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Capital Will Not Become More Expensive as the World Ages

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Abstract

Aging of populations and convergence between developed and developing countries in per capita incomes are shaping the evolution of saving, investment, capital flows, and, in particular, the cost of capital. When considering these trends, the existing literature argues for either continued, low interest rates, or sharply rising ones. This paper presents an alternative view: modest rises in interest rates, which result from a combination of increases in the global weight of high-saving developing economies (limiting declines in global saving), and decelerations in the rate of growth in developing countries (constraining upward pressure in global investment). For the majority of countries, slowing capital demand resulting from decelerating growth, coupled with structural changes that influence its attractiveness as a destination for capital, moderate increases in interest rates. Changes in key assumptions do not alter this view. More specifically, the small rise in interest rates persists even in a scenario where growth in developing countries decelerates more slowly, or when elasticities governing the behavior of saving and investment are varied.

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Capital Will Not Become More Expensive as the World Ages

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> [I]n most under-developed countries net capital formation is not as high as 5 percent of national income... [i]n many of these countries, the savings have been sufficient only to keep up with population growth... the under-developed countries need capital from abroad, whether by grant or by loan, if their standards of living are to rise.
>
> United Nations (1951, p. 35, 75)

> [The] emergence of a global saving glut in the past eight to ten years... is the result of a number of developments... [an] important source of the rise in the global supply of saving is the recent metamorphosis of the developing world from a net user to a net supplier of funds to international capital markets.
>
> Ben S. Bernanke (2005)

1 Introduction

The global economy is in the midst of sweeping changes, all of which will continue to play out over the coming decades. Between 1970 and 2000, high-income countries commanded a steady four-fifths of global output, saving, and investment. By 2010, they accounted for about half, and this share is set to further erode into the future, especially if developing countries continue to grow at twice the rate as the nations of the developed world. The developing world—which used to be regarded as in desperate need of saving to finance their capital formation—is now seen as the source of excess saving, inducing a global saving glut.

These changes in economic activity have occurred, and will continue to evolve, alongside shifts in the fundamental structure of the world's economies, especially in the developing world. Asynchronicities in the timing, pace, and magnitude of countries' demographic transitions means that certain regions of the world will experience significant growth in their working-age populations, while others will see substantial contractions. And if other structural and institutional factors—such as the level of financial development and the quality of political-economic institutions—continue to follow the trends that have developed in the recent past, their evolution will further accelerate convergence between the global North and South.

Abstracting from short term fluctuations and focusing on the long term—defined here as ten to twenty years into the future—what will these impending changes mean for global saving and investment? More specifically, will the world—or perhaps some individual countries—need more or less capital than what will be available from savers? And, finally, what will the consequences be for long-term interest rates?

One plausible answer to this set of questions, articulated in Dobbs *et al.* (2010), is that impending demographic changes in high-income and East Asian countries—in the form of population aging—will entail a substantial reduction in the global supply of saving. At the same time, rapid growth in the developing world translates into major investment needs, especially in financing in-

frastructure, with upward pressures on the global demand for investment. Taken together, these two forces point to a future where interest rates are set to rise, ending the era of cheap capital.

Another possible answer is offered by Caballero, Farhi & Gourinchas (2008). In their analysis, developing countries are distinguished by both underdeveloped domestic financial markets, and a high propensity toward saving. As these countries sustain their relatively faster growth and further integrate into the global economy, their demand for scarce high-quality financial instruments—the kind produced in high-income countries—induces large capital flows toward the latter. With the saving glut unlikely to dissipate, the continued reallocation of saving from the developing to the developed world will serve to keep interest rates low for the indefinite future.

In this paper, we propose a different answer to this question. Relying on a multi-country, multi-sector recursive dynamic computable general equilibrium (CGE) model that embeds structural factors such as demography, financial development, institutional quality, and social protection, we find that the equilibrium paths of saving, investment, and interest rates are likely to be fairly benign. In our baseline scenario, the world will experience a small decline in global investment and saving rates, slightly shy of 2 percent. The relatively small magnitude of this decline masks, however, sharp changes in the distribution between high-income and developing economies: the former will experience decreases in its saving rate more than twice that of the developing world, and a greater global contraction is mostly offset by the growing size of the developing countries. It is this combined effect—a greater global weight among developing economies, who possess higher saving rates—that explains the relatively small decline in the global saving rate.

While investment rates in developing countries will mostly exceed those of their high-income counterparts, our baseline suggests that they will nevertheless experience slowdowns relative to today. These decelerations are the natural consequence of the slowing in the rate of growth in developing countries as they become richer. To verify that this is indeed the case, we perform a counterfactual exercise where we examine the demand for capital, *if increases in the rent on capital were indeed not binding*. We confirm that, for the majority of economies, there is little tension between investment demand and its financing. This mechanism—where the developing world, which tends to rely on less capital-intensive production in any case, experiences a relative slowdown in growth—explains contained increases on the investment side. Taken together, the small movements in saving supply and investment demand means that interest rates that are are held largely in check: in our baseline, global returns to capital are virtually unchanged between 2014 and 2030. Moreover, a number of fast-growing, high-saving developing countries will not only not "run out" of saving to finance investment; they will actually be in a position to finance investment opportunities across both the developed and developing world.

Our adoption of a general equilibrium perspective enables us to capture relative price effects stemming from moderating investment demand pressures, which results in our distinct prediction vis-à-vis the essentially partial equilibrium outcome proposed in Dobbs *et al.* (2010). And while the findings in Caballero *et al.* (2008) are premised on a general equilibrium approach, their privileging of the financial side of the economy leads them to focus on the role of consumer demand for safe

assets, whereas our modeling of producer demand for investment financing leads us to distinct predictions centered on the real side.

Our reliance on a multi-sector, multi-region CGE model offers several additional advantages. One is granularity, which is crucial since the economies of the developing world vary substantially along several key structural dimensions. For example, as mentioned earlier, developing countries are currently undergoing different stages in their demographic transition. Given our purposes, therefore, it is crucial that the model adequately captures the potentially distinct future paths of these structural factors, in order to refine the accuracy of our projections.[1] Moreover, the multi-sectoral nature of the model offers the ability to capture changing demand shifts between sectors that arise from income growth, which is particularly important for our longer time frame under consideration. Indeed, it is precisely this country-region heterogeneity in economic structure and trends that allows us to derive our conclusions that differ from the existing literature. Finally, in contrast to DSGE models—which by design are focused on short-run dynamics—our dynamic CGE model offers the cleanest way to study the long-run effects of changes that result from structural factors.

The use of CGE modeling for scenario analysis has a long tradition in applied work, although many models have been developed to analyze issues in international trade (Adam & O'Connell 2004; Dimaranan, Ianchovichina & Martin 2009; Harrison, Rutherford & Tarr 1997; Ianchovichina & Martin 2004) or income distribution (Bourguignon, Levin & Rosenblatt 2009; Bussolo, De Hoyos & Medvedev 2010; Bussolo, de Hoyos, Medvedev & van der Mensbrugghe 2011; Coady & Harris 2004), rather than open-economy macroeconomics, which is the focus of this paper.[2]

Despite the general nature of our central question, there are remarkably few papers that explore the issue of saving and investment from an explicitly global perspective. A clutch of empirical papers examine saving (Koskela & Virén 1983; Loayza, Schmidt-Hebbel & Servén 2000; Masson, Bayoumi & Samiei 1998) and investment (Byrne & Davis 2005; Davis 2010; Greene & Villanueva 1991; Servén 2003) using cross-country panel data, but these tend to be focused on establishing determinants of each, rather than modeling projections, and saving and investment are typically estimated independently of the other, thus glossing over the issue of global adding up constraints. The theoretical literature is even more limited.[3]

In a series of papers, Kraay, Loayza, Servén & Ventura (2005) and Dollar & Kraay (2006) develop a model of global investment and saving using a portfolio allocation framework, but their country coverage is limited to two country/regions, and the thrust of their work is to explain global patterns of net capital flows. Feyrer & Shambaugh (2012) examine the effect of (U.S.) saving on

[1] Related to this is the ability to impose, within the context of a CGE model, a large number of distinct trend paths. Although incorporating such trends in other classes of models (such as DSGE) is possible in principle, one would have to contend with potential nonlinearities that result when any given factor deviates from its linearized long-run steady state.

[2] See, however, Dixon & Jorgenson (2013) for a host of other applications.

[3] Desroches & Francis (2010) is a notable exception; the authors also take into account, as we do, the effect of financial development. Unfortunately, their econometrically-based approach is backward-looking in nature, and concerned with saving and investment at the global level only.

world capital markets, but they are interested in transmission mechanisms related to fiscal shocks. A few papers in the global imbalances literature (Laibson & Möllerström 2010; Obstfeld & Rogoff 2005) do also adopt a global perspective on saving and investment flows, but their investigations likewise abstract from excess country heterogeneity, and is moreover centered on the shorter-term saving-investment differential, as opposed to trends affecting the longer-term evolution of capital demand and supply.

To our knowledge, there are a small handful papers that are closest in spirit to our multi-country/region emphasis, forward-looking concern, and substantive focus. Among these, the vast majority are focused on the effect of changes that are purely due to demographic effects (Brooks 2003; Fehr, Jokisch & Kotlikoff 2008; International Monetary Fund 2004; Krüger & Ludwig 2007; McKibbin 2006), with a smattering of papers that consider the role of social protection (Aglietta, Chateau, Fayolle, Juillard, Le Cacheux, Le Garrec & Touze 2007; Börsch-Supan, Ludwig & Winter 2006). While we acknowledge the central role that demographic changes play, we allow for the coevolution of other structural factors, especially financial development.

By and large, most papers analyze the impact of other major structural factors—such as institutional and financial development—use econometric techniques (see, for example, International Monetary Fund (2005) and Ito & Chinn (2009)). The papers by Caballero *et al.* (2008) and Lemelin, Robichaud & Decaluwé (2013) do capture the role of financial development, but both papers ground their analytical framework firmly in their modeling of financial portfolios and asset-market reallocation decisions. In contrast, our approach is focused on the real side, since we embed these structural variables directly as conditioning factors in a globally-consistent model of saving and investment.

The rest of this paper is organized as follows. In Section 2, we outline the main contours of our model, its calibration, and our main assumptions. Section 3 documents and discusses our main results, and 4 explores the sensitivity of our main findings. A final section concludes with some thoughts on policy implications.

2 Analytical Framework

2.1 Description of the model

Our analysis relies on a modified version of the Linkage model (van der Mensbrugghe 2011), to which saving and investment functions are rendered fully endogenous (with net capital flows determined as the residual from the current account identity). Linkage is a multi-region, multi-sector recursive dynamic applied general equilibrium model. Firms adopt nested constant elasticity of substitution (CES) production functions, with distinct substitution elasticities between three inputs: capital—skilled labor, and unskilled labor—and sectors are distinguished by differing assumptions regarding substitution elasticities and input combinations.

Consumption comprises private and government consumption. Household decisionmaking is also nested, with the consumption-saving tradeoff embedded into the top nest, followed by consumption

decisions over final goods and services according to a constant demand elasticity (CDE) utility function. We abstract from the dynamics of government consumption by assuming that government expenditures and transfers, net of revenues, are fixed at the levels prevailing in the initial year, so that the government saving rate $\frac{S_t^g}{Y_t} = \xi_i$ diminishes in importance over time.[4] The dynamics of the model derive from three main sources: changes to productivity, the evolution of the labor force, and the accumulation of productive capital via investment. Of these three, only the process of capital accumulation is fully endogenous; the former two follow assumed paths, which are described in detail in Section 2.3.

The other crucial dynamics of the model deals with the accumulation of physical capital. This results from the interaction of global saving supply, domestic investment demand, and international capital allocation (summarized in Figure 1).

