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Hans Fehr
Sabine Jokisch
Ashwin Kambhampati
Laurence J. Kotlikoff

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ABSTRACT

We simulate corporate tax reform in a single good, five-region (U.S., Europe, Japan, China, India) model, featuring skilled and unskilled labor, detailed region-specific demographics and fiscal policies. Eliminating the model's U.S. corporate income tax produces rapid and dramatic increases in the model's level of U.S. investment, output, and real wages, making the tax cut self-financing to a significant extent. Somewhat smaller gains arise from revenue-neutral base broadening, specifically cutting the corporate tax rate to 9 percent and eliminating tax loop-holes.

Hans Fehr
University of Wuerzburg
Sanderring 2
97070 Wuerzburg, Germany
hans.fehr@uni-wuerzburg.de

Sabine Jokisch
University of Wuerzburg
Sanderring 2
D-97070 Wuerzburg, Germany,
sabine.jokisch@gmx.net

Ashwin Kambhampati
Oberlin College
173 W Lorain St,
Oberlin, OH 44074
akambham@oberlin.edu

Laurence J. Kotlikoff
Department of Economics
Boston University
270 Bay State Road
Boston, MA 02215
and NBER
kotlikoff@gmail.com

An online appendix is available at:
http://www.nber.org/data-appendix/w19757

1 Introduction

The U.S. Corporate Income Tax is a controversial element of the U.S. tax system. The tax produces remarkably little revenue- only 1.8 percent of GDP in 2013, but entails major compliance and collection costs. The IRS regulations detailing corporate tax provisions are tome length and occupy small armies of accountants and lawyers.

As with many elements of our tax system, there is disagreement over what the corporate tax does and who ultimately bears its burden. The public's general view of the corporate tax is that it's paid by the owners of corporations, who are, when weighted by their ownership shares, disproportionately rich.

But many economists, going back to the writings of David Bradford (1978) and Arnold Harberger (1982), have suggested that the tax may actually fall on workers, not capitalists. The reason is simple. Workers living in a country are generally immobile, i.e., they rarely seek employment abroad. On the other hand, capital that is invested domestically can be withdrawn and invested in other countries. When this capital flight occurs, the workers and their jobs are left behind leading to lower labor demand and real wages for those able to retain their positions.

The so-called Irish Miracle of the late 1980s comports with this view of the corporate income tax. In 1987, Ireland began cutting its 50 percent corporate tax rate to 12.5 percent - the rate reached in 2003. As a consequence, the country experienced a massive inflow of capital, with over 1,000 multinationals setting up shop. The list includes Motorola, Delly, Wyeth, Intel, Microsoft, IBM, Citigroup, and Bristol-Myers Squibb. The extra investment drove growth. Indeed, between 1987 and 2007, Ireland's GDP growth rate averaged 6.4 percent per year compared with 3.7 percent per year between 1971 and 1987.

Concern about the adverse impact on workers of corporations leaving town is not confined to economists. The International Association of Machinists and Aerospace Workers' recent major protest of Boeing's shifting some of its aircraft manufacturing from Washington State to South Carolina changes in asset holdings well illustrates workers' fear of outsourcing.

Could the U.S. replicate the Irish Miracle in full or in part? The answer, which this paper answers largely in the affirmative, is not a priori obvious. Ireland is a very small open economy, whereas the U.S. is a very large open economy. In the extreme, were the U.S. to account for virtually the entirety of global production, taxing corporate capital in the U.S. would lead to very little capital flight since the capital would have nowhere to go. In this case, the extra revenue generated from the corporate tax would not come at the cost of substantially lower real wages paid to U.S. workers. Although the U.S. is the world's largest economy, it accounts for only about one quarter of the world's capital stock. Hence, there is, potentially, major scope for capital to emmigrate in response to differentially higher U.S. corporate income taxes.

This paper posits, calibrates, and simulates a multi-region life-cycle dynamic general equilibrium model to study the impact of U.S. and global corporate tax reforms. The model incorporates the U.S., Europe, Japan+ (with + referencing Hong Kong, Taiwan, and Korea), China, and India. It accounts for each country or region's demographic composition and transition and each country's panoply of fiscal policies.

