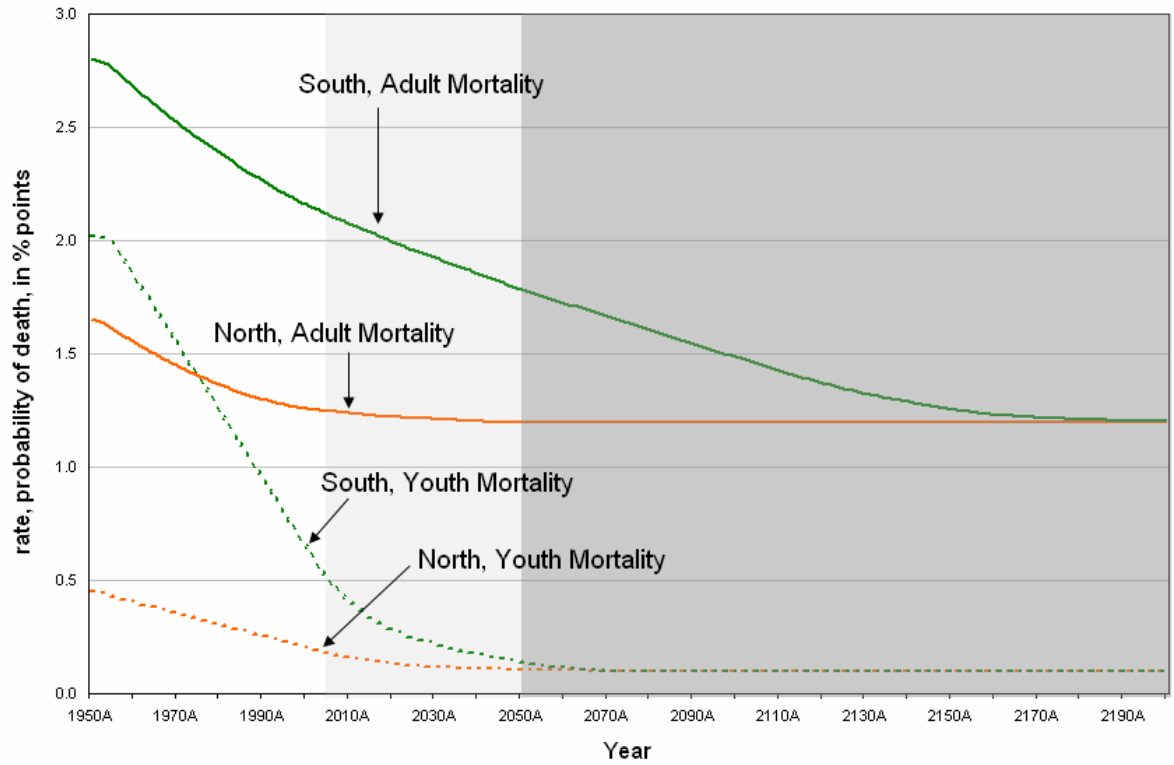
1a. Annual Growth Rate of Adult Populations

History 1950-2005. UN Projections 2005-2050. Author's Extrapolations 2050-2200.

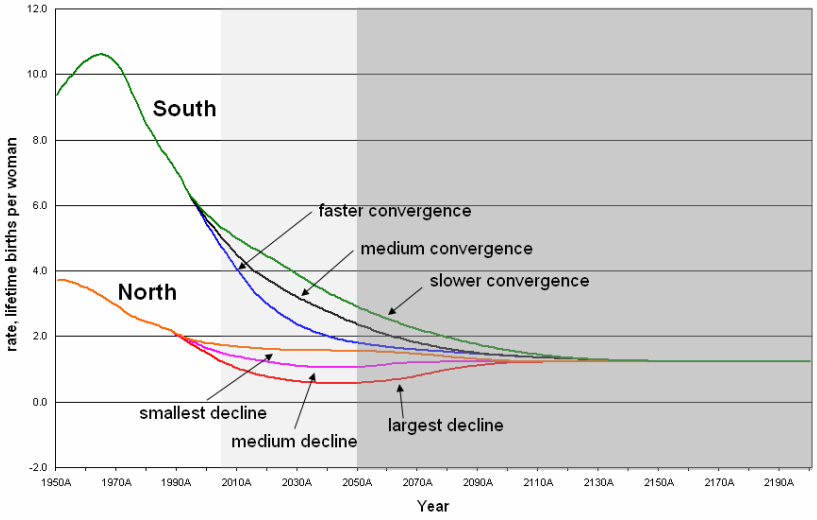


1b. Mortality Rate Assumptions

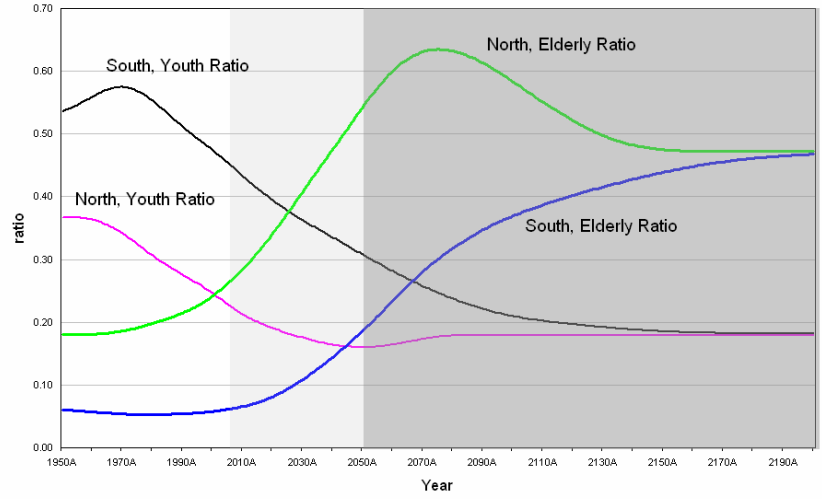
Based on UN Historical and Projected Data for Life Expectancy