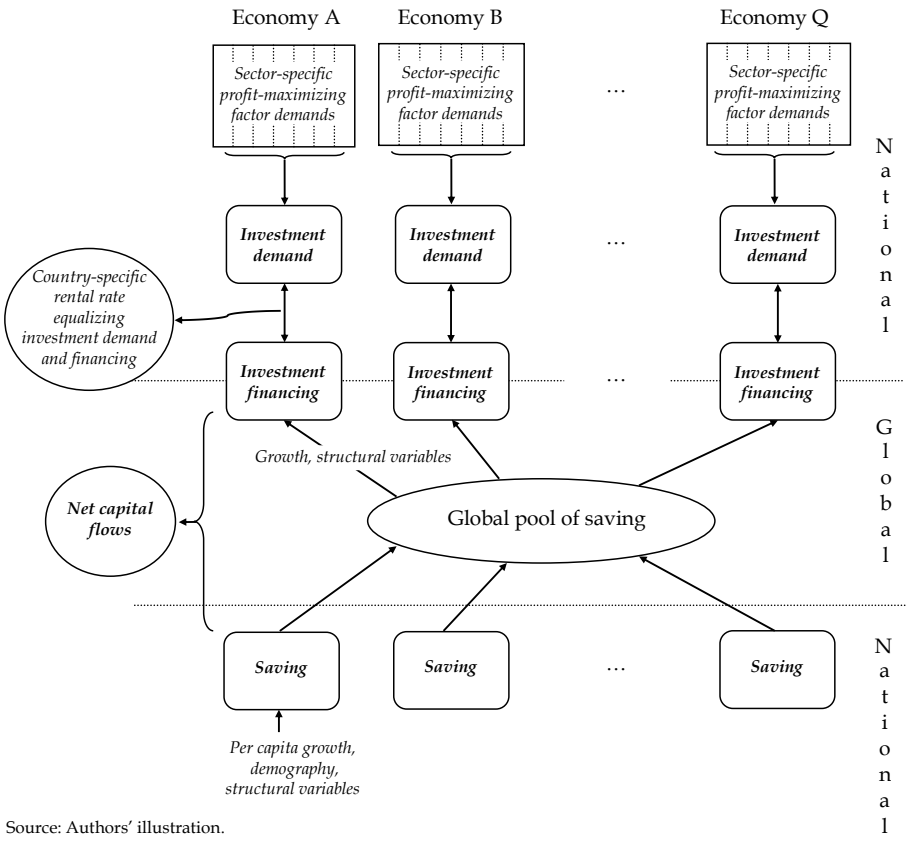


Figure 1: Schematic summarizing crucial investment-saving dynamics in the CGE model. Boxes represent key country-specific equations, circles represent equilibrium outcomes, and arrows indicate the direction of influence. Unbordered italicized text capture key variables that are codetermined with the respective equation.

[4]Fiscal closure is ensured by allowing the direct tax on households to endogenously adjust to meet this target; in practice, government saving (or dissaving) is generally dominated by household saving.

In each country, saving behavior, in accordance to a standard life-cycle approach, depends on demography and per capita income growth, as well as additional determinants. More specifically, private household saving, S_{it}^h, as a share of national income, Y_{it}, is determined in country $i \in I$ at time t by

$$\frac{S_{it}^h}{Y_{it}} \equiv \sigma_{it} = \alpha + \beta^\sigma \sigma_{i,t-1} + \beta^y \Delta y_{it} + \beta^d dr_{it} + \beta^f fd_{it} + \beta^s sp_{it}, \tag{1}$$

where Δy_t is the (endogenously-determined) growth rate of *per capita* income at time t, dr_t is the aged dependency ratio (the ratio of the population aged over 65 to the working-age population between 15 and 64), fd_t is the level of financial development, sp_t is the degree of social protection afforded to the population, and α is a (constant) adjustment factor. Note that saving is assumed to depend on the lagged saving rate, with a persistence parameter β^σ; this can be justified by models of habit formation (Alessie & Lusardi 1997; Pollak 1970).

The determinants of private saving in (1) include income growth and the age structure—both implied by standard life-cycle (Modigliani 1970; Modigliani & Brumberg 1954) or permanent income (Friedman 1957) models—along with two structural factors implied by theory: the degree of financial development (Deaton 1991; Jappelli & Pagano 1994) and social insurance coverage (Hubbard, Skinner & Zeldes 1995). These determinants have also generally found support in the empirical literature (Attanasio & Weber 2010; Loayza *et al.* 2000).

The capital stock in country i at time t evolves in the standard fashion given by

$$K_{i,t+1} = (1-\delta) K_{it} + I_{it}, \tag{2}$$

where the capital stock $K_{it} = \sum_{j \in J} K_{j,it}$ aggregates the capital for each sector j, depreciates at rate δ, and is supplemented in each period by a flow of new investment $I_{it} = \sum_{j \in J} I_{j,it}$. Demand for capital—or domestic investment demand—in each sector is derived from a constant elasticity of substitution function:

$$K_{j,it}^d = \kappa_{j,i} \left[\frac{\gamma_{j,it} Y_{it}}{R_{j,it}^\mu} \right], \tag{3}$$

where $R_{j,it} \equiv (r_{it} + \delta) P_{it}^k$ is the sector-specific rental rate, with r_t and P_{it}^k representing the rate of return and price of capital in country i at time t, respectively, $\gamma_{j,it}$ is the share of the sector j's value-added in economywide output for country i, $\kappa_{j,it}$ is the contribution of capital to value-added in sector j in country i at time t, and $0 < \mu < \infty$ is the elasticity of substitution between capital and labor.

The global pool of saving is allocated across countries following a function representing the global financing of investment. More specifically, aggregate investment in country i at time t is financed according to

$$\frac{I_{it}^f}{Y_{it}} \equiv \iota_{it} = \lambda + \theta^\iota \iota_{i,t-1} + \theta^Y \Delta Y_{it} + \theta^r \frac{r_{it}}{r_t^w} + \theta^f fd_{it} + \theta^q iq_{it} + \pi P_t^s, \tag{4}$$

where λ is a constant adjustment term, $\frac{r_{it}}{r_t^w}$ is the return on capital r relative to the global (capital

stock-weighted) average, $r^w \equiv \sum_{i \in I} \frac{k_i}{\sum_{i \in I} k_i} \cdot r_i$, where k is the capital stock, iq_t is a measure of institutional quality, and P^s is an accounting variable designed to ensure that investment equals saving at the global level.[5] Analogous to the case for saving, (4) introduces a role for lagged investment (with adjustment coefficient θ^ι). Partial adjustment of this form easily arises either due to time-to-build (Kydland & Prescott 1982) or delivery lags (Jorgenson 1963), and the result has also found powerful validation in horse-races that compare traditional models of business investment spending (Kopcke & Brauman 2001).

In addition to relative returns embodied in $\frac{r_i}{r^w}$, (4) allows economic growth and structural factors to exert independent effects on investment financing, over and above the effect of relative returns. This can be rationalized by acknowledging that return differentials alone may not fully capture all factors affecting expected returns for the international investor.[6] We take the cue for including growth from a flexible accelerator-type model (Caballero 1999; Hall & Jorgenson 1967).[7] The inclusion of structural variables such as financial development and institutional quality appeals to models where investment responds to either capital market imperfections (Holmström & Tirole 1997) or uncertainty (Caballero & Pindyck 1996; Lucas & Prescott 1971), which suggests that a country's level of financial development or political-institutional risks may matter for aggregate investment activity. Indeed, the empirical literature has found fairly robust empirical support for such structural (Benhabib & Spiegel 2000; Campos & Nugent 2003; Levine 2005; Mauro 1995) and economic (Chirinko 1993; Davis 2010) determinants of investment.

In equilibrium, all financing is fully disbursed, so $I_i^f = I_i P_{it}^k$. Moreover, investment is funded either by domestic saving, $S_{it} \equiv S_{it}^h + S_{it}^g$, or foreign saving (or, equivalently, net capital flows), so that country i receives on a net basis from the rest of the rest of the world:[8]

$$-S_{it}^f \equiv CA_{it} = S_{it}^h + S_{it}^g - I_{it}^f. \tag{5}$$

Finally, at the global level, aggregate saving and investment clears in every period, so we have

[5] We embed this "price" of capital into the model purely as an accounting mechanism to ensure that the global adding-up constraint (6) for saving and investment is always respected.

[6] In practice, interest rates may deviate from fundamental values due to financial market distortions arising from, for example, financial repression, which is a common problem in many developing countries.

[7] Although we recognize that such models were designed to capture actual investment activity, and not investment financing, *per se*. Recent research has found that growth can have an independent effect on cross-country capital flows (Ghosh, Kim, Qureshi & Zalduendo 2012), more so than interest rate differentials. Incidentally, including growth in (4) and per capita growth in (1) implicitly allows for a certain degree of home bias in investment, which serves as an additional friction to cross-border flows in the model.

[8] In the absence of frictions, most canonical theoretical models will render net capital flows in a North-South direction, due to higher the marginal product of capital in developing countries. In reality, capital has, somewhat paradoxically (Lucas 1990), flowed from the South to the North. Our model generates consistency with reality in this regard in two ways. First, the model is benchmarked to observed 2007 data for saving and investment, which allows surpluses (deficits) to coexist with positive (negative) return differentials (and implicitly introduces a wedge to cross-country capital flows). Consequently, only innovations to the path of relative returns to capital—and other determinants of investment financing in (4)—will potentially alter the path of capital flows. Second, the constraint that the elasticity on return differentials θ^r be below infinity serves as an additional friction in our framework, which limits the degree to which return differentials can affect capital flows. This assumption is relaxed in the robustness section.

the equivalence of global investment and saving:

$$\sum_{i \in I} I_{it}^{f} = \sum_{i \in I} \left(S_{it}^{h} + S_{it}^{g} + S_{it}^{f} \right). \tag{6}$$

It is important to emphasize that in the model just described, saving, investment, output and income—as well as relative factor and good prices—are endogenous. However, for any specific country or region, income growth rates, investment and saving rates, as well as net capital flows generated by the model are subject to a margin of error. This is because the resulting trends in these variables depend on: (a) Parameterization of equations (1) and (4); more explicitly, the elasticity of the saving and investment rates with respect to aged dependency (only for saving), income growth, financial sector development, the quality of institutions, and the level of social protection (only for saving); (b) Assumptions regarding the path of exogenous variables; specifically on productivity, demography, financial sector development, the quality of institutions, and the level of social protection. These two issues are addressed in the following section.

2.2 Parameterization of the saving and investment financing equations

In order to parameterize (1) and (4), it is necessary to populate the coefficient vector $[\mathbf{B}\ \mathbf{\Theta}] = \left[\beta^{\sigma}\ \beta^{y}\ \beta^{d}\ \beta^{f}\ \beta^{s}\ \theta^{\iota}\ \theta^{y}\ \theta^{r}\ \theta^{f}\ \theta^{q}\right]$. We do so with econometric estimates of the respective equations. More precisely, we independently estimate the following two equations:

$$\sigma_{it} = \hat{\alpha}_i + \hat{\beta}^{\sigma}\sigma_{i,t-1} + \hat{\beta}^{y}\Delta y_{it} + \hat{\beta}^{d} dr_{it} + \hat{\beta}^{f} fd_{it} + \hat{\beta}^{s} sp_{it} + \epsilon_{it}, \tag{1'}$$

$$\iota_{it} = \hat{\lambda}_i + \hat{\theta}^{\iota}\iota_{i,t-1} + \hat{\theta}^{y}\Delta Y_{it} + \hat{\theta}^{r}\frac{r_{it}}{r_t^{w}} + \hat{\theta}^{f} fd_{it} + \hat{\theta}^{q} iq_{it} + \varepsilon_{it}, \tag{4'}$$

where ϵ and ε are i.i.d. innovation terms, lowercase variables denote logarithmic forms, and we have allowed the respective adjustment factors to enter as country-specific fixed effects, α_i and λ_i.

We draw on data from the World Bank's Financial Development and Structure (Beck, Demirgüç-Kunt & Levine 2000) and World Development Indicators (WDI) databases, the International Country Risk Guide (ICRG), Bloom, Canning, Mansfield & Moore (2007), and Chinn & Ito (2008). Details regarding the sources and definitions of these variables are provided in Annex Table A.1. The resulting dataset for the investment regressions is an unbalanced country-level panel, covering up to 106 economies over the period 1985–2009, while the saving regressions rely on an unbalanced panel of as many as 56 economies (summary statistics are provided in the annex).[9]

We estimate (1) and (4) using both annual and 5-year averages. This twofold choice reflects a compromise between the desire to best match the annual nature of the two equations, against a desire to capture longer-run relationships that would require smoothing out cyclical fluctuations with period averaging. The differential periodicity of the data call for distinct estimation

[9] The limiting factor in the saving regressions is the inclusion of the social protection variable, for which data are only available for a relatively small set of countries, distributed about equally between high income and developing economies.

methodologies, each with their own relative strengths. For the annual data, we rely on (Nickell 1981) biased-corrected least square dummy variables (Corr-LSDV)[10](Bruno 2005), which yields coefficients reflecting within variation in the data. For the 5-year average data, we rely on system general method of moments (Sys-GMM), which offers some (weak) control of endogeneity, and generates coefficients from variation in both the cross section and time series nature of the data.[11]

Regression results using both fixed effects and system GMM are reported in Table 1. For each periodicity (and estimation approach), we construct two alternative specifications: a structural specification that follows the exact specifications of (1) and (4) (columns (I1) and (S1) for the annual data, and columns (I3) and (S3) for data in 5-year averages, respectively), and a complete specification that introduces additional controls that could be of relevance (columns (I2)/(S2) and columns (I4)/(S4)). For instance, we introduce to both equations variables that capture the potential effects of trade and financial openness on each.