Of central issue is the effect of eliminating the U.S. corporate income tax in its entirety while using either wage or consumption taxation to make up lost revenue. According to our model, this policy produces major economic benefits and welfare gains in the U.S., with the precise timing and magnitude of these gains depending on whether wage or consumption taxes are used to make up for any loss in corporate tax revenue not recovered by the economy's expansion. For example, when wage taxation is used as the substitute revenue source, eliminating the U.S. corporate income tax, holding other countries' corporate tax rates fixed, engenders a rapid and sustained 23 to 37 percent higher capital stock, depending on the year in question, with most of the added investment reflecting capital inflows in response to the U.S.' highly favorable corporate tax climate. Higher capital per worker means higher labor productivity and, thus, higher real wages. Indeed, in the wage-tax simulation, real wages of unskilled workers end up 12 percent higher and those of skilled workers end up 13 percent higher.

These higher real wages raise the incentive to work. But they also deliver offsetting income effects that induce less, not more labor supply. The net impact is a modest decrease over time in the supply of labor. But, on balance, output rises – by 8 percent in the short term, 10 percent in the intermediate term, and 8 percent in the long term – all relative to the level of GDP in the baseline path.

The economy's endogenous expansion expands existing tax bases, with the increased revenue making up for roughly one third the loss in revenue from the corporate tax's elimination. While we find no Laffer Curve, switching from corporate- to higher wage-taxation does produce something quite remarkable – a Pareto improvement with no required additional compensation mechanism. Stated differently, each generation, including those initially alive, benefits from the reform, with those born after 2000 experiencing an 8 to 9 percent increase in welfare measured as a compensating differential. The compensating differential measures the percentage change in annual consumption under the baseline simulation needed to achieve the same utility gain as arises in the policy reform. Those born in 1940, both skilled and unskilled, enjoy a 0.3 percent welfare gain. And those born in 1980, regardless of skills, enjoy a roughly 4 percent welfare gain. While the welfare effects for skill groups in the same generation are very similar, they aren't identical. In some generations, the unskilled fare better. In other generations, it's the skilled who fare slightly better.

With consumption-tax, rather than wage-tax finance of the corporate tax's elimination, the beneficial economic effects are somewhat greater as are the long-run welfare gains accruing to Americans. But, in this case, the reform is not a full win-win. It comes at some modest welfare losses to initial older generations. For example, those born in 2040 suffer a 0.7 percent loss. But such losses could easily be nullified via cohort-specific compensation policies.

The expected welfare gain for most U.S. generations associated with replacing the corporate income tax is associated with welfare losses for workers in other nations. The capital flowing into the U.S. does so by exiting these other areas, which lowers their output, capital per worker, labor productivity, and real wages. Foreign output and real wage levels fall by roughly 4 percent in the early stages of the transition before reverting back to essentially their pre-reform levels. Foreign retirees generally end up with modest welfare gains thanks to the higher worldwide net return they receive on their savings. In contrast, foreign workers experience significant to modest welfare loses depending on their age of birth.

These findings are based on Mintz and Chen's (2011) calculated effective marginal corporate tax rates. These authors measure the U.S. rate at 35 percent. Their corresponding rates for Europe, Japan+, China, and India are 25 percent, 30 percent, 20 percent, and 33 percent. We find qualitatively identical, but quantitatively more limited impacts using Devereux and Bilicka's (2012) effective marginal corporate tax rates of 23 percent for the U.S., 18 percent for Europe, 27 percent for Japan+, 16 percent for China, and 21 percent for India.

Both sets of findings suggest that when it comes to the impact of eliminating corporate income taxation, the U.S. will react more like a small open than a large closed economy. The model also generates the two-part story of corporate tax incidence (burdens) that Bradford (1978), Harberger (1982), and more recently Brill and Hassett (2007) emphasize.

Part one of this story: In the short run, the global capital stock can run from region to region to avoid corporate taxes, but it can't hide. Its net return will be equalized across regions, so a corporate tax levied anywhere will reduce the net return to capital everywhere. Indeed, in the short run, owners of corporate capital worldwide can expect to bear close to 100 percent of the burden of all corporate income taxes. But part two of the story is that movements of capital away from high corporate tax-rate regions to low corporate tax-rate regions redistributes from workers left behind (i.e., with less capital with which to work) to workers who will now work with more capital.