1c. Fertility (Birth) Rates

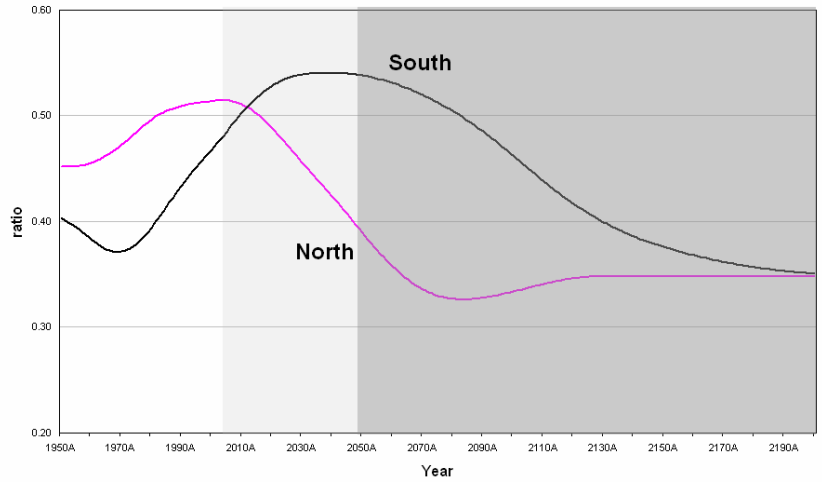


1d. Dependency Ratios: Youths to Total Population, Elderly to Total Population



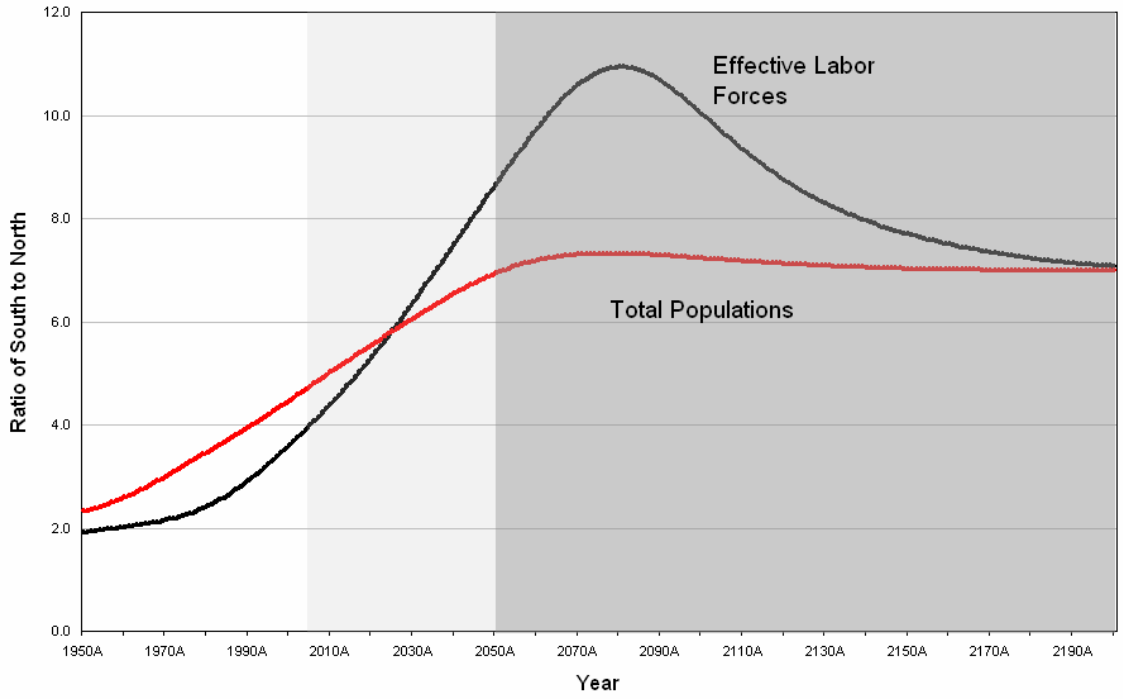
UN fertility paths underlying these ratios: "medium convergence " for South and "medium decline" for North.

1e. Active Ratios: Adults of Working Age as a Proportion of Total Population



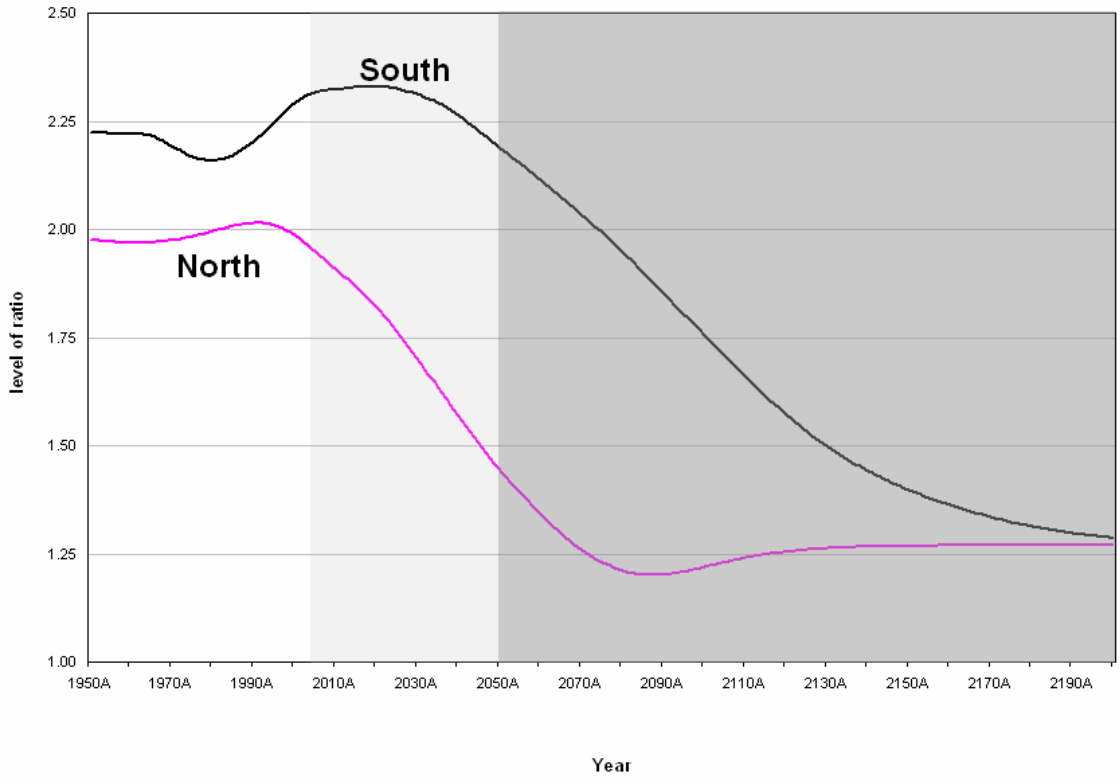
UN fertility paths underlying these ratios: "medium convergence " for South and "medium decline" for North.

2. Ratios of South to North: Total Populations and Effective Labor Forces



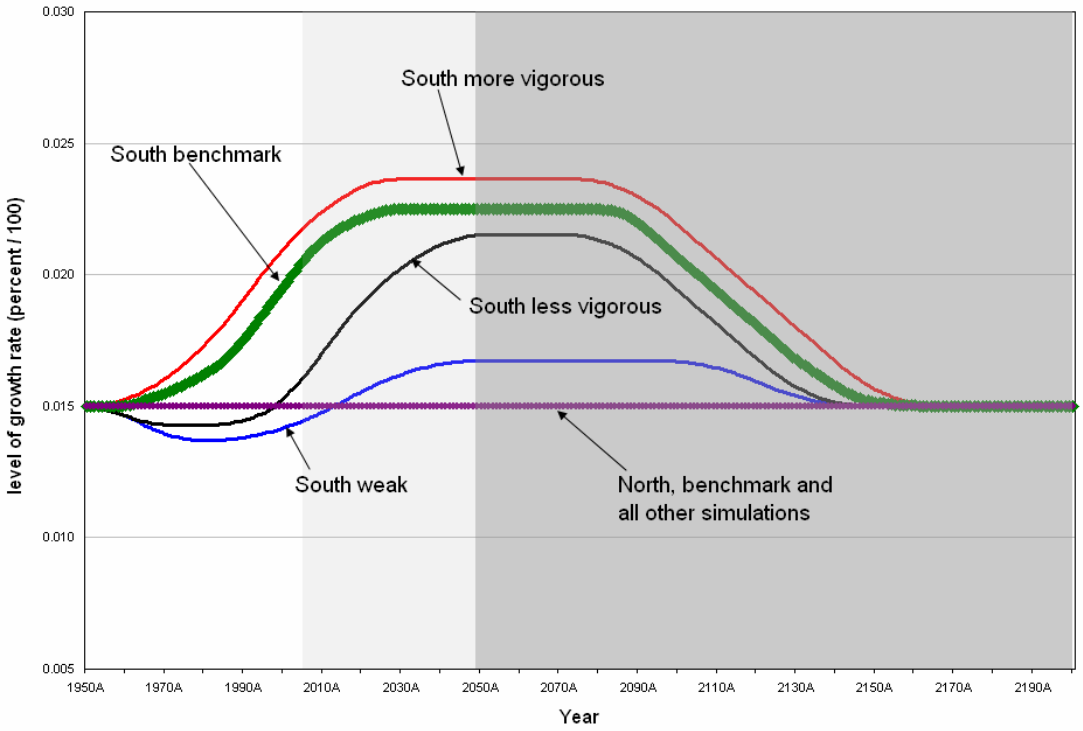
UN fertility paths underlying these ratios: "medium convergence " for South and "medium decline" for North.