We make a number of observations about these results. First, there is a nontrivial degree of variability in the relevant coefficients, both in terms of the range of the point estimates, as well as in their associated standard errors. Although there are no systematic differences between estimates produced from the two data frames and estimation methodologies, it is often the case that coefficients obtained from 5-year averages are somewhat greater in magnitude vis-à-vis the annual data, although they remain roughly within the same order of magnitude (with the notable exception of the lagged dependent variable for investment).[12] Second, the series are fairly persistent, especially for saving but also for investment when estimating with the annual data. Although this is not unexpected, such persistence would point to potentially lower levels of international capital flows, even though we have not explicitly modeled cross-border financial frictions.

Third, the signs of the significant coefficients are typically consistent with expectations *a priori*. For example, financial development is positively associated with the investment rate (more sophisticated financial markets are able to lend more readily to firms for investment purposes), and negatively related to the saving rate (households with easier access to credit need to save less for consumption smoothing). Fourth, the point estimates for the coefficients of interest in [$\mathbf{B}$ $\mathbf{\Theta}$], when statistically significant, are not that different when comparing the more parsimonious structural against the more complete specifications. Finally, we recognize that the *level* of per capita income in the full specifications enters with statistically significant coefficients, but per capita income is omitted in the saving function given by (1) and (1′). This is because income per capita tends to be

[10]The bias-correction uses Anderson-Hsiao initializations, and standard errors computed from a bootstrapped variance-covariance matrix generated from 100 replications. As demonstrated in Bruno (2005), alternative initializations have only a marginal impact on the estimates. Estimates obtained from naive fixed effects yield broadly similar results, and are available on request.

[11]For the system GMM estimates, growth and the returns differential are treated as fully endogenous, and entered into the (orthogonalized) instrument matrix with two lags or more, while the lagged investment rate and openness variables are treated as predetermined and entered with one or more lags. Institutional and structural variables are instrumented with their lagged values. The instrument set is then collapsed to limit instrument proliferation (Roodman 2009)

[12]This result is likely because investment series tend to be highly persistent at the annual level. Consequently, much of the impact from the structural variables are absorbed into the lagged term; estimates from the five-year average series may therefore better capture the impact of the structural factors of interest.

Table 1: Econometric estimates for saving and investment rates, unbalanced annual and 5-yr. avg. panel, 1985–2009†

	I1	**I2**	**I3**	**I4**
Lagged investment rate	0.813 (0.02)***	0.816 (0.02)***	0.293 (0.17)*	0.249 (0.18)
Output growth	0.147 (0.01)***	0.140 (0.02)***	0.257 (0.04)***	0.242 (0.04)***
Relative returns differential	0.000 (0.00)	0.000 (0.00)	0.003 (0.00)	0.000 (0.00)
Financial development	0.014 (0.01)***	0.008 (0.01)	0.017 (0.01)	0.040 (0.02)**
Institutional quality	0.008 (0.03)**	0.009 (0.00)***	0.029 (0.02)*	0.012 (0.01)
Trade openness		0.008 (0.01)		0.005 (0.04)
Financial openness		0.001 (0.00)		-0.035 (0.01)***
Investment climate		0.005 (0.00)*		0.016 (0.02)
Democratic accountability		-0.004 (0.00)		0.004 (0.02)
Adj. R^2	0.727	0.728		
R^2 (within)	0.728	0.729		
Wald χ^2			50.19***	89.09***
Hansen J			12.481	22.683
AR(2) z			-0.027	-0.012
Estimation	Corr-LSDV	Corr-LSDV	Sys-GMM	Sys-GMM
Instruments			18	33
N (countries)	1,582 (106)	1,582 (106)	323 (105)	323 (105)
	S1	**S2**	**S3**	**S4**
Lagged saving rate	0.754 (0.02)***	0.669 (0.04)***	0.610 (0.20)***	0.721 (0.14)***
Income per capita growth	0.062 (0.01)***	0.062 (0.01)***	-0.002 (0.08)	0.025 (0.03)
Financial development	-0.002 (0.00)	-0.010 (0.00)***	0.003 (0.02)	-0.032 (0.01)**
Aged dependency ratio	-0.013 (0.03)	-0.099 (0.03)***	0.091 (0.06)	-0.185 (0.09)**
Social protection coverage	-0.000 (0.00)	-0.004 (0.00)	-0.055 (0.02)**	-0.007 (0.01)
Income per capita		0.016 (0.00)***		0.012 (0.01)**
Real interest rate		-0.020 (0.05)		-0.043 (0.05)
Trade openness		0.013 (0.00)**		0.008 (0.03)
Financial openness		-0.003 (0.00)***		0.012 (0.00)**
Adj. R^2	0.614	0.635		
R^2 (within)	0.615	0.638		
Wald χ^2			94.62***	284.86***
Hansen J			2.752	28.055
AR(2) z			-1.262	-1.418
Estimation	Corr-LSDV	Corr-LSDV	Sys-GMM	Sys-GMM
Instruments			12	31
N (countries)	1,102 (56)	1,102 (56)	183 (55)	183 (55)

† All variables are in log form. Standard errors, generated from bootstrapped variance-covariance matrices (corr-LSDV) or rendered heteroskedasticity and autocorrelation robust (sys-GMM), are reported in parentheses. A constant term was included in the regressions, but not reported. *, **, and *** indicate significance at 10, 5, and 1 percent level, respectively.

I(1), even though we expect the saving rate (our dependent variable) to be I(0); in our application it is therefore more appropriate to include per capita income expressed as a trend-stationary growth rate.

In sum, investment appears to be most sensitive to changes in output growth, while saving is most sensitive to the aged dependency ratio (exempting their own respective lags). Thus, our results are especially likely to be affected by assumptions about the future paths of these two factors; this motivates our examination, in Section 4, of the sensitivity of our results to perturbations in these assumptions.

We rely on the point estimates in Table 1 to build our initial parameterizations, which are presented in Table 2. We utilize the *upper bound* of these coefficient estimates as initial parameters, with two exceptions, which we then perturb in Section 4 to examine sensitivity.

Table 2: Initial parameterizations, main variables of interest, baseline scenario†

Variable	**Parameter**	**Value**
Lagged investment	θ^{ι}	0.25
Growth	θ^{y}	0.26
Relative returns differential	θ^{r}	1.26
Financial development (I)	θ^{f}	0.04
Institutional quality	θ^{q}	0.03
Lagged saving	β^{σ}	0.61
Per capita growth	β^{y}	0.06
Aged dependency	β^{d}	-0.19
Financial development (S)	β^{f}	-0.03
Social protection	β^{s}	-0.06

† Notes: Parameter values were chosen based on maxima for estimated coefficients in Table 1, except for lagged investment and saving, where minima were chosen. The parameterization for the relative returns differential is the maxima for the coefficient on the level rate of return, in analogous regressions to those reported in Table 1.

The first exception is that we use the *lower bound* for the lagged dependent variable. This is for two reasons. First, our exercise is concerned with the impact of changes in our explanatory variables of interest, and so using smaller coefficients for the analytically uninteresting lagged term (and larger coefficients for the other variables of interest) allows us to examine their the effect of changes in the underlying drivers more directly (rather than implicitly through the lagged term). Second, a large coefficient on the autoregressive term implies a certain amount of friction in changes to saving, investment, and cross-border capital flows. Economic development, technological advancement, and increased globalization all suggest that it is reasonable that these frictions decline in the future,

which supports a decision to lower the degree of stickiness in saving and investment.

The second exception is that we use, as the coefficient on the relative returns differential, the upper bound obtained from analogous regressions of (I1)–(I4) using instead the *level* real rate of return.[13] This is because the existing coefficient estimates for the differential are simply too small to be plausible, for a number of reasons. First, in the estimates reported in Table 1, the real rates of return are (reasonably) adjusted to accommodate exchange rate changes present in the empirical data used to estimate; however, since the CGE model does not directly model nominal exchange rates (only relative prices), the adjustment may overcompensate for the speed of adjustment to relative return differentials (since exchange rates are jump variables, but relative prices are stickier). Second, real rates of return in any given country, especially developing ones, may suffer from mismeasurement issues due to financial repression. Taking the difference between two potentially mismeasured variables strikes us as more problematic than simply using one potentially mismeasured one. In any case, we explore in detail the robustness of our main results to changes in this coefficient in Section 4.

2.3 Paths of exogenous variables in the model

The Linkage model draws on data from the Global Trade Analysis Project (GTAP) 8 dataset, which incorporates 129 country-regions and 57 sectors. For our application, we further aggregate these into 17 country-regions and 7 sectors (these are listed in detail in the annex). Our selection of countries was dictated by the desire to capture all the major high-income and developing countries; all remaining economies were then collected into aggregated regions following the regional classification scheme of the World Bank.

The model relies on two key exogenous paths for productivity and the labor force (which in turn depends on the demographic structure of the population). Productivity growth is assumed to be capital and labor-augmenting in the agricultural sector (technical change is factor and skill-neutral), but only labor-augmenting in the manufacturing and services sectors (Harrod-neutral); the average annual percent growth rate in agriculture is assumed to be be unity for high-income countries, and twice that in developing countries (owing to catch-up effects). Productivity in manufacturing is sector-biased, and assumed to be 2 percentage points higher than that in services, which, given Baumol-Bowen effects, is largely uncontroversial. Finally, services productivity is calibrated so that it matches actual per capita GDP growth for 2007 (the benchmark year), and growth in potential GDP for 2014 onward, with a linear transition for growth rates between 2007 and 2014.[14] From 2015 onward, the calibrated productivity is fixed, and GDP growth becomes endogenous.[15]

[13] These separate estimates are available from the authors on request.

[14] The potential output data were drawn from the World Bank's *Global Economics Prospects* database (World Bank 2012b).

[15] The resulting growth rates of GDP and factor inputs can then be used to back out implied TFP growth rates; we compute these as a consistency check. The results in Table 3 yield average annual TFP growth, over the 2010–30 period, in the range of 0.1–0.5 percent for high-income countries, and -0.2–3.0 for developing countries (full results are reported in the annex). While these estimates are at the high end of the literature (e.g. Bosworth & Collins (2003), they are consistent with TFP trends from the early and mid-2000s.

The evolution of the labor force draws on population projections from the United Nations' *Population Prospects* (medium variance) (United Nations 2013), and assumes a constant labor force participation rate (from 2007). Additional details regarding the implementation methodology for the simulations are exhaustively discussed in (van der Mensbrugghe 2011). These assumptions are documented in Table 3, which also reports, in the final column, the implied (endogenous) growth rate for real GDP.