There is a third part, namely the role of intergenerational redistribution initially clarified in Diamond's (1965) classic paper on government debt and illustrated in Auerbach and Kotlikoff (1987).

When it comes to reducing corporate taxes, regardless of where they are reduced, and the loss of revenue is made up by taxes on wages, this policy induces, globally speaking, a redistribution from the young to the old. This, in turn, leads to more global consumption, less saving, and less future capital formation than would otherwise be true. The opposite effect occurs when the loss of corporate tax revenues is made up via higher consumption taxes. In this case, the global elderly face a larger remaining lifetime tax burden.

The reason that placing a relatively larger burden on the elderly matters to long-run capital formation in this and any other life-cycle model is that the elderly have higher propensities to consume. Hence, redistribution away from them to younger and, indeed, future cohorts means taking from spenders and giving to savers, which, in turn, means more global saving and investment.

Hence, when the U.S. switches from corporate taxation to higher wage taxation, although this leads to a permanently higher level of capital in the U.S., it leads, over time, to less total capital globally than would otherwise be true. The opposite general equilibrium story arises if the elimination of the U.S. corporate tax is financed by higher consumption taxes in the U.S. On balance, this shifts more taxation up the current age chain as can be seen by considering the taxes paid by the model's oldest age group, those who survive to age 90. For these households, the corporate income tax reduces their remaining consumption opportunities by limiting their net return on their wealth. But when this tax is replaced by a tax on consumption, all of their terminal wealth, principal plus its return, is, in effect, hit by the consumption tax when they spend these resources on their last supper.

The fourth and, arguably, most interesting effect underway in this paper reflects the distortionary aspect of the U.S. corporate income tax. Were Mintz and Chen's 35 percent effective marginal U.S. corporate income tax rate applied to all corporate income with no write offs of any kind apart from economic depreciation, it would produce roughly 2.7 times more revenue than is actually being collected. The revenue shortfall, which is not unique to the U.S., reflects a range of explicit and implicit corporate tax breaks, including the indefinite deferral of foreign-source income, accelerated depreciation, bonus depreciation, and transfer pricing schemes. Our model accommodates these inframarginal tax breaks via lump-sum subsidies to U.S. households in proportion to their ownership of assets.

In combination, the high marginal corporate tax rate and the very significant inframarginal rebate of the U.S. corporate tax makes the tax, in good part, a distortion, rather than a source of revenue. This distortion leads to an inter-regional misallocation of the global capital stock, placing more capital in less productive regions. This lowers wages of U.S. workers, who end up with less capital to work with, and raises them for foreign workers who end up with more capital to work with. Eliminating this distortion helps explain some of the welfare gains accruing to current and future U.S. generations. Foreign nationals also experience some of these efficiency gains via a higher net return on their assets.

Given the very significant expansion of the economy, one might think that eliminating the corporate income tax might pay for itself. But this turns out not to be the case. When the model's progressive wage tax is used to cover, as needed, the average wage tax rate rises by 3 percentage points initially compared to its baseline path value. Over time, the percentage difference declines to .7 percent.

When the model's consumption tax is used, as needed, its rate also rises by about 3 percent short term and by .9 percent long term. In the wage-tax finance case, the rise in worker's lifetime wages produces an income effect that more than offsets the loss in their corporate tax's inframarginal subsidy. This net positive income effect leads them to cut back on their labor supply, which, in turn, necessitates high tax rates to both collect the revenue previously generated by the wage tax as well as the new revenue needed to cover the loss of corporate tax revenue.

In the consumption-tax finance case, the loss in the corporate tax's inframarginal subsidy leads older, particularly retired agents, to cut their consumption. This, in turn, reduces the consumption tax base, necessitating a higher consumption tax rate to both collect the revenue previously generated by the consumption tax as well as the new revenue needed to cover the loss of corporate tax revenue.

This is not to understate the economy's remarkable simulated reaction to eliminating the corporate income tax. In the wage-tax finance case, for example, were labor supply not to fall, the economy's expansion from the corporate tax cut might well pay for half of the revenue loss.

We also simulate the impact of raising foreign corporate marginal effective tax rates to the U.S. level. This visits modest welfare losses to existing older U.S. generations, but modest welfare gains to current and future U.S. workers. There is a countervailing sizeable welfare loss to foreign workers, current and future, as they are forced to wave goodbye to some of the capital with which they were working.