3. Ratios of Effective Labor Forces to Adult Populations

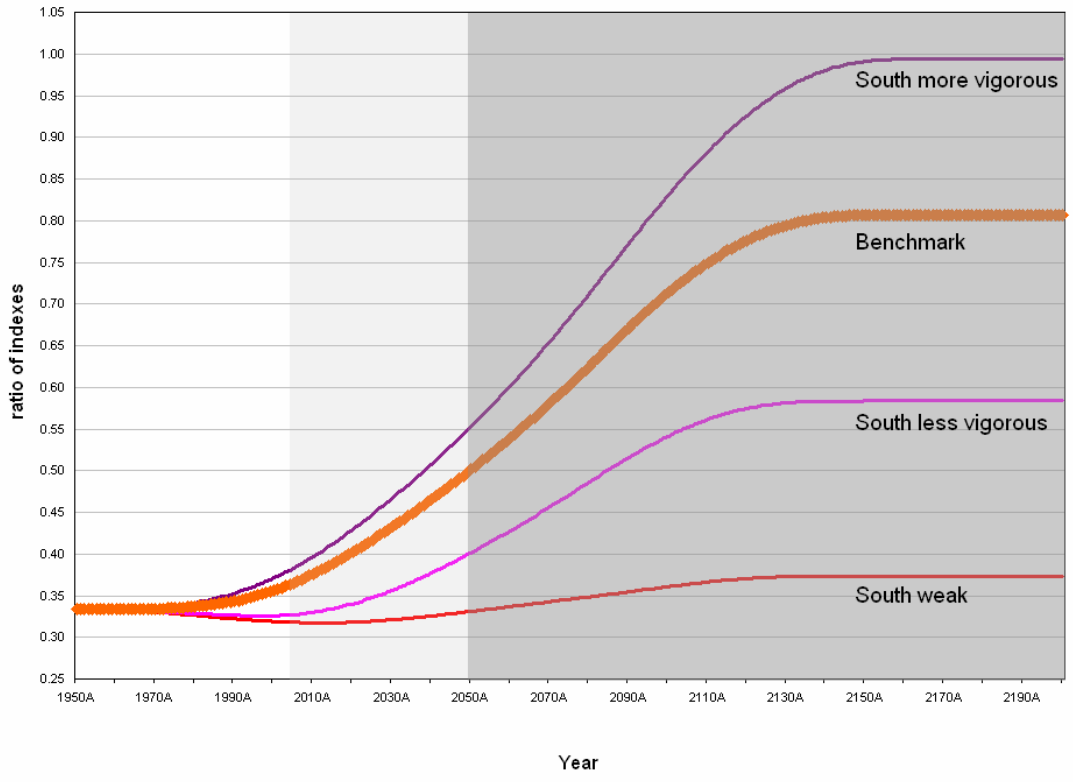


UN fertility paths underlying these ratios: "medium convergence " for South and "medium decline" for North.

4a. Alternative Paths for Growth Rates of South and North TFP ("Total Factor Productivity") Indexes