Table 3: Main assumptions for exogenous paths, baseline, and implied GDP growth rates†

	Productivity growth				**Factor supplies**			**GDP**
	Labor			*Capital*	*Labor*		*Capital*	
	Agr.	Mfg.	Svc.	Agr.	Skl.	Uns.	Stk.	
High income								
Europe	1.0	1.9	-0.1	1.0	-0.3	-0.3	1.5	0.8
Japan	1.0	2.0	0.0	1.0	-0.8	-0.8	0.9	0.2
USA	1.0	2.1	0.1	1.0	0.3	0.3	2.0	1.1
Other high income	1.0	2.6	0.4	1.0	0.4	0.4	2.9	2.1
Developing								
China	2.0	8.1	6.1	2.0	-0.1	-0.1	8.0	7.4
Indonesia	2.0	3.9	1.9	2.0	0.9	0.9	5.4	4.9
Other East Asia	2.0	3.2	1.2	2.0	1.0	1.0	4.5	4.0
India	2.0	6.5	4.5	2.0	1.3	1.3	7.7	7.1
Other South Asia	2.0	2.0	0.0	2.0	1.8	1.8	4.3	3.7
Russia	2.0	4.2	2.2	2.0	-0.8	-0.8	3.3	2.8
Other Eastern Europe	2.0	2.4	0.4	2.0	0.2	0.2	3.2	2.4
Middle East	2.0	1.8	-0.2	2.0	1.6	1.6	4.0	3.6
South Africa	2.0	2.2	0.2	2.0	0.6	0.6	2.9	2.2
Other Sub-Saharan Africa	2.0	4.3	2.3	2.0	2.8	2.8	6.3	6.0
Brazil	2.0	3.3	1.3	2.0	0.6	0.6	3.9	3.1
Mexico	2.0	1.7	-0.3	2.0	1.1	1.1	3.0	2.6
Other Latin America	2.0	3.1	1.1	2.0	1.1	1.1	4.1	3.5

† Notes: Values are average annual growth rates, in percentage points. Productivity growth in agriculture (agr.) is assumed to be capital and labor augmenting, but only labor augmenting in manufacturing (mfg.) and services (svc.). Skilled (skl.) and unskilled (uns.) labor are assumed to grow at the same rate. Implied GDP growth rates are endogenous, and reported for informational purposes.

The resultant growth rates for the 2011–30 simulation period indicates that, for the baseline, real GDP growth in China and India will average 7.4 and 7.1 percent annually, and around 3.5 percent on average for the remaining developing country-regions, and around 0.9 percent for high income economies. For all countries this represents a decline in their respective long term growth rates below their 2010 figures, but is consistent with convergence in per capita incomes between the rich and poor world. Notably, the growth path for Sub-Saharan Africa (excluding South Africa)—which has underperformed until the past decade—will follow a fairly strong 6.0 percent annual real growth rate on average, and among high-income economies, the United States attains an annual growth rate slightly more than one percent over the period (we consider scenarios with much weaker and

stronger growth outlooks in Section 4). In most cases, our assumptions also point to substantially higher sectoral productivity growth in the developing versus the developed world; manufacturing (labor) productivity in Russia and the rest of Sub-Saharan Africa, for example, is more than twice that of productivity growth in manufacturing in Europe and the United States.

Finally, we also require future paths for the structural variables. The path for the aged dependency ratio is computed by separating the UN population projections into cohorts aged under 15 (youth), 15–64 (working-age), and 65 and older (elderly), and tracing the ratio of the elderly cohort to the working-age cohort over time. Each of the remaining structural variables (S_{it}) is assumed to evolve endogenously in response to growth in per capita income:

$$\dot{\boldsymbol{X}}_{it} = \eta \dot{y}_{it}, \tag{8}$$

where $\boldsymbol{X}_{it} = [fd_{it}\ iq_{it}\ sp_{it}]$, and the dot above the variable denotes its growth rate. The coefficient vector $\boldsymbol{\eta} = \left[\eta^{fd}\ \eta^{iq}\ \eta^{sp}\right]$ is populated by estimating the bivariate pooled OLS regression of the respective structural variable on per capita income, separately for high-income and developing countries, using annual data for the period 1985–2009. These parameterizations are reported in Table 4.

Table 4: Econometric estimates for structural variables, by income group, baseline scenario†

Variable	**Parameter**	**Developing**	**High income**
Financial development	η^{fd}	0.09	0.27
Institutional quality	η^{iq}	0.03	0.18
Social protection	η^{iq}	0.15	0.00

† Notes: All variables are in log form. Reported coefficients are for a bivariate pooled OLS regression of the respective structural variable on per capita income, for each respective income group. Since Brazil already has a level of social protection that is at unity, it is assumed to grow at high-income rates of zero.

It is also clear from Table 4 that, in the baseline, the evolution of the structural variables of interest proceeds at a relatively slower pace vis-à-vis *a given rate of growth* in per capita income in developing countries as compared to high income ones. However, this does not imply that these structural variables grow at an absolutely slower rate, since by and large per capita income growth rate in the developing world outstrips that of high income countries. Indeed, in order to anticipate the future path of these factors, it is necessary that Table 4 be considered alongside the growth paths in Table 3 (along with the necessary population adjustments).

3 Results

In this section we present our baseline results. We first report numerical findings for saving, investment, and net capital flows, followed by a discussion of the codeterminants of the saving and investment equations, and finally by the baseline results for returns to capital.

3.1 Baseline results for investment, saving, and net capital flows

The results for the baseline simulation, for the projection period 2011–30, are shown in Table 5. Investment, saving, and net capital flows (reported as the difference between outflows and inflows, or, equivalently, as the current account) are reported for 2011 and 2030.

Table 5: Baseline results, investment, saving, and net capital flows, global and by country-regions, 2011 and 2030†

	I/Y		**S/Y**		**CA/Y**	
	2011	2030	2011	2030	2011	2030
High income						
Europe	19.6	17.8	20.6	16.8	1.0	-1.1
Japan	21.4	19.4	24.0	19.2	2.6	-0.1
USA	18.1	16.1	12.6	8.5	-5.5	-7.6
Other high income	24.8	20.0	31.0	26.6	6.2	6.6
Developing						
China	41.1	31.7	48.0	42.4	6.9	10.7
Indonesia	26.5	21.0	29.1	25.7	2.7	4.7
Other East Asia	27.3	23.2	34.2	30.9	6.9	7.7
India	32.0	28.9	28.7	25.8	-3.3	-3.1
Other South Asia	23.9	18.3	11.0	9.4	-13.0	-8.9
Russia	23.1	21.2	28.6	24.2	5.5	2.9
Other Eastern Europe	26.2	21.0	15.3	12.2	-10.9	-8.8
Middle East	26.2	23.2	31.7	28.8	5.5	5.6
South Africa	21.4	18.1	18.2	16.1	-3.1	-1.9
Other Sub-Saharan Africa	24.9	23.7	21.1	20.0	-3.8	-3.7
Brazil	21.4	17.4	17.9	14.0	-3.4	-3.4
Mexico	22.4	20.8	22.7	19.5	0.3	-1.3
Other Latin America	23.8	19.5	22.4	19.3	-1.4	-0.2
World	22.7	20.9	22.7	20.9	0.0	0.0

† Notes: Investment, saving, and net capital flows are all reported as a share of GDP, in percentage terms. Net capital flows are reported as the current account.

A first set of interesting results in our baseline is related to trends at the global or broad regional levels. The simulation indicates that the worlds investment/saving rate will remain relatively stable, reaching 20.9 percent by 2030, thus recording a less than two percent decline from the current rate (see the bottom row of Table 5). This result is broadly in line with projections that others have performed for global saving rates (OECD 2012), and the decrease in the global investment/saving

rate is well within standard bounds; the historical rate has averaged 23 percent, with a standard deviation of 1.2 percent (this can be seen in Figure A.2 in the appendix).

This decline at the global level is actually smaller than either of the declines of the high income or developing country groups. Investment rates in these groups fall by 2.7 and 4.0 percent, respectively, and the equivalent reductions in saving rates are 4.3 and 3.1 percent, respectively. This apparent paradox can be explained by the increasing global weight of developing countries, which also possess higher saving (and investment) rates than high-income countries.

Over the course of the next two decades, faster growth in developing countries (see Table 3) means that they will grow in size relatively more than high-income countries. Consequently, by 2030, developing countries will account for 41 percent of global GDP (up from 28 percent in 2010).[16] And over the same period, developing countries' saving rates will, on average, remain more than 10 percentage points above that of high-income countries. Since the world saving rate is a weighted average of the saving rates for these two groups, the shifting weight toward the higher-saving group will partially counteract the individual groups' slowdowns, even if both groups experience reductions in their respective rates. The same reasoning applies for the investment rates.

This first set of results thus uncovers—beneath an otherwise stable global saving/investment rate—a notable shift in the world economy: for every dollar saved (or invested), developing nations will increase their contribution from the 33 cents they averaged during of the period 1960–1990, or the 50 cents in 2010, to about 66 cents in 2030.

The second set of results deals with the heterogeneity of the trends at the country level. Despite the (statistically) negligible decline at the global level, there is also substantially more variation in the path of investment and saving rates at the regional and country level. For example, the regions of South Asia (excluding India) and Sub-Saharan Africa (excluding South Africa) will experience shrinkages in saving, of 1.5 and 1.1 percentage points, respectively. But this amounts to a fraction of the declines other country-regions will face, in particular China (5.6 percentage points) and the rest of high-income countries (6.0 percentage points). For investment, the dierences are even starker: the largest decline (China, at 9.4 percentage points) will be almost an order of magnitude larger than the smallest one (other Sub-Saharan Africa, at 1.2 percentage points).

Nevertheless, the overall trend toward lower investment and saving rates across all countries is clear. There is some indication of a limited degree of mean reversion: the countries that are among those with the highest saving or investment rates in 2010 are also those that face some of

[16]The reported figures for 2011 may not exactly match actual numbers, for several reasons. First, the model is focused on projecting long-run equilibrium estimates, and so short-run disruptions, especially arising from the post-2008 global crisis recovery, are not captured. Second, for a small number of countries (in particular China), the model does not adequately reflect Harrod-Balassa-Samuelson effects, so that the real price of both capital goods and output rise slower than in reality; in practice, this amounts to a small underestimation of investment in rapidly-growing economies. Third, it is a well-known fact that national accounts and balance of payments data do not fully reconcile, which leads to divergences in the 2011 current accounts for a few economies (in particular other Sub-Saharan Africa). Finally, most deviations between the actual data for 2011 and the numbers reported in Table 5 are small. While it is possible to recalibrate the model to track actual data, we decline to do so for a number of reasons. First, imposing a one-to-one match will lead to unacceptably large price fluctuations in the earlier years (since prices move to equilibrate potentially short-term imbalances). Second, and related to the first, forcing this match to accommodate the short-run data appears unnecessary, since the goal of the paper is to establish stable long-run projections.

the largest declines in these rates.[17,18]

Finally, current account balances reveal that, for the most part, capital flows maintain current paths, with a few notable exceptions. The deficit in the United States and surplus in China actually widen relative to current levels (Figures 2(a) and 2(b).) This result, which suggests a continuation of global imbalances, is a direct implication of our modeling choices and can be easily rationalized by considering equation (5).

Thus, the small widening of China's surplus is the result of a slowing of growth that negatively affects its financing of investment more than it reduces its domestic saving. The funding of trade balances, as captured by (5), . Therefore, it implicitly suggests that the exhaustion of investment opportunities in China may occur at a slightly faster pace than the switching of expenditures away from saving and toward consumption. Given the broad consensus among academic (Bardhan 2010), market (Dobbs *et al.* 2010), and policy (World Bank 2012a) economists that investment rates consistently in excess of 40 percent are unsustainable, and the equally well-acknowledged difficulty of lowering private saving in the absence of a more comprehensive social safety net (Blanchard & Giavazzi 2006; Yan & Pan 2010) and sophisticated corporate financing environment (He & Cao 2007), it is perhaps unremarkable that China's strong surplus may persist into the future. By a similar token, the continued technological edge of the United States, together with its persistently low domestic saving, also points to a continued deficit position for the country, going forward.