Our third experiment entails eliminating the corporate income tax in all five regions. If wage-tax finance is used to cover revenue losses in each region, there are moderately large welfare gains to existing U.S. retirees and current and all workers born through 2060. Those born after 2060 are worse off, but not much worse off. In the foreign regions, there are sizeable welfare gains for initial older generations, modest losses for current young workers, sizable gains for workers born in the next few decades, but moderate losses for those born toward the turn of the century. For the other regions, the picture is different. In China's, India's, and Japan's case, the gains to existing elderly are very large. But the losses to today's and all of tomorrow's workers are also very substantial.

When we eliminate all corporate income taxes globally, but use consumption taxes in each region to offset revenue losses, we get modest losses to existing elderly Americans, but remarkably sizable gains to today's and tomorrow's workers. These results are qualitatively similar, but less pronounced in Japan and Europe. For India and particularly China, this policy has detrimental to very detrimental impacts on most generations.

Our forth policy experiment entails the elimination of all foreign corporate income taxes with no change in the U.S. corporate tax. Consider first foreign use of wage taxation to make up revenue loses. This is moderately good news for initial older Americans, but relatively bad news for current and future U.S. workers who end up with even less capital to work with. Current and future Europeans, except those born far in the future, are estimated to experience welfare gains. For the Japanese, Indians, and Chinese, however, the elderly are made substantially better off, but current and future workers face lower lifetime welfare.

With consumption-tax finance, the current U.S. elderly are substantially better off, while most young and future American workers suffer moderate welfare losses. For Europe, Japan, India, and China, the initial elderly get hit either hard or very hard, but most young and future workers, particularly those born after 2030, are significantly better off.

Our last policy experiment entails corporate tax-base broadening, specifically reducing, rather than eliminating the corporate marginal tax rate, but also eliminating all infra-marginal tax breaks so that the marginal and average tax rates are the same. Unlike eliminating the corporate income tax, this base-broadening policy does pay for itself. I.e., it's revenue neutral, roughly speaking, over the economy's new transition path insofar as the tax rate, be it the wage or consumption tax rate, that let adjust to maintain debt-to-GDP ratios constant over the economy's transition path is slightly higher in the short run and slightly lower in the long run. In the case of wage-tax finance, base-broadening produces a Pareto improvement, for American cohorts, but not, as one would expect, for cohorts in all other regions. Under consumption tax finance, it comes very close to producing a Pareto improvement in the U.S.[1] For both the wage and consumption tax simulations, the roughly revenue neutral corporate tax rate is 9 percent. The baseline simulation entails a marginal U.S. tax rate of 35 percent and an average U.S. tax rate of 14 percent (as close as we could get to the actual 13 percent observed U.S. average rate while still hitting our other calibration targets). The fact that we can lower the marginal rate from 35 percent to 9 percent, which is 36 percent lower than the initial 14 percent average rate, and still maintain rough revenue neutrality reflects the policies' impacts on growing the U.S. economy primarily by attracting capital from abroad.

The following sections review the literature on corporate tax reform, present our model, discuss our calibration, present results, and conclude.

2 Model

We start with demographics and then clarify household economic behavior, firm behavior, the macroeconomic equilibrium, and fiscal institutions.

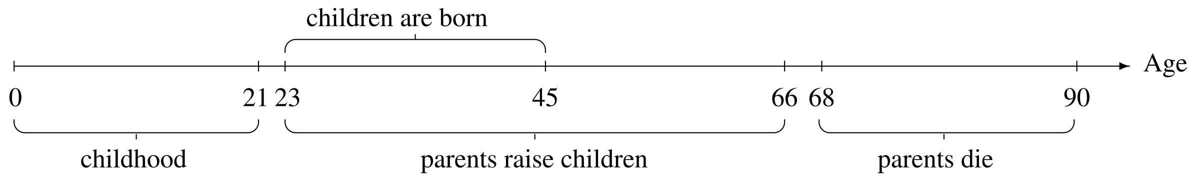
2.1 Demographics

Agents in each region live at most to age 90. Consequently, there are 91 generations with surviving members at any point in time. The life cycle of a representative agent is described in Figure 1. Between ages 0 and 20 our agents are non-working children supported by their parents. At 21 our agents go to work and become individual households. Between ages 23