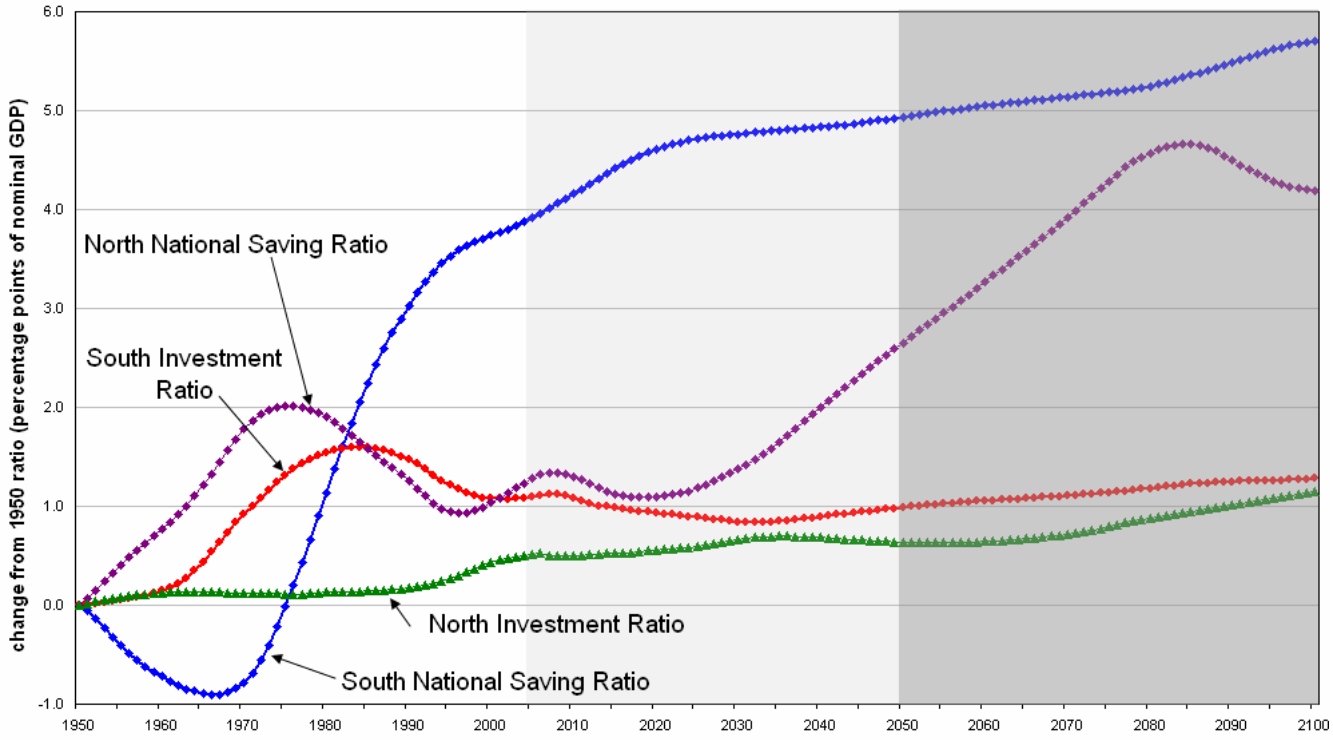


4b. Ratio of South's to North's TFP Indexes



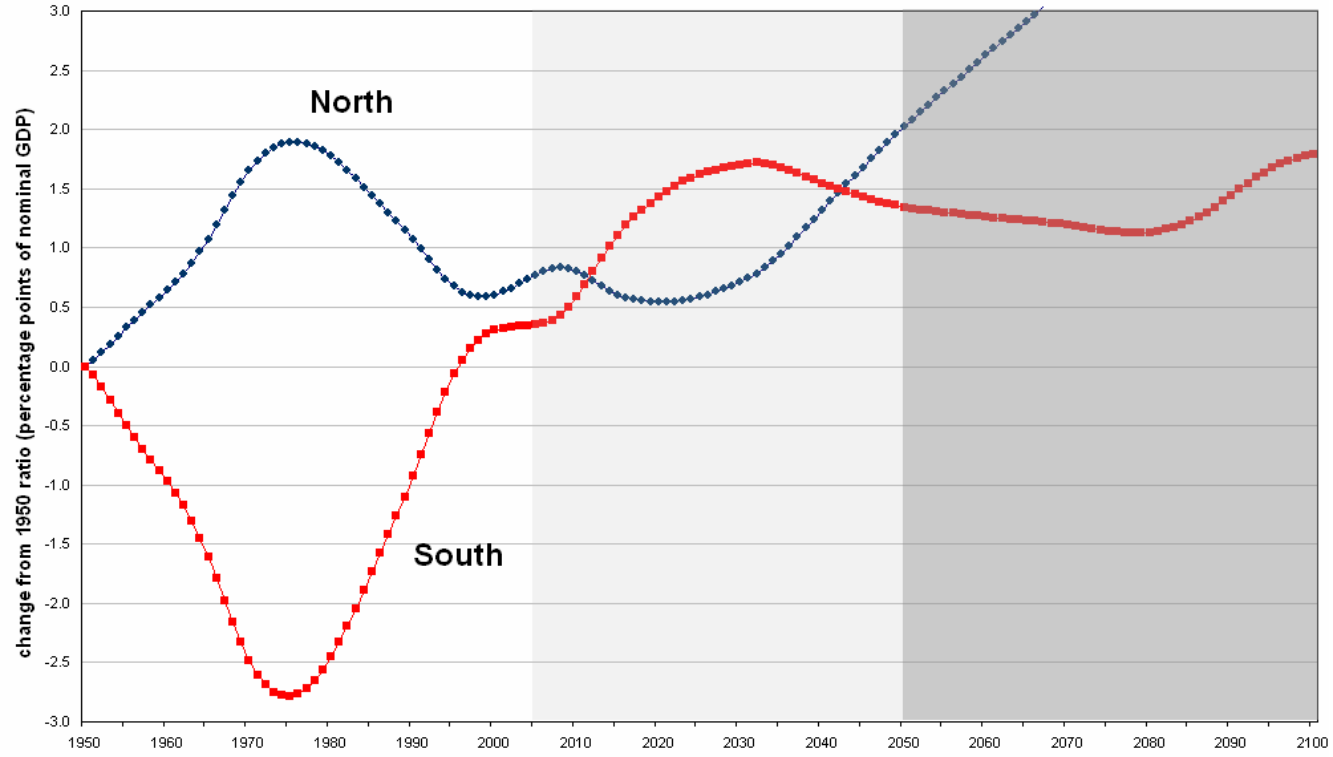
5a. Ratios of Domestic Investment and National Savings to Nominal GDP, South and North

benchmark simulation, change from 1950 value of ratios



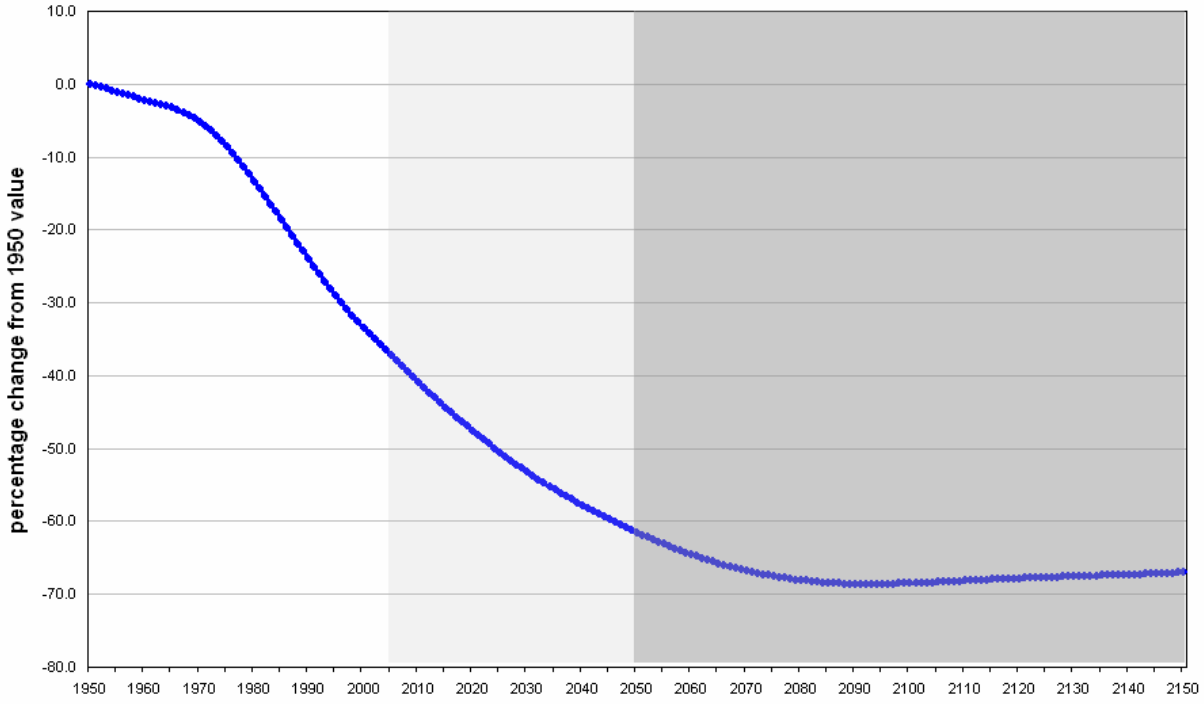
5b. Ratios of Current-Account Balance to Nominal GDP, South and North