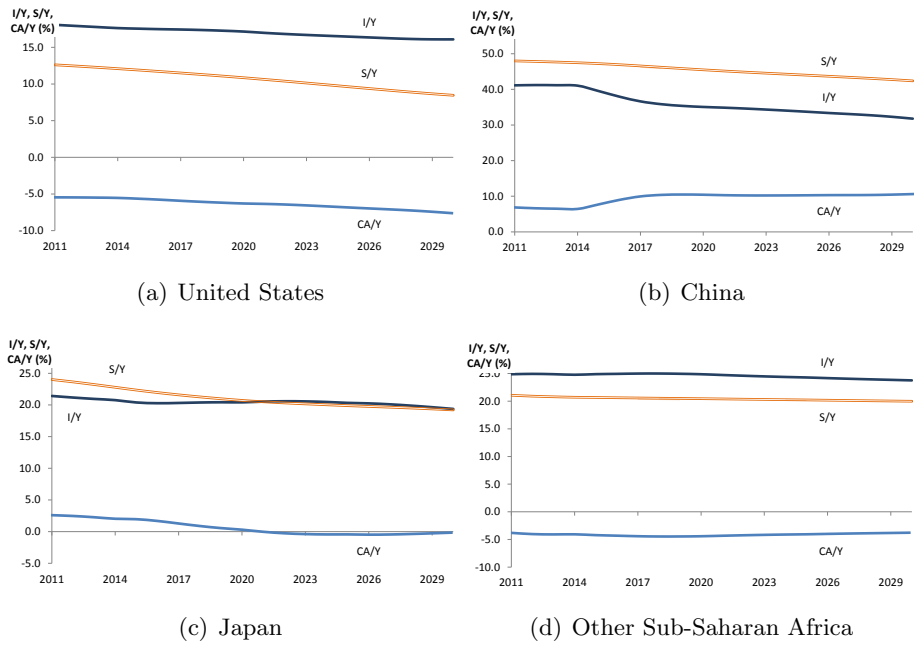
More generally, what the deficits and surpluses suggest is that the pessimism that has historically surrounded developing-world growth prospects—where the developing world has needed massive inflows of capital from high-income countries in order to finance their development—is not only misplaced, but missing the main point. The future is likely to see investment projects in developing countries financed by a number of fast growing, high-saving economies, many of which are in the developing world (the largest, of course, being China). They key point here is that rapid growth in developing countries will not only generate sufficient saving to finance investment, but that many of them would even finance investment opportunities elsewhere in the developing world, leading to a net increase in South-South and South-North capital flows.

3.2 Coevolution of investment and saving in the baseline

To better understand the dynamics of investment and saving, it is useful to examine the evolution of the variables that constitute the right-hand side of (4) and (1). This is presented in Table 6; the first five columns document the changes in the other codeterminants of (4), while the last five

[17] Although the identity of these economies differs depending on the variable. For investment, Other Eastern Europe, Indonesia, and China had rates in 2010 that were (tied) fourth-highest and highest, respectively, and experience declines that are the fourth, third, and largest, respectively. For saving, the three equivalent country-regions are China, Other high-income, and Russia.

[18] Note that the composition "paradox" described above for the global versus the broad income-group level can also be observed at the smaller scale of the country-region. For example, among high-income countries, the decline in saving is greatest in the residual group (which comprises mainly high-saving East Asia and the GCC), but their increased size (since this group grows relatively faster than the rest of the high-income countries) partially osets the negative contribution from reduced saving rates.



(a) United States

(b) China

(c) Japan

(d) Other Sub-Saharan Africa

Figure 2: Saving rates, investment rates, and net capital flows, selected developed and developing economies, 2011–30. Analogous figures for additional country-regions are provided in the technical annex.

document those associated with (1).[19] We consider these in turn.

For most economies, saving appears to be most affected by demographic changes. Across almost all economies, the growth rate of the aged dependency ratio is more than 2 percent per year, and its average increase is larger than that of any other determinant. In tandem with the much larger elasticity on this variable (-0.19), it is clear that the worldwide contraction in saving in the baseline scenario is due primarily to aging.[20]

As important as demography is, however, its effect is tempered by that of rising per capita incomes, especially in India and the rest of Sub-Saharan Africa. While the drag from a higher dependency ratio in these economies is still significant, their comparatively smaller declines in saving rates attests to the important positive contribution from fast per capita income growth, which arrests an even larger decline. In this baseline, given the fairly small coefficients and growth rates on the remaining structural variables, their impact on saving rates is marginal. In Section 4, we consider more aggressive rates of evolution for these factors.

Since investment declines across the board for all economies, the effect of both investment demand—which by (3) is a function of output growth as well as the initial conditions described in

[19]Recall, that since the model fully endogenizes the RHS variables in (4) and (1), these should not be regarded as exogenous determinants, but rather variables that coevolve alongside saving and investment.

[20]This does not rule out the possibility that other factors, which we do not model, may also give rise to contractions in global saving in the future. Dobrescu, Kotlikoff & Motta (2012) have argued, for example, that preferences for lower saving as economies develop may play a central role, and to the extent that per capita incomes will rise across the world in the future, the global decreases in saving presented here may be an underestimate.

Table 6: Coevolution of investment and saving with structural variables in baseline results, by country-regions, 2011–2030†

	Change	**Annual growth rate**				**Change**	**Annual growth rate**			
	$\frac{I}{Y}$	$\frac{r}{r^w}$	ΔY	fd	iq	$\frac{S}{Y}$	Δy	dr	fd	sp
Coefficient		1.26	0.26	0.04	0.03		0.06	-0.19	-0.03	-0.06
High income										
Europe	-1.8	0.1	0.8	0.1	0.1	-3.9	0.5	2.1	0.1	0.0
Japan	-2.1	0.1	0.2	0.1	0.1	-4.8	0.3	1.9	0.1	0.0
USA	-2.0	0.1	1.1	0.1	0.0	-4.2	0.3	2.6	0.1	0.0
Other high income	-4.9	-0.2	2.1	0.3	0.2	-4.5	1.1	3.5	0.3	0.0
Developing										
China	-9.4	-0.4	7.4	0.6	0.2	-5.6	6.8	3.9	0.6	1.0
Indonesia	-5.4	-0.3	4.9	0.3	0.1	-3.4	3.9	3.2	0.3	0.6
Other East Asia	-4.2	-0.1	4.0	0.3	0.1	-3.4	2.9	3.2	0.3	0.4
India	-3.1	0.1	7.1	0.5	0.2	-2.9	5.7	2.4	0.5	0.9
Other South Asia	-5.6	-0.4	3.7	0.2	0.1	-1.5	2.0	1.6	0.2	0.3
Russia	-1.9	0.2	2.8	0.3	0.1	-4.5	2.9	2.7	0.3	0.4
Other Eastern Europe	-5.2	-0.3	2.4	0.2	0.1	-3.1	1.9	2.0	0.2	0.3
Middle East	-3.0	0.1	3.6	0.2	0.1	-2.9	2.0	2.6	0.2	0.3
South Africa	-3.3	-0.1	2.2	0.1	0.0	-2.1	1.6	2.5	0.1	0.2
Other Sub-Saharan Africa	-1.2	0.3	6.0	0.3	0.1	-1.1	3.4	0.3	0.3	0.5
Brazil	-4.0	-0.2	3.1	0.2	0.1	-3.9	2.4	3.4	0.2	0.0
Mexico	-1.6	0.2	2.6	0.1	0.0	-3.2	1.5	3.0	0.1	0.2
Other Latin America	-4.3	-0.2	3.5	0.2	0.1	-3.1	2.3	2.3	0.2	0.3

† Notes: Changes in investment and saving rates are in percentage points, while annual growth rates are in percentages. Growth rates in a given variable indicate the total effect of changes in the variable on investment or saving rates, for a given country, and are computed from the product of the coefficient and independent changes in the variable.

Subsection A.3—as well as financing availability governs the extent of the relative decline in each country. Realized investment ultimately results primarily from the interaction between real growth and relative rental rates.[21] Where these two factors operate in the same direction—as is the case for Europe, Japan, and the United States—the resulting decrease in investment is relatively mild. When relative returns are negative and dominates the positive contribution of GDP growth[22] (which is the case especially in China, Indonesia, and the rest of South Asia), the resulting contractions in investment rates are more substantial. As in the case of saving, structural factors play a fairly small role in driving investment patterns in the baseline.

It is the interplay between demographics and saving, and growth and investment, that explains much of the patterns observed in Figure 2. In the appendix, we elaborate on how these mechanisms operate for the case of Japan, the United States, and Sub-Saharan Africa.

3.3 Baseline results for returns to capital

One of the central results of this paper is that returns to capital will remain benign into the future. This possibility is already alluded to in Subsection 3.1, where we find a relatively stable path of global saving and investment. To further flesh out the details concerning this outcome, this subsection reports realized rate of return results for our baseline.[23]

Of course, it is possible that returns to capital serve their equilibrating role, so that observed changes in investment would fail to fully convey the levels that would result *investment were truly independent of returns*. To better evaluate where it is investment financing or investment demand serves as a constraint on the other, we also compute *notional* values for the demand and financing of capital. Notional calculations hold rates of return constant at a given value (we use the prevailing rate in the year 2014, the first year in which the model converges to potential GDP), which allows us to ascertain the extent to which there may be an *ex ante* surplus or shortage of capital in any given country. These notional values for capital demand ($K_{it}^{nd}|_{r_{it}=r_{2014}}$) and financing ($K_{it}^{nf}|_{r_{it}=r_{2014}}$) serve as a counterfactual exercise that helps explain the direction of changes in returns over time.[24]

These results are reported in Table 7, for 2014 and 2030. The final column reports the ratio of notional demand to notional supply of capital, which is an indication of *ceteris paribus* pressure on the rate of return: a higher ratio would suggest greater upward pressure on the rate of return—and *vice versa* for a lower ratio —and so positive changes in the ratio between 2014 and 2030 would suggest increased tensions; this tension would typically be relieved by accompanying increases in

[21] While the coefficient on relative returns is an order of magnitude larger than that on growth, the opposite is true of their annual growth rates; consequently, the total effect is dependent on them both.

[22] Crucially, low output growth rates mean that *both* investment demand as well as the ability to attract investment financing are circumscribed, which together act to suppress investment.

[23] The CGE model normalizes, for all countries, the initial returns to investment in 2007 to unity, so that the level of the rate of return is indeterminate. To pin down a level and hence assist the interpretation of relative returns, we compute an initial level based on the marginal product of capital, and apply changes in rates of return in the model to this level. Details on these calculations are provided in the technical annex.

[24] Our use of capital stocks, as opposed to investment flows, is to ensure that anomalous one-period changes in the direction of investment do not give rise to perverse results, where for example an increase in demand is accompanied by decreasing rates of return. Full details on the calculation of these notional values are provided in the annex.

rates of return (although not always; this is discussed below).

Table 7: Baseline results for returns to capital, and corresponding notional demand and supply of capital, 2014 and 2030†

	r_{it}		$K_{it}^{nd}\|_{r_{it}=r_{2014}}$		$K_{it}^{nf}\|_{r_{it}=r_{2014}}$		$\frac{K_{it}^{nd}}{K_{it}^{nf}}$	
	2014	2030	2014	2030	2014	2030	2014	2030
High income								
Europe	4.5	4.6	42.70	57.60	42.70	57.30	1.00	1.00
Japan	1.2	1.2	17.80	20.30	17.80	19.80	1.00	1.02
USA	3.4	3.5	61.40	77.80	61.40	75.60	1.00	1.03
Other high income	5.9	5.7	19.70	29.70	19.70	31.00	1.00	0.96
Developing								
China	9.4	8.8	17.90	55.60	17.90	63.10	1.00	0.88
Indonesia	13.9	13.2	1.50	3.30	1.50	3.60	1.00	0.93
Other East Asia	8.5	8.4	3.00	5.90	3.00	6.10	1.00	0.96
India	9.8	10.0	5.00	15.80	5.00	16.40	1.00	0.96
Other South Asia	9.7	9.1	0.90	1.70	0.90	1.80	1.00	0.93
Russia	9.6	10.0	4.50	7.50	4.50	7.50	1.00	1.00
Other Eastern Europe	8.9	8.5	5.50	8.60	5.50	9.20	1.00	0.94
Middle East	9.7	9.9	3.30	6.10	3.30	6.10	1.00	0.99
South Africa	6.6	6.5	0.90	1.40	0.90	1.50	1.00	0.97
Other Sub-Saharan Africa	12.3	13.0	2.00	5.40	2.00	5.40	1.00	1.00
Brazil	9.6	9.4	4.40	7.70	4.40	8.10	1.00	0.96
Mexico	6.4	6.7	3.70	6.00	3.70	5.80	1.00	1.04
Other Latin America	7.7	7.5	5.00	9.20	5.00	9.60	1.00	0.95
World	5.4	5.4	199.20	319.50	199.20	327.90	1.00	0.97

† Notes: Rates of return and notional demand/supply are in percentage points. Details for the computation of K^{nd} and K^{nd} are reported in the technical annex. 2014 is the first year where the model converges to potential GDP, and notional demand and financing are equal by construction. World rates are calculated as the capital stock-weighted rates of return for the individual countries.