[1] To achieve a Pareto or near Pareto path for these two simulations for the U.S, these base broadening simulations required some additional adjusting of the path of U.S. government pensions (Social Security) to ensure they were closer to the no-policy change transition path values.

and 45 our agents give birth each year to fractions of children. An agent's first-born children (fractions of children) leave home when the parents are age 43 and the last-born leave when the agents are age 66. Our agents die between ages 68 and 90. The probability of death is 1 at age 91. Children always outlive their parents, meaning that parents always outlive grandparents.[2]

Figure 1: The individual life-cycle



We denote the population vector for year t by $N(a, t, k)$, where $a = 1, \ldots, 90$, $k = 1, 2$. Agents age are born in a and k is the skill class. Since agents younger than 23 have no children and those over 65 have only adult children, the total number of children of an agent age a with skill k in year t $KID(a, t, k) = 0$ for $0 \leq a \leq 22$ and $66 \leq a \leq 90$. Agents between these ages have children. Take, for example, a 30 year-old agent. Such an agent has children who were born in the years since she/he was 23. In year t, these children are between age 0 and 7. The $KID(\cdot)$-function sums the total number of children of the respective parent skill-class generation and divides it by the total number of parents of age a in year t who belong to skill k. This function takes into account that the family's age structure will change over time due to changes over time in age-specific fertility.[3]

Immigration is set exogeneously in our model to match population projections. [4] In each year new immigrants in each skill and age group arrive with the same number and age distribution of children and the same level of assets as natives of the identical skill and age. Once they join a native cohort, they experience the same future age-specific fertility and mortality rates as native-born cohort members.

[2]If a parent reaches age 90, his or her oldest children will be 67. These are children who were born when the parent was age 23.

[3]This approach permits the distribution of births by the ages of parents to change over time – an important improvement relative to the birthing process stipulated in Kotlikoff, Smetters and Walliser (2007).

[4]Specifically, we do not consider endogenous migration decisions, including return-migration, and assume that all migrants come from other regions of the world not included in the model.

2.2 The household sector

The model's preference structure is represented by a time-separable, nested, CES utility function. Remaining lifetime utility $U(l,t,k)$ of a generation age l at time t and who belong to skill-class k takes the form

$$U(l,t,k) = V(l,t,k) + H(l,t,k), \tag{1}$$

where $V(l,t,k)$ records the agent's utility from her/his own goods and leisure consumption and $H(l,t,k)$ denotes the agent's utility from the consumption of her/his children.The two sub-utility functions are defined as follows:

$$V(l,t,k) = \frac{1}{1-\frac{1}{\gamma}} \sum_{a=l}^{90} \left(\frac{1}{1+\delta}\right)^{a-l} P(a,i) \left[c(a,i,k)^{1-\frac{1}{\rho}} + \varepsilon \ell(a,i,k)^{1-\frac{1}{\rho}}\right]^{\frac{1-\frac{1}{\gamma}}{1-\frac{1}{\rho}}} \tag{2}$$

$$H(l,t,k) = \frac{1}{1-\frac{1}{\gamma}} \sum_{a=l}^{90} \left(\frac{1}{1+\delta}\right)^{a-l} P(a,i) KID(a,i,k) c_K(a,i,k)^{1-\frac{1}{\gamma}}, \tag{3}$$

where $c(a,i,k)$ and $\ell(a,i,k)$ denote consumption and leisure respectively, and $i = t + a - l$. The children's consumption of skill-class k parents who are age a in period i is defined as $c_K(a,i,k)$, and the number of children supported by parents age a is $KID(a,i,k)$.

Since lifespan is uncertain, the utility of consumption in future periods is weighted by the survival probability of reaching age a in year i

$$P(a,i) = \prod_{u=l}^{a} [1 - d(u, u-a+i)], \tag{4}$$

which is determined by multiplying the conditional survival probabilities from year t (when the agent's age is l) through year i. Note that $d(l,t)$ is the mortality probability of an agent age l in year t. The parameters $\delta, \rho, \varepsilon$ and γ represent the rate of time preference, the intratemporal elasticity of substitution between consumption and leisure, the leisure preference parameter, and the intertemporal elasticity of substitution between consumption and leisure, respectively.