benchmark simulation, change from 1950 value of ratios

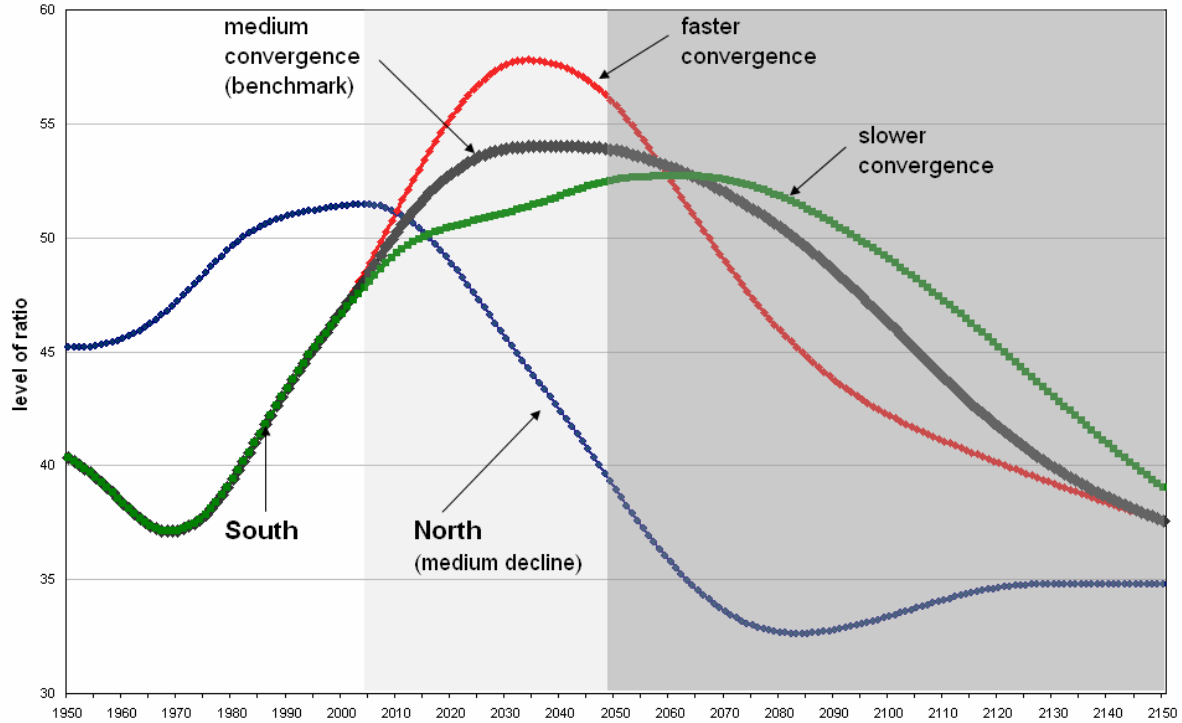


6. Real Exchange Rate, Percent Change from 1950 Value

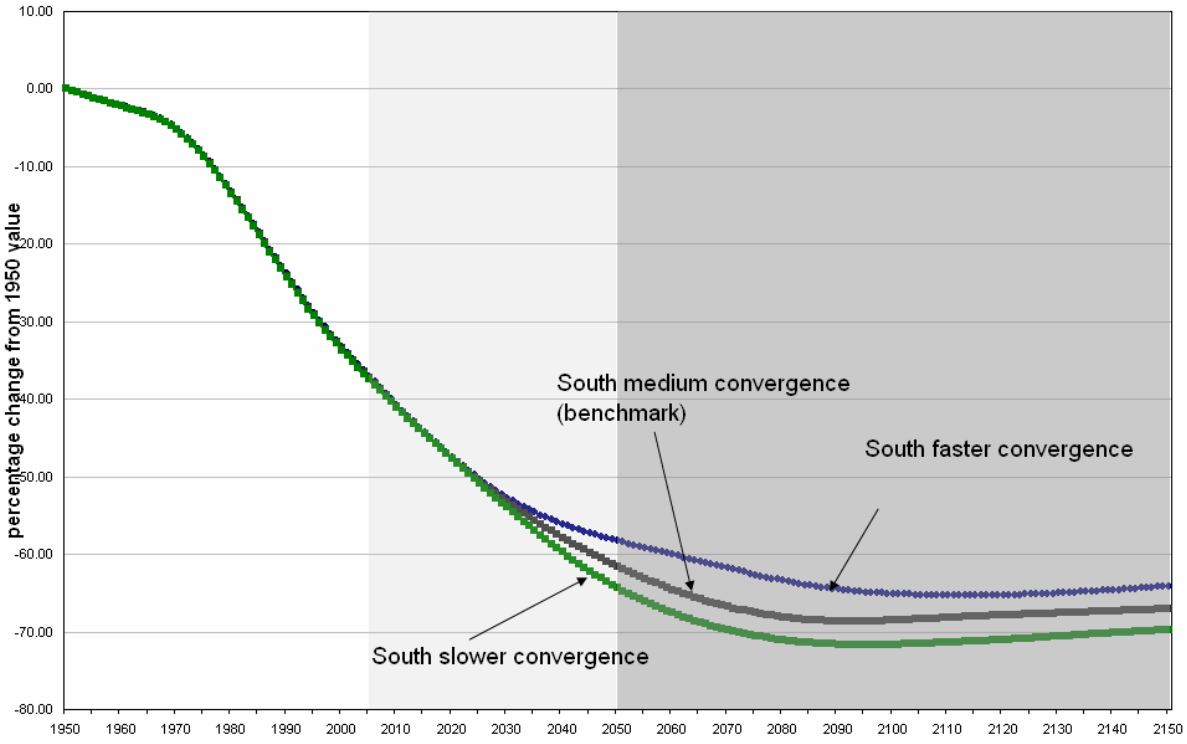
benchmark simulation
(- = depreciation of South currency)



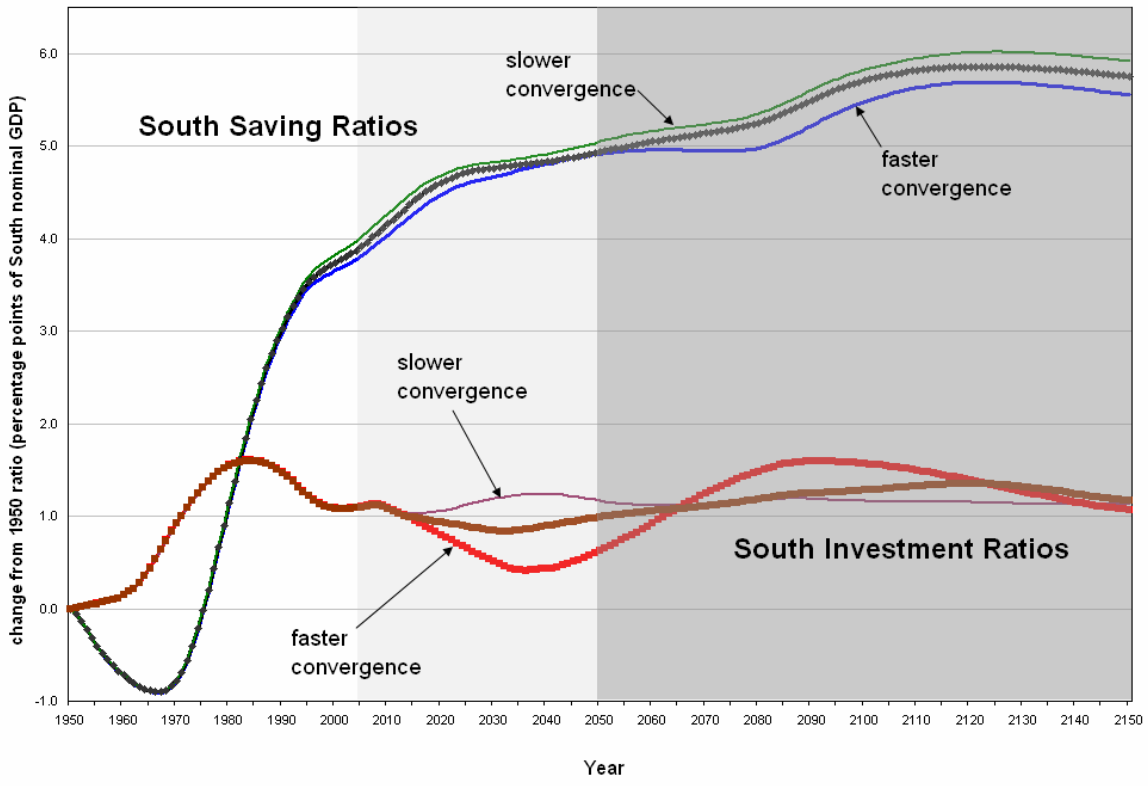
7. Active Ratios in South and North:
Three Alternative Paths for South Demographic Evolution