It is clear from the table that, at least in the baseline, increases in the realized rate of return to capital are fairly small: the average change across all countries is close to zero, with the largest increases (in other Sub-Saharan Africa) and decreases (in Indonesia and China) both less than one percentage point. Economies that experienced substantial increases (decreases) in the ratio of notional demand to financing experienced the greatest increases (decreases) in rates of return, as would be expected when capital demand is greater (lesser) than supply. For example, China, Indonesia, and the rest of South Asia will experience the largest falls in returns, alongside the greatest declines in the K_{it}^{nd}/K_{it}^{nf} ratio; the converse is true for Russia, Mexico and the rest of Sub-Saharan Africa.[25]

[25] A small number of economies, notably India and the Middle East, will see rates of return move in the opposite direction to the notional demand-financing ratio. This is due to the fact that the investment financing equation (4) includes *relative* rates of return, whereas investment demand relies on absolute returns. Consequently, it is possible

One central observation from Table 7 is that cases where excess demand for capital is greater than available financing $K^{nd}_{i,2030}/K^{nf}_{i,,2030} > 1$ are far less than the converse. This indicates that, for the majority for economies, the constraint of investment financing is nonbinding; in other words, available investment opportunities do not outstrip the availability of capital to finance them. Thus, upward pressure on returns are simply absent for the vast majority of economies. This absence can be explained by the fact that most economies in the developing world—which already engage in less capital-intensive production to begin with (see Figure A.3)—concomitantly experience relative slowdowns their rates of economic growth (see Table 3).

The overall message from the country-level results are also evident at the global level. (Capital-weighted) returns at the global level are (to 2 significant figures) unchanged between 2014 and 2030, and increases in notional capital demand will not exceed increases in notional financing (in fact, the global notional demand-financing ratio falls). The result is the stability of the global (capital-weighted) rate of return.

4 Sensitivity Analyses

Given the distinctive nature of our main results, it is natural to question its robustness. In this section we demonstrate the remarkable stability of our baseline findings. In particular, we examine the sensitivity of saving and investment paths to a broad range of perturbations. As will be clear, there are no cases where equilibrium investment and saving rates deviate from the baseline to a degree that is statistically significant at conventional levels, whether these rates are measured in terms of their means, or variance.

We consider sensitivity analyses along three dimensions: (a) variations in the parameterizations for equations (1) and (4); (b) variations in the paths of the exogenous variables. For tractability, we report investment, saving, and current account shares of GDP analogous to the baseline results in Table 5, but only for global, high-income, and developing country aggregates, along with means and standard deviations for these variables within each country group.[26] The results are given in Table 8.

The top panel presents, for comparison purposes, the baseline results. The left half of the table reports (GDP-weighted) aggregates for the world, high-income, and developing country groups. The right half reports (unweighted) means and standard deviations for each respective group. This half also computes, for the scenarios that follow, two-tailed t and F tests that compare, respectively, sample means and standard deviations for each sensitivity scenario to the baseline.

The second panel offers the robustness checks for parameterizations. The first two we consider alter the relative returns elasticity of investment financing so that it deviates from the $\theta^r = 1.26$

that the absolute rate rises (reducing notional investment demand in the numerator), but the relative rate falls; if the latter also dominates the changes in (4), there will be a decline in notional investment financing (which reduces the denominator). If reductions in the numerator exceed those in the denominator, the paradoxical case where notional demand-financing ratio falls, despite an increase in returns.

[26] Detailed results for individual countries are available from the authors on request.

employed in the baseline. We consider both substantially more inelastic and elastic possibilities: first, we substitute this parameter with the upper bound of the *actual* coefficient on relative returns (as opposed to the coefficient on level returns used for the baseline), so that $\theta^r = 0.003$, and second, we allow the coefficient to be highly elastic ($\theta^r = 3$), which more closely corresponds to the special case of frictionless global capital markets.

Given the relative importance of demographic changes as a factor in the saving function, a third robustness check allows the dependency ratio to attain the (statistically significant) lower bound as estimated in Table 1, $\beta^d = -0.10$. Finally, as a fourth robustness check on the parameters, we allow the coefficients for the persistence terms to take on upper bounds of estimates from Table 1—specifically, $\theta^\iota = 0.82$ and $\beta^\sigma = 0.75$—so that there is effectively greater friction to cross-border capital flows, relative to the baseline.

The third panel offers alternative assumptions for the growth rate of productivity (and hence growth) in developing countries, the major factor affecting the investment function. In contrast to the baseline, we allow two alternative productivity paths: a faster growth rate where productivity evolves at a rate 50 percent higher, and a slower growth rate where productivity evolves at a rate 75 percent slower.[27] For the high productivity growth setting, this results in growth rates that average 4.1 percent across developing countries, and 0.9 percent across high-income ones, while the low productivity growth case yields, respectively, 2.9 and 1.0 percent (other assumptions about relative productivity between sectors and income groups remain unchanged).

In the final panel we consider perturbations to the path of both productivity and structural variables in unison. The scenario combines the case where productivity grows 50 percent faster than in the baseline, and couples this with paths for the evolution of the structural variables that are assumed to close a quarter of the initial gap between the given economy and the United States by 2030 (the U.S. is assumed to evolve in the same fashion as in the baseline).[28] Since countries begin at different starting points relative to the U.S., however, the growth rate of the specific variable will differ by the country, with countries initially further away from U.S. levels catching up faster than countries closer to U.S. levels.

We regard this final scenario as our major alternative simulation of interest. It encapsulates a world where the per capita growth incomes of developing countries converge toward that of high-income countries at a rate consistent with catch-up growth, and changes in structural factors in the developing world that are allowed to deviate from their historical rates of evolution, and advance far more quickly.

The results from this set of sensitivity analyses attest to the overall robustness of the baseline results. The various perturbations do not give rise to any case where the 2010 or 2030 estimates in the first or second moments deviate from the baseline at a statistically significant level lower than 10 percent. Among the seven different settings, only in four cases—when the dependency ratio is relatively insensitive, when saving and investment is relatively persistent, when productivity growth

[27] We considered a symmetric outcomes of 50 percent higher and lower, but chose this greater rate of slowdown to more closely match data from developing countries in the 1980s and 90s.

[28] This is implemented by overriding (8) with an exogenous target $\bar{S}_{i,2030}$, and allowing η to evolve endogenously.

Table 8: Sensitivity analysis of baseline results, aggregates and unweighted means/standard deviations by income group, 2011–2030[†]

	Aggregate						Unweighted					
	I/Y		**S/Y**		**CA/Y**		**I/Y**		**S/Y**		**CA/Y**	
	2011	2030	2011	2030	2011	2030	2011	2030	2011	2030	2011	2030
							Baseline					
World	22.7	20.9	22.7	20.9	0.0	0.0	24.9 (5.3)	21.3 (4.0)	24.5 (9.1)	21.1 (8.6)	-0.4 (6.0)	-0.1 (5.8)
High income	20.0	17.7	19.6	15.5	-0.3	-2.1	21.0 (2.9)	18.3 (1.7)	22.1 (7.7)	17.8 (7.5)	1.1 (4.9)	-0.5 (5.8)
Developing	29.4	25.6	30.3	28.7	0.8	3.1	26.2 (5.3)	22.2 (4.2)	25.3 (9.6)	22.2 (8.9)	-0.9 (6.4)	-0.0 (6.0)
							Inelastic returns differential ($\theta^r = 0.003$)					
World	22.7	21.1	22.7	21.1	0.0	0.0	23.6 (5.7)	20.3 (4.9)	24.6 (9.1)	21.2 (8.6)	0.9 (6.5)	0.8 (6.2)
High income	20.5	17.7	19.6	15.6	-0.9	-2.1	21.3 (2.3)	18.3 (2.0)	22.1 (7.7)	17.8 (7.5)	0.8 (5.4)	-0.6 (5.5)
Developing	28.1	26.0	30.4	29.1	2.3	3.1	24.4 (6.3)	20.9 (5.5)	25.3 (9.6)	22.2 (8.9)	0.9 (7.0)	1.3 (6.5)
							Elastic returns differential ($\theta^r = 3.0$)					
World	22.7	20.9	22.7	20.9	0.0	0.0	25.3 (5.4)	21.5 (4.1)	24.5 (9.1)	21.1 (8.6)	-0.8 (6.0)	-0.4 (5.9)
High income	19.8	17.6	19.6	15.5	-0.1	-2.1	20.9 (3.1)	18.2 (1.6)	22.1 (7.7)	17.8 (7.5)	1.2 (4.8)	-0.5 (6.0)
Developing	29.9	25.5	30.2	28.5	0.4	3.0	26.7 (5.2)	22.5 (4.1)	25.3 (9.6)	22.2 (8.9)	-1.4 (6.3)	-0.4 (6.2)
							Low dependency sensitivity ($\beta^d = -0.10$)					
World	22.8	22.7	22.8	22.7	0.0	0.0	25.1 (5.3)	23.1[‡] (4.4)	24.6 (9.1)	22.4 (8.7)	-0.5 (6.0)	-0.7 (5.9)
High income	20.1	19.1	19.8	17.5	-0.3	-1.6	21.1 (2.9)	19.8[‡] (2.0)	22.3 (7.7)	19.9 (7.5)	1.2 (4.9)	0.0 (5.6)
Developing	29.6	27.8	30.3	30.0	0.7	2.2	26.3 (5.3)	24.1[‡] (4.4)	25.3 (9.6)	23.2 (9.1)	-1.0 (6.4)	-0.9 (6.1)
							Persistent saving/investment ($\theta^\iota = 0.82, \beta^\sigma = 0.75$)					
World	22.6	18.6	22.6	18.6	0.0	0.0	25.7 (5.5)	19.3 (3.9)[†]	24.4 (9.1)	19.2 (8.5)	-1.3 (6.1)	-0.1 (6.1)
High income	19.4	15.7	19.5	13.3	0.1	-2.3	20.6 (3.3)	16.2 (1.4)[*]	22.0 (7.7)	15.6 (7.7)	1.4 (4.7)	-0.6 (6.6)
Developing	30.3	22.9	30.0	26.3	-0.3	3.3	27.3 (5.1)	20.3 (3.9)[‡]	25.1 (9.7)	20.3 (8.7)	-2.2 (6.4)	0.0 (6.2)
							High productivity growth					
World	22.7	21.8	21.8	21.8	0.0	0.0	24.9 (5.3)	21.6 (4.9)	24.5 (9.1)	21.2 (8.6)	-0.4 (6.0)	-0.4 (5.5)
High income	20.0	17.2	15.6	15.6	-0.3	-1.6	21.0 (2.9)	17.8 (1.8)	22.1 (7.7)	17.8 (7.5)	1.1 (4.9)	0.0 (5.7)
Developing	29.4	27.4	29.4	29.4	0.8	2.0	26.2 (5.3)	22.8 (5.0)	25.3 (9.6)	22.2 (8.9)	-0.9 (6.4)	-0.5 (5.7)
							Low productivity growth					
World	22.7	19.5	22.7	19.5	0.0	0.0	25.1 (5.3)	19.9[‡] (2.5)[*]	24.6 (9.1)	21.1 (8.5)	-0.5 (6.1)	1.2 (6.8)
High income	19.9	18.4	19.6	15.4	-0.3	-3.0	20.9 (2.9)	19.0 (1.7)	22.1 (7.7)	17.7 (7.4)	1.2 (4.9)	-1.3 (5.9)
Developing	29.6	21.6	30.3	27.2	0.7	5.6	26.3 (5.3)	20.2[†] (2.7)[†]	25.3 (9.6)	22.1 (8.8)	-1.0 (6.5)	2.0 (7.0)
							Rapid convergence					
World	22.7	20.5	22.7	20.5	0.0	0.0	24.9 (5.3)	20.4 (4.6)	24.5 (9.1)	18.3 (9.3)	-0.4 (6.0)	-2.1 (6.9)
High income	19.9	16.1	19.6	15.6	-0.3	-0.5	21.0 (2.9)	16.7[‡] (1.7)	22.1 (7.7)	17.8 (7.5)	1.1 (4.9)	1.1 (5.9)
Developing	29.4	25.8	30.2	26.5	0.8	0.7	26.2 (5.3)	21.6 (4.7)	25.2 (9.7)	18.5 (10.0)	-0.9 (6.4)	-3.1[‡] (7.2)

[†] Notes: Investment, saving, and net capital flows are all reported as a share of GDP, in percentage terms. Net capital flows are reported as the current account. Aggregate results are computed as GDP-weighted means for each income group. Unweighted results are computed as unweighted means, with group standard deviations reported in parentheses. Means (standard deviations) for each respective group are compared between the baseline and the respective scenario using two-tailed t and F tests. [‡] indicates significance at 30 percent level, † indicates significance at 20 percent level, [*] indicates significance at 10 percent level.

is significantly slower, and when there is both rapid productivity growth and changes in structural factors in the developing world (the rapid convergence scenario)—do investment or capital flows even exceed a 70 percent confidence interval around the baseline estimates. Furthermore, these deviations tend to be limited to projections of investment in 2030, rather than saving; this is reflective of the much more substantial change to either parameters or variable paths affecting the investment function, vis-à-vis the saving function.