Given the asset endowment a(l,t,k) of the agent in year t, the lifetime budget constraint is defined by:

$$\text{a}(l+1,t+1,k) = \big[\text{a}(l,t,k) + I(l,t,k)\big](1+r(t)) + w(k,t)E(l,t)\big[h(l,t) - \ell(l,t,k)\big] \\ - T(l,t,k) - c(l,t,k) - KID(l,t,k)c_K(l,t,k), \quad (5)$$

where $r(t)$ is the pre-tax return, $I(l,t,k)$ denotes inheritances received in year t. The budget incorporates our assumption that annuity markets are not operative. Instead, agents who die leave unintended bequests. Private assets of all agents who died are aggregated and then distributed according to an exogenous age-dependent distribution scheme $\Gamma(l)$ to all agents aged between 21 and 49. To be precise, the inheritance of agents age l in year t is given by:

$$I(l,t,k) = \Gamma(l)\frac{\bar{A}(t,k)}{N(l,t,k)} \qquad \text{where} \quad \sum_{l=21}^{49}\Gamma(l) = 1. \quad (6)$$

The numerator in this ratio measures the aggregate assets of skill-class k agents who die in year t. A share $\Gamma(l)$ of these bequests is dedicated to inheritants aged l of the same skill class. This share is split equally among all agents of the same age group.

As in Altig et al. (2001) and Kotlikoff, Smetters and Walliser (2007), we model technical progress as permitting successive generations to use time more effectively, whether in working or enjoying leisure. We implement this assumption by having the time endowment of successive generations in each region grow at the common rate λ. Denote $h(a,i)$ as the time endowment of an agent age a at time i, then

$$h(a,i) = (1+\lambda)h(a,i-1). \quad (7)$$

This treatment of technical change ensures eventual convergence of the economy to a long-run steady state. Other formulations of technical change, such as making it labor-augmenting, preclude a steady state given the model's preferences. And our iterative method for determining the model's equilibrium transition path requires the terminal conditions provided by the economy's long-run steady state.[5]

[5] Note that assuming a higher rate of technical progress is isomorphic to assuming a higher rate of fertility;

Gross labor income of an agent in year i is derived as the product of her labor supply and wage rate. The latter is the product of the skill-specific wage rate $w(k,i)$ in year i and age- and year-specific productivity per time-unit $E(a,i)$.

Net taxes, $T(l,t,k)$, include consumption, capital income, and progressive wage taxes as well as social security contributions net of pension, disability, and health benefits received in the form of transfer payments. Given the assumed ceiling on payroll tax contributions, payroll tax rates, both average and marginal, differ across agents. Each agent's pension benefits depend on her pre-retirement earnings history, while healthcare and disability transfers are provided on a per capita basis. Finally, households also receive lump-sum rebates for corporate tax payments.

Given taxes, interest rates $r(i)$, and wages $w(k,i)$, agents maximize utility (1) subject to the intertemporal budget constraint (5) and the constraint that leisure in each period not exceeds the time endowment (i.e. $\ell(l,t,k) \leq h(l,t)$). They do this by choosing their leisure and consumption demands, i.e., $\ell(l,t,k), c(a,i,k)$ and $c_K(a,i,k)$.

Given individual consumption and leisure, agents' asset levels are derived from (5). Aggregate values of assets, private consumption goods, and labor supply obey

$$A(t+1) = \sum_{k=1}^{2}\sum_{a=21}^{90} \underbrace{\mathrm{a}(a+1,t+1,k)N(a,t,k)}_{\bar{A}(a+1,t+1,k)}, \tag{8}$$

$$C(t) = \sum_{k=1}^{2}\sum_{a=21}^{90} \big[c(a,t,k) + KID(a,t,k)c_K(a,t,k)\big]N(a,t,k), \tag{9}$$

$$L^s(k,t) = \sum_{a=21}^{90} E(a,t)\big[h(a,t) - \ell(a,t,k)\big]N(a,t,k). \tag{10}$$

Since households die at the beginning of each period, we aggregate across all agents alive at the end of the prior period to compute $\bar{A}(a+1,t+1,k)$, which is used in the calculation of