8. Real Exchange Rate, Percent Change from 1950 Value
Three Alternative Paths for South Demographic Evolution
(- = depreciation of South currrency)

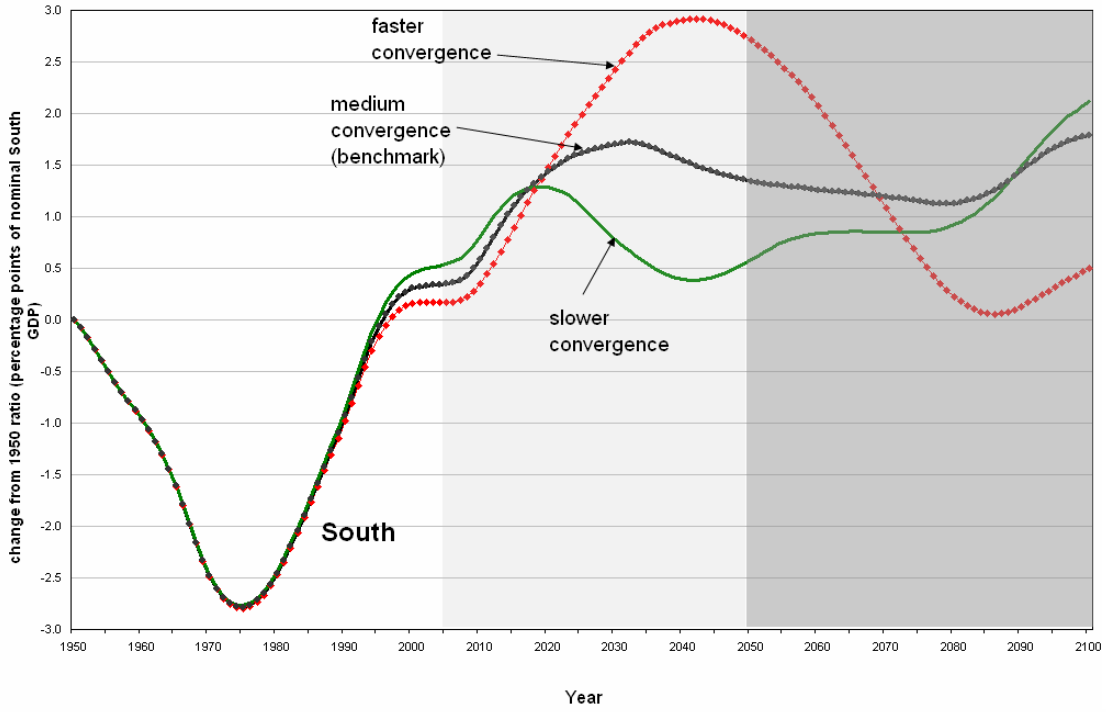


9. South: Ratios of National Saving and Domestic Investment to Nominal GDP
Three Alternative Paths for South Demographic Evolution
change from 1950 value of ratios



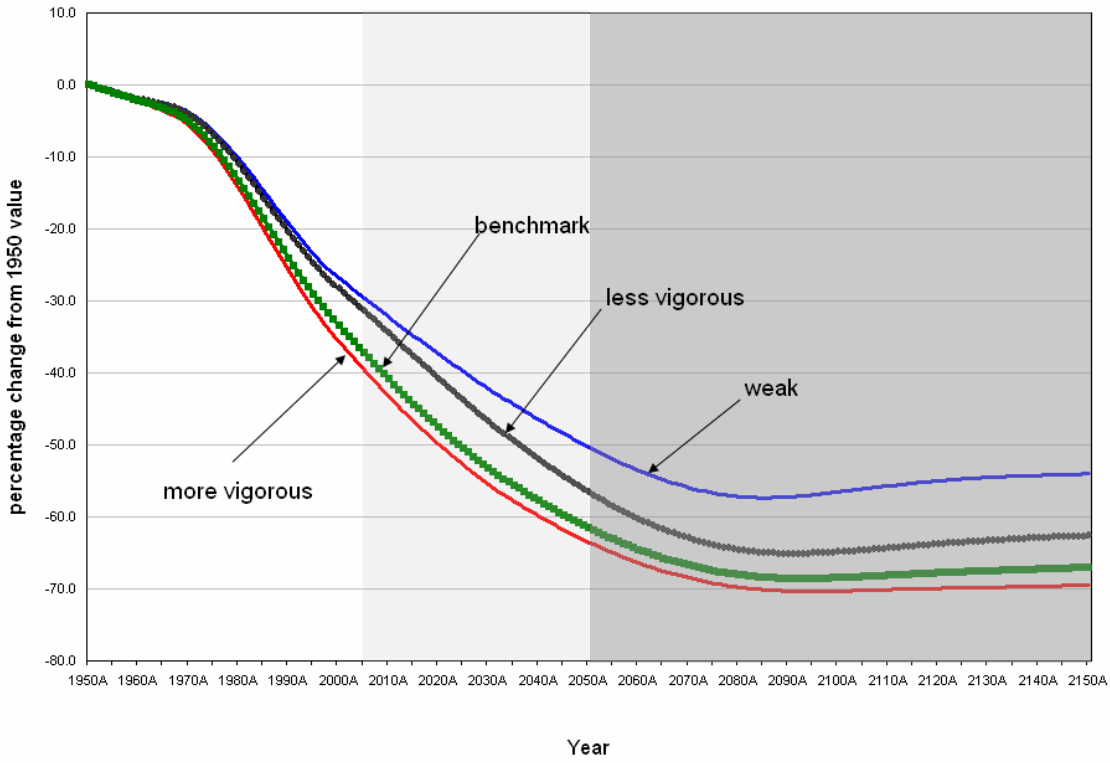
10. South: Ratio of Current-Account Balance to Nominal GDP
Three Alternative Paths for South Demographic Evolution

change from 1950 value of ratios



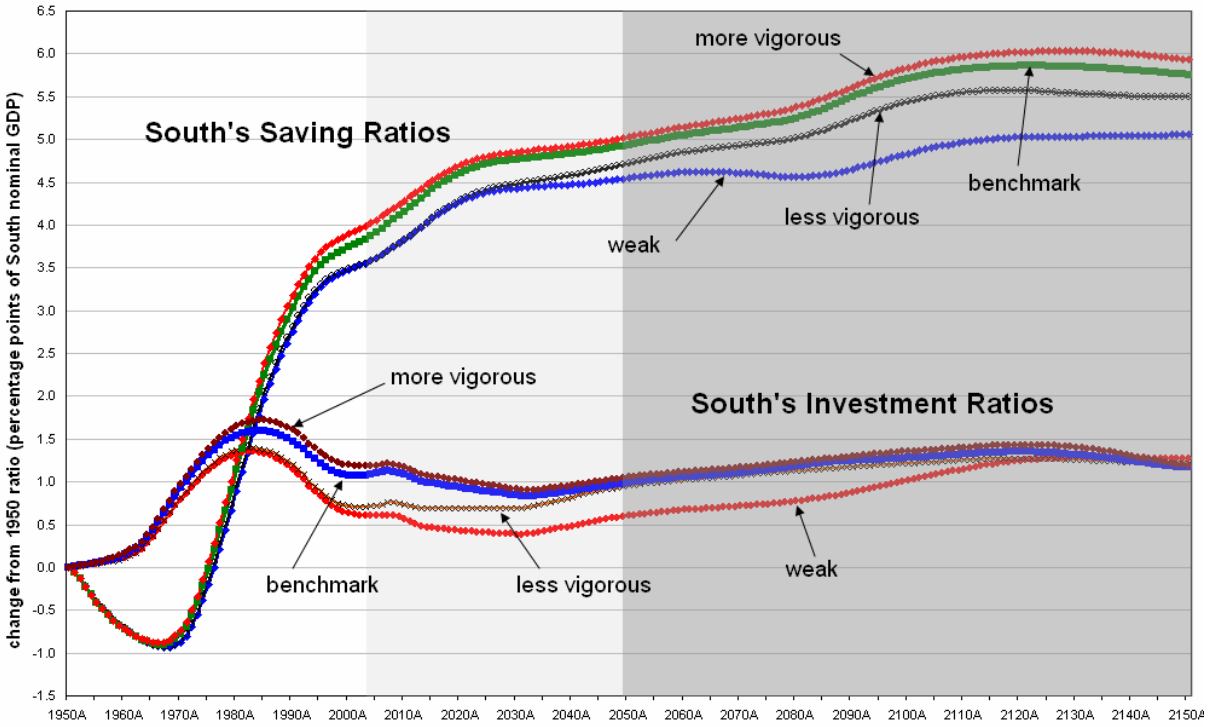
11. Real Exchange Value of South's Currency,
Percent Change from 1950 Value.
Alternative Scenarios for Growth in South's TFP Index