Although the changes to investment, saving, and capital flows in the final, rapid convergence scenario are not statistically distinguishable (at standard levels) from the baseline, the changes in this case remain of independent economic interest, mainly because the perturbations introduced take into account a number of simultaneous changes that result in a very compelling alternative future scenario.[29] There are three main takeaways from this scenario, as compared to the baseline.

First, such a world will see saving rates fall, on average, worldwide, and this contraction will be concentrated in the developing countries. This outcome results from the fact that the positive contribution of faster growth to higher saving rates in the developing world will be more than dominated by the negative contribution from higher levels of financial development. Second, investment will likewise decline, but in this case the brunt of decline in the investment rate will be borne by high income countries: the 1.6 percentage point lower investment rates relative to the baseline is more than twice the 0.6 percentage point difference experienced by developing countries. This shrinkage is even more dramatic in absolute terms, since developing countries will be significantly larger in the rapid convergence scenario.

Finally, capital flows in this scenario will tend to flow toward developing countries; thus, balances will remain positive for the developing world as a whole (largely due to the large surplus position that China will continue to maintain), and the majority of developing economies will be running current account deficits by 2030 in this scenario. This outcome—where developing countries tend to be net recipients of capital inflows (of the 13 developing country-regions, only traditionally high-saving economies such as China, the rest of East Asia, and the Middle East and North Africa, will be running surpluses in 2030)—is consistent with their expected growth prospects. Notably, the scenario also leads to a reversal of the deficit (surplus) position of high-income (developing) countries, which suggests a modest reversal of the Lucas (1990) paradox.

5 Conclusion

In this paper, we have sought to provide a picture of future trends in saving, investment, and capital flows. To do so, we develop a multi-country, multi-sector CGE model with endogenous investment and saving behavior, which in turn are determined by economic and, more importantly, structural variables, such as demography, financial development, and institutional quality. Premised on a set

[29] Although convergence between the developed and developing world has been elusive for much of the 20th century, upgrading of education and health, improvements in governance in the developing world, continued economic and financial globalization, and the rapid diffusion of information and communications technology increasingly point to convergence as a likely reality (Spence 2011).

of assumptions regarding likely future demographic changes and productivity growth that favors convergence in the per capita incomes of high-income and developing countries, the baseline scenario examined in the model indicates that global investment and saving will experience nontrivial but fairly small declines. Declines in saving at the country level are offset by increases in the size of developing economies, while relative slowdowns in developing-country growth translates into little upward pressure for that investment at the country level. Moreover, our estimates demonstrate remarkable stability to changes in a host of assumptions, so that even in the case where we allow productivity and structural factors to evolve in a fairly rapid fashion (as described in the rapid convergence scenario considered in Section 4), our overall message remains largely unchanged.

In conclusion, it is also useful to contrast just how different our results are, both in comparison to other studies of future global saving and investment patterns, as well as to the *status quo*. We argue that the future will see neither a spike in interest rates (Dobbs *et al.* 2010) nor its continued repression (Caballero *et al.* 2008). Rather, interest rates are likely to remain stable at the global level, while rising or falling in countries according to their heterogeneous capital demands. Moreover, compared to dismal stories of developing countries "running out" of financing for investment, or contributing to a global saving "glut," we argue that the future will see a number of fast-growing, high-saving developing countries assume the position of financing investment opportunities in *both* the global North and South.

As in all CGE modeling exercises, a shortcoming of our work here is that our conclusions rely on a set of assumptions and parameterizations, and these results may be sensitive to perturbations in our baseline choices. We have sought to show, in Section 4, that by and large our findings are reasonably robust to a wide range of possible perturbations. Still, there is a difference between statistical and economic (in)significance, and so we remain modest in any claims that our vision of the future is more certain than it is. A second shortcoming, again common to all models of this nature, is that the enormous number of moving parts in the model means that—even though not a black box—it is occasionally difficult to convey the precise mechanisms underlying any given variable change. We have sought to offer a transparent accounting of the main drivers of our baseline outcomes in Subsection 3.2, but undoubtedly there will remain idiosyncratic results that are harder to explain. Finally, we are aware that our focus on saving and investment means that other aspects of the model have been simplified; consequently, we gloss over several additional elements that may yield second-order effects on saving and investment—such as differential growth rates between skilled and unskilled labor, the importance of natural resource endowments, or the modeling of longer-term commodity shocks—which are natural candidates for future research efforts.

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Technical Appendix

A.1 Additional tables

Table A.1: Sources and definitions for main variables of interest

Variable	**Definition**	**Source**
	Economic variables	
Fixed investment rate	Gross fixed capital formation as share of GDP, in 2000 U.S. dollars	WDI†
Domestic saving rate	Gross domestic saving as share of GDP, both in current U.S. dollars‡	WDI
Output growth	Growth in real gross domestic product (GDP)	WDI
Income per capita	Real GDP per capita	WDI
Income per capita growth	Growth in real GDP per capita	WDI
Relative returns differential	Difference in domestic real and risk-free interest rates*	Bloomberg, WDI
Real rate of return	Lending rate adjusted for inflation	WDI
Trade openness	Imports plus exports divided by GDP	WDI
Financial openness	Index of capital account openness	Chinn & Ito (2008)
	Structural variables	
Aged dependency ratio	Ratio of population over 65 years to working-age population (15-64 years)	WDI
Democratic accountability	Index of democratic accountability	ICRG
Financial development	Domestic credit to private sector	WDI
Institutional quality	Simple average of rule of law and control of corruption indices	ICRG†
Investment climate	Index of strength of investment protection	ICRG
Social protection coverage	Replacement rate of income in pay-as-you-go social security systems	Bloom *et al.* (2007)

† WDI = World Development Indicators, ICRG = International Country Risk Guide. ICRG indicators are measured such that higher values indicate lower risk (better outcomes).
‡ The saving series measured in current terms was chosen due to superior data availability.
* The U.S. real interest rate is taken as the risk-free rate of return, and the calculation adjusts for exchange rate changes.

Table A.2: Country-region aggregations and production sectors[†]

	Country-Regions	
China (CHN)	Russian Federation (RUS)	Europe (EUR)[*]
Indonesia (IDN)	Rest of Eastern Europe and Central Asia (XEC)	Japan (JPN)
Rest of East Asia and Pacific (XEA)	Middle East and North Africa (MNA)	United States (USA)
Brazil (BRA)	India (IND)	Rest of high income (XHI)
Mexico (MEX)	Rest of South Asia (XSA)	
Rest of Latin America and Caribbean (XLA)	South Africa (ZAF)	
	Rest of Sub-Saharan Africa (XAF)	
	Sectors	
Agriculture (Agric.)	Manufacturing (Manuf.)	Infrastructure (Serv.)
Natural resources (Agric.)	Capital goods (Manuf.)	Construction (Serv.)
		Services (Serv.)

[*] Europe comprises the 27 economies of the European Union (EU-27).

[†] Notes: Abbreviations are indicated in parentheses. Residual regions in the developing world were chosen to correspond to the World Bank's regional classification of developing countries, and are prefixed with an "X." For presentational purposes, sectors were further aggregated into agriculture, manufacturing, and services, with the corresponding aggregation in parentheses.

Table A.3: Summary statistics for main variables of interest†

Variable	**N**	**Mean**	**Std. Dev.**	**Min**	**Max**
Investment rate	1,582	0.22	0.06	0.01	0.63
GDP growth	1,582	0.04	0.04	-0.33	0.35
Financial development	1,582	59.01	47.77	2.97	319.46
Institutional quality	1,582	3.67	1.25	0.50	6.00
Saving rate	1,102	0.21	0.09	-0.11	0.52
GDP per capita growth	1,102	0.02	0.04	-0.15	0.18
Aged dependency ratio	1,102	13.51	7.03	4.28	28.19
Social protection coverage	1,102	0.48	0.34	0.00	1.43

† Notes: Sample sizes for investment and saving rates differ due to limited data availability for saving. Summary statistics are presented for annual data; those for 5-year averages were similar, but with generally smaller values for the minimum and maximum.

Table A.4: Implied TFP growth rates for baseline scenario, 2010–2030†

	2010–20	2020–30	2010–30
High income			
Europe	0.2	0.2	0.1
Japan	0.2	0.2	0.2
USA	0.3	0.3	0.2
Other high income	0.5	0.5	0.5
Developing			
China	2.9	2.9	3.0
Indonesia	1.0	1.1	1.0
Other East Asia	0.7	0.7	0.6
India	2.2	2.4	2.1
Other South Asia	1.1	1.0	1.1
Russia	1.0	1.0	0.9
Other Eastern Europe	0.5	0.5	0.5
Middle East	0.1	0.2	0.1
South Africa	0.3	0.3	0.3
Other Sub-Saharan Africa	1.0	1.1	1.0
Brazil	1.0	1.0	0.9
Mexico	0.0	0.2	-0.2
Other Latin America	0.8	0.8	0.8

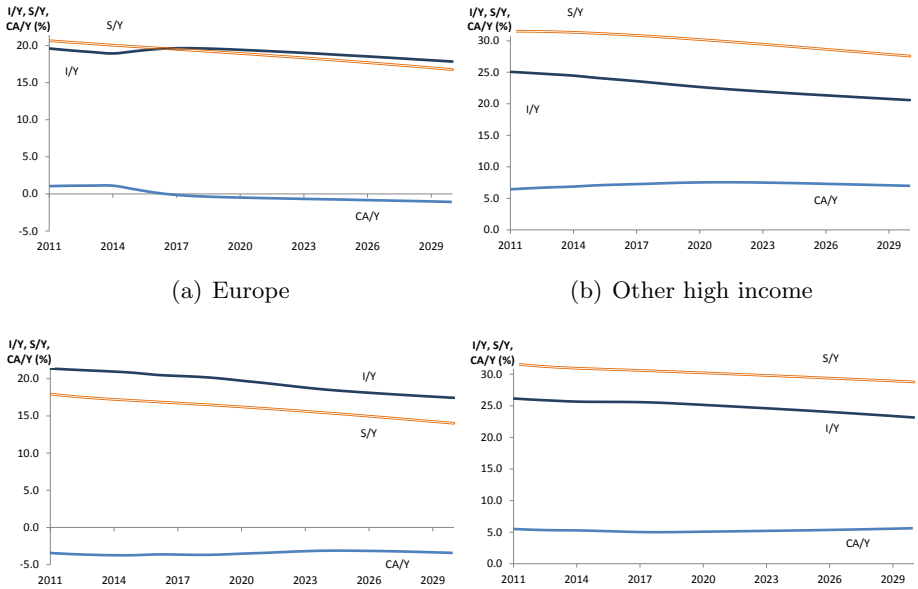
† Notes: Average annual growth rates of TFP are reported in percentage points.

Table A.5: Evolution of structural variables, baseline†

	Fin. Dev.		**Inst. Qual.**		**Soc. Sec.**		**Aged Dep.**	
	2011	*Growth*	2011	*Growth*	2011	*Growth*	2011	*Growth*
High income								
Europe	202	0.1	4.5	0.05	0.5	0	0.2	2.6
Japan	169	0.1	4.6	0.06	0.5	0	0.37	1.9
USA	141	0.1	4.7	0.08	0.6	0	0.27	2.1
Other high income	82	0.3	4.7	0.19	0.3	0	0.14	3.5
Developing								
China	131	0.6	3.0	0.21	0.1	1.02	0.12	3.9
Indonesia	29	0.3	3.0	0.12	0.1	0.58	0.08	3.2
Other East Asia	94	0.3	3.0	0.09	0.2	0.43	0.09	3.2
India	49	0.5	3.3	0.18	0.1	0.86	0.08	2.4
Other South Asia	33	0.2	2.6	0.06	0.1	0.3	0.07	1.6
Russia	45	0.3	3.0	0.09	0.1	0.43	0.18	2.7
Other Eastern Europe	40	0.2	2.2	0.06	0.1	0.29	0.14	2.0
Middle East	53	0.2	3.4	0.06	0.4	0.3	0.07	2.6
South Africa	146	0.1	2.7	0.05	0.2	0.24	0.07	2.5
Other Sub-Saharan Africa	21	0.3	2.1	0.1	0.2	0.5	0.06	0.3
Brazil	57	0.2	2.5	0.07	1	0	0.11	3.4
Mexico	25	0.1	2.3	0.05	0.1	0.23	0.1	3.0
Other Latin America	28	0.2	2.5	0.07	0.6	0.35	0.11	2.3

† Notes: Financial development is domestic credit to private sector as a share of GDP, in percent, institutional quality is ICRG rating (0–6), social security is the replacement rate of income, aged dependency is the ratio of the population aged 65 and older to the working age population. All growth rates are in percentage points.