(- = depreciation of South currrency)



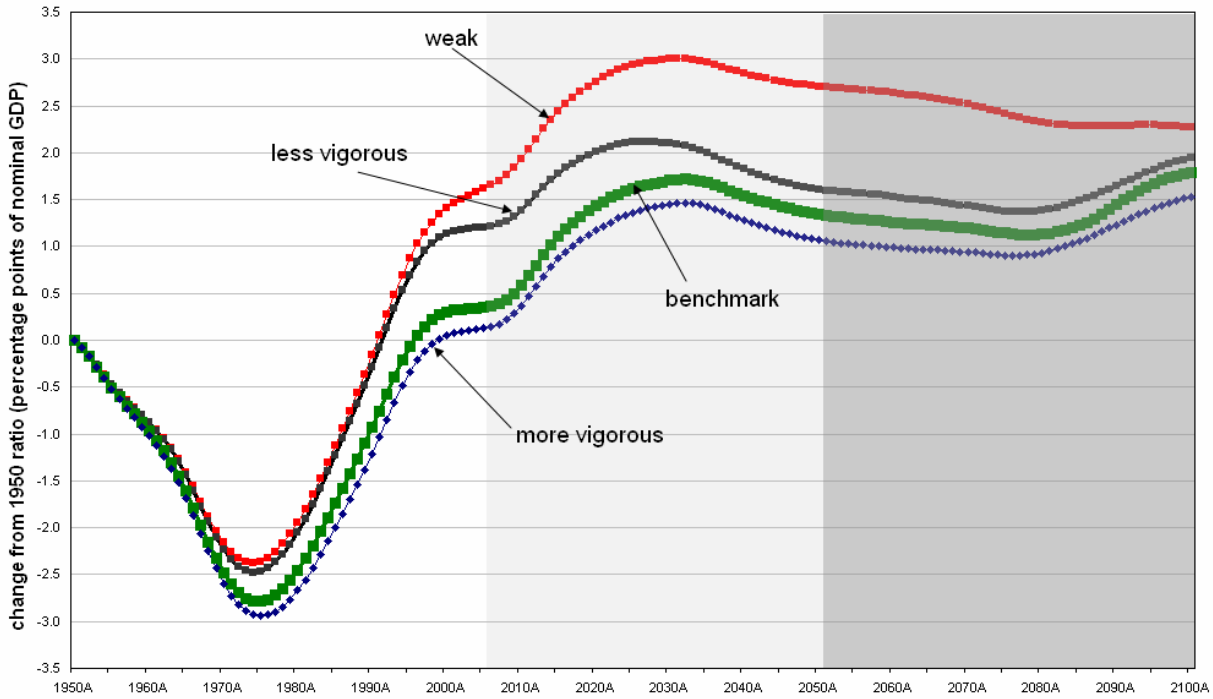
12. Ratios of Nat'l Saving & Domestic Investment to Nominal GDP. Alternative Scenarios for Growth in South's TFP Index

change from 1950 value of ratios



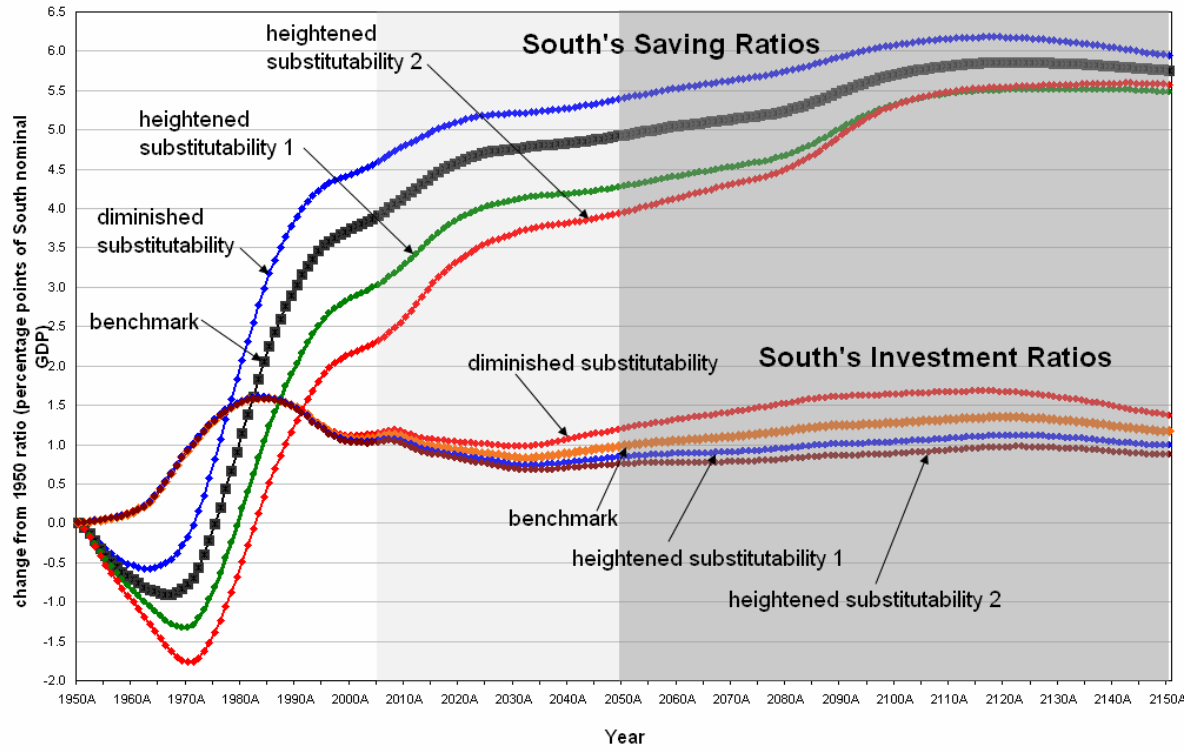
13. South: Ratio of Current-Account Balance to Nominal GDP. Alternative Scenarios for Growth in South's TFP Index

change from 1950 value of ratios



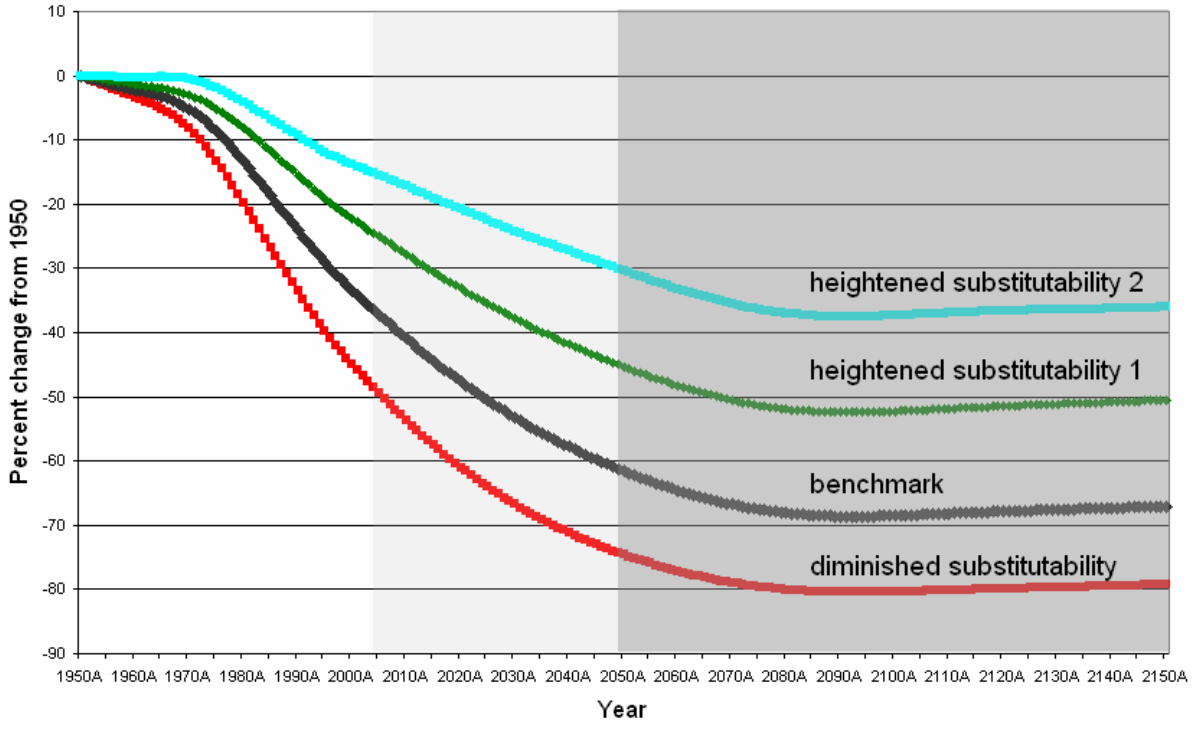
14. Ratios of Nat'l Saving and Domestic Investment to Nominal GDP. Alternative Substitutability Parameters

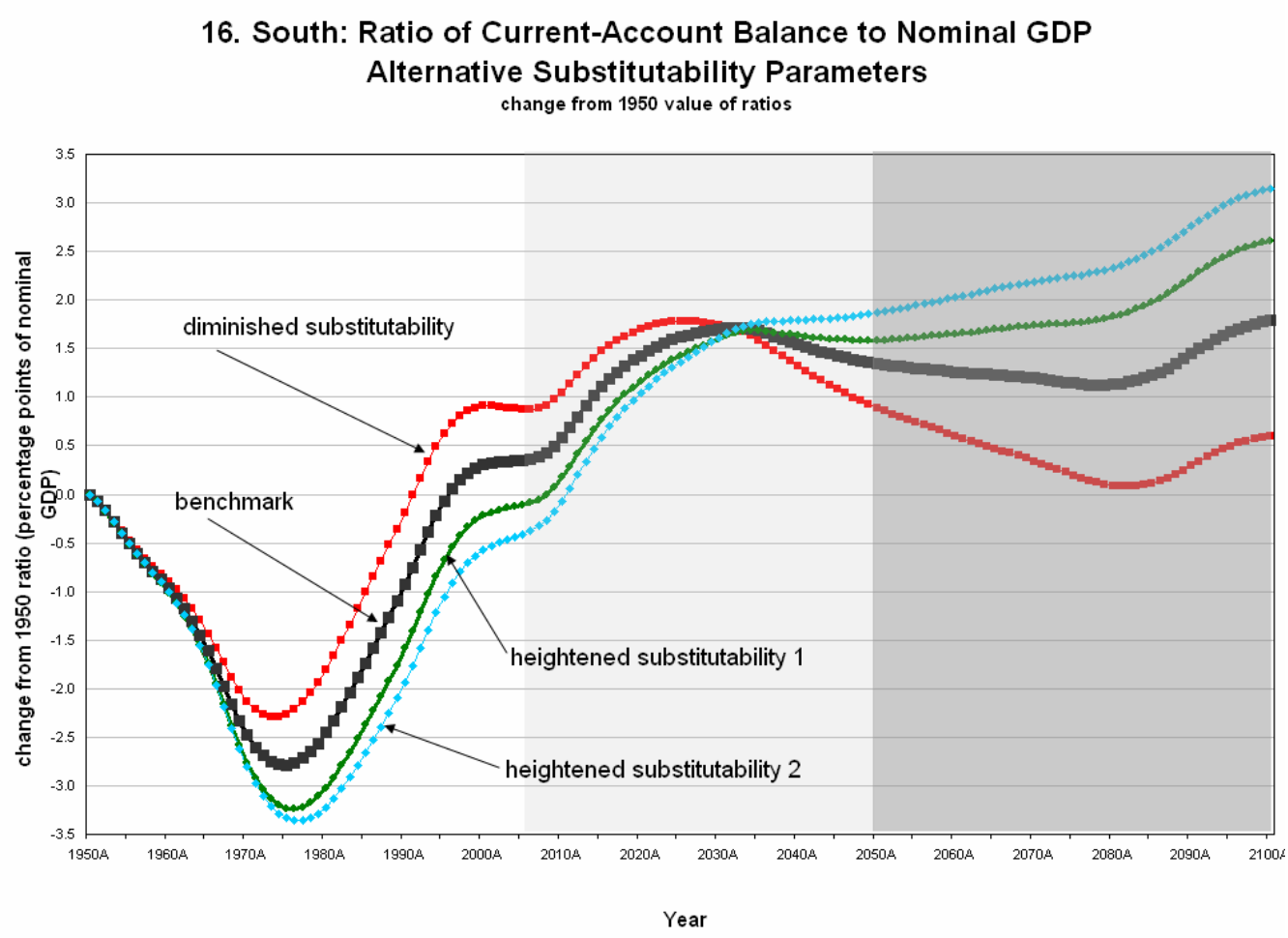
change from 1950 value of ratios



15. Real Exchange Value of South's Currency, % Change from 1950 Value. Alternative Substitutability Parameters

(- = depreciation of South currrency)




16. South: Ratio of Current-Account Balance to Nominal GDP
Alternative Substitutability Parameters
change from 1950 value of ratios
change from 1950 ratio (percentage points of nominal GDP)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
diminished substitutability
benchmark
heightened substitutability 1
heightened substitutability 2
1950A
1960A
1970A
1980A
1990A
2000A
2010A
2020A
2030A
2040A
2050A
2060A
2070A
2080A
2090A
2100A
Year