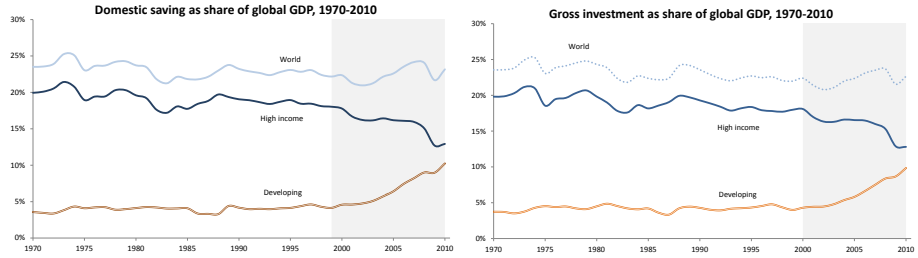
A.2 Additional figures



(a) Europe (b) Other high income

(c) Brazil (d) Middle East and North Africa

Figure A.1: Saving rates, investment rates, and net capital flows, selected developed and developing economies, 2011–30.



(a) Saving shares of global output (b) Investment shares of global output

Figure A.2: Shares of high income, developing, and world gross domestic saving (top panel) and gross capital formation (bottom panel) in global GDP, 1970–2010. The shaded region indicates the period after 2000, where there was a structural break with developing economies' shares increasing substantially.

A.3 Initial differentials in factor endowments and structural factors

In addition to the assumptions outlined in Section 2.3, the results of the simulations also hinge critically on the initial differentials that exist between countries, both in terms of efficiency-adjusted factor endowments as well as in the prevailing levels of each structural factor.

This is best understood in terms of the initial capital-output ratio, reported in Figure A.3. It is worth noting that cross-country differences in the absolute level of capital stocks may systematically differ from differences in their capital-output ratios. For example, the distribution in 2007 would have, by far, the largest stock of capital residing in the United States; as evident from Figure A.3, however, the capital-output ratio in the United States falls well within the mean for the country-regions considered. This distinction is important for understanding future production patterns. Countries with high K/L ratios require large investments to expand production. Hence, *ceteris paribus*, high income countries such as Japan and Europe—but not so much the United States—would need relatively more capital investment to grow at a given rate.

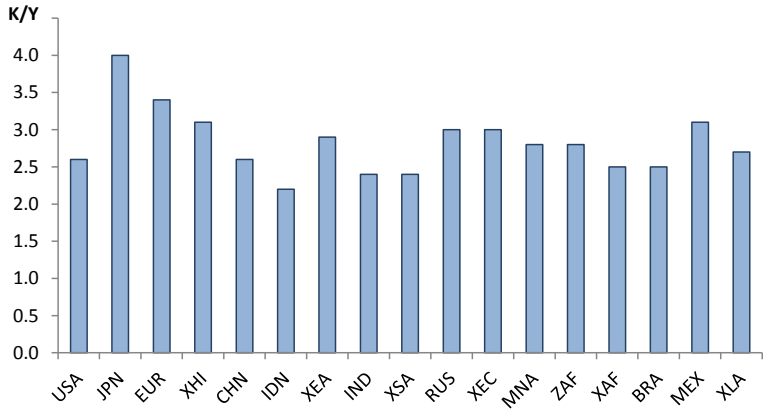
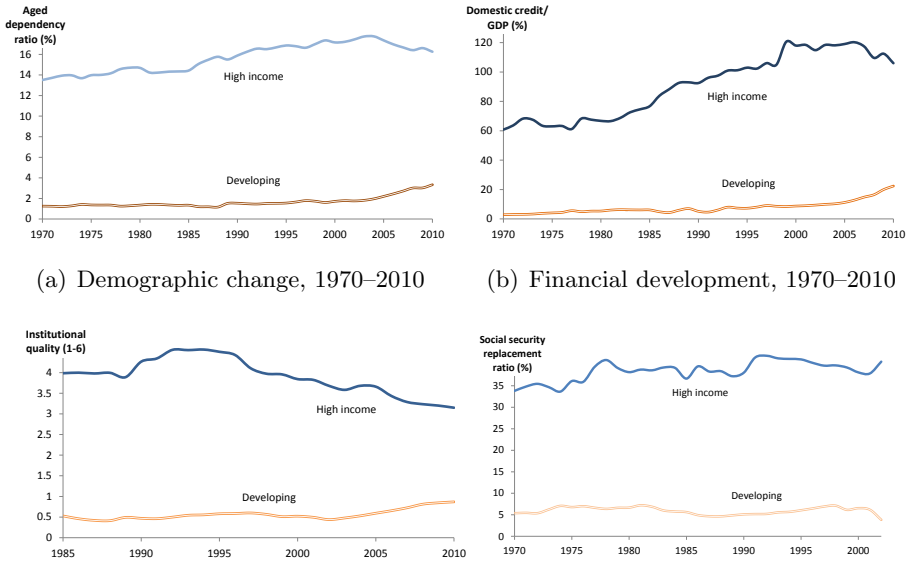


Figure A.3: Initial ratio of capital stock to GDP, measured at factor cost, 2007. Country and region abbreviations are defined in Appendix Table A.2.

The clear difference in starting points for high income versus developing countries in terms of their structural factors is also stark, although for a number of structural factors—in particular the degree of financial development and the quality of institutions, but also for demographic change—there appears to be a limited degree of convergence between the two income groups starting in 2000 (Figure A.4). This is also borne out by comparing the compound annual growth rates (CAGR) in these factors: between 1970 and 1999, the CAGR for the GDP-weighted aged dependency ratio (domestic credit to the private sector) grew by 3.6 (0.8) percent in developing countries, versus 2.6 (0.8) percent in high-income countries; but over the decade from 2000 through 2010, this CAGR had increased to 8.9 (6.2) percent compared to -0.1 (-0.5) percent. For indices of corruption and rule of law, the equivalent CAGRs were -0.2 versus 0.0 percent in the earlier period, and 4.8 versus -1.8 in the latter period.



(a) Demographic change, 1970–2010

(b) Financial development, 1970–2010

(c) Institutional quality, 1985–2010

(d) Social protection, 1970–2003

Figure A.4: Historical evolution of structural variables, high income and developing economies, various years. All variables are weighted by GDP. Demographic change is measured as the aged dependency ratio, financial development is measured as domestic credit extended to private sector as a share of GDP, institutional quality is measured as the average of corruption and rule of law indices, and social protection is measured as the social security replacement rate.

A.4 The evolution of saving and investment: The cases of Japan, the United States, and Sub-Saharan Africa

The interplay between demographics and saving, along with its effect on investment and capital flows, is well illustrated by examining the cases of Japan (Figure 2(c)) and Sub-Saharan Africa (Figure 2(d)) more closely, given their diametrically opposite demographic futures. Over the next two decades, absent migratory flows, Japan will face a rapidly aging population and low birth rates, which will lead to an acute contraction of its labor supply. In and of itself, such demographic pressures will mean significantly lower rates of saving. But as the labor supply becomes scarcer relative to capital, real wages will also rise relative to real rents, which lowers returns on capital, reducing the attractiveness of Japan as an investment destination. This is borne out by the decreases in saving and investment (Table 5). Moreover, given Japan's high capital intensity of production, coupled with dissaving due to an aging population, sustaining even its very modest rate of growth will require access to capital inflows; this is indeed what we observe in the baseline, which projects that Japan will reverse its long-standing current account surplus and yield a small deficit by 2030.

In contrast, Sub-Saharan Africa will enter into the phase of its demographic transition where its working-age population will accumulate rapidly, and coupled with low elderly dependency ratios, saving will be elevated. However, the abundance of capital and labor, alongside rapid productivity growth—especially in manufacturing (Table 3)—will translate to high rates of per capita income growth that offset in part the positive demographic shock to saving (so that, while its saving rates decline the least among all economies in projection period, the change is nevertheless negative). The relative scarcity of capital, set against a fast-growing labor supply, translates to relative increases in rent, and hence returns, paid relative to other regions; this will sustain an investment rate that will be among the highest in the world. This expansion of investment opportunities will result in a steady inflow of capital into the region, realized as a stable current account deficit position.

The manner by which economic growth may offset negative demographic shocks is also well illustrated by considering the United States (Figure 2(a)). With an anemic per capita growth rate, alongside demographic pressures from an aging society, saving will fall sharply. Were labor productivity in the United States to remain strong (Table 3), however, the resulting rate of growth (which, while low, is fairly strong for a high-income economy), coupled with rising relative returns to capital, attracts rising inflows of capital from abroad, which in turn serves to limit the fall in the investment rate.

A.5 Details on construction of rate of return and notional demand/financing of capital

To understand the theoretical basis for utilizing the adjusted marginal product of capital, recall that, in equilibrium, the value marginal product of capital (MPK) should equate to the rental rate on capital:

$$P_{it}^{y} \frac{\partial Y_{it}}{\partial K_{it}} = R_{it} \equiv (r_{it} + \delta) P_{it}^{k},$$

where R_{it} is the economywide rental rate, and P_{it}^{y} the price of output, in economy i at time t. Solving for returns gives us

$$r_{it} = \left[\frac{P_{it}^{y}}{P_{it}^{k}} \frac{\partial Y_{it}}{\partial K_{it}} \right] - \delta. \tag{A.1}$$

We apply the formula (A.1) to compute the MPK-based returns to capital for each economy. To do so, we apply a Cobb-Douglas functional form to Y_{it}, but several additional corrections are needed. First, as argued by Bernanke & Gürkaynak (2001); Gollin (2002), the labor share of an economy should be adjusted to account for, *inter alia*, self-employment. Second, in Caselli & Feyrer (2007) have made a strong case that the share of reproducible capital should be further adjusted (downward) to account for payments to natural wealth.[30]

The first issue is addressed by making the necessary corrections to labor share by utilizing the labor force-corrected measure from Bernanke & Gürkaynak (2001), unless this was not available, in which case the OSPUE measure from Gollin (2002) is utilized (due to limited coverage, however, we are unable to apply the correction to all economies in our database, but the correction is undertaken for most of the major economies). We address the second issue in a slightly different fashion from Caselli & Feyrer (2007): instead of imputing the entire stock of natural wealth to nonreproducible capital—which may be an overestimate, since the calculation of GDP does not, at any rate, include factor payments to *all* natural wealth (such as, for example, clean air)—we simply reduce the value-added share to reproducible capital by netting out factor payments to land and natural resource inputs. We then compute returns by dividing the residual value added, which is attributed to reproducible capital, by the capital stock. The resulting computation for initial returns, as reported in Table 7 of the main text, generally fall between prevailing observed market returns for long-dated corporate debt, and the estimates in Caselli & Feyrer (2007).

Notional capital demand is calculated in a sequence of steps. First, the volume of sectoral demand for capital is computed following (3), assuming that returns remain constant at the 2014 level. Second, this is aggregated across sectors to obtain the country-level notional capital stock. To obtain the notional financing of capital, we assume that, in 2014 when the economies attain their potential GDP, the notional demand and notional financing of capital are equal. The notional financing of capital is then calculated by augmenting the notional capital stock in 2014 with notional investment financing calculated by substituting contemporaneous national and global (capital stock-

[30] Another correction applied by Caselli & Feyrer (2007) is to correct for the price of capital relative to output. However, this correction is only necessary when applied to PPP data; since the GTAP data are already in national prices, the relative price $\frac{P^y}{P^k}$ is simply set to unity for the benchmark year (2007).

weighted) average returns with their 2014 levels in (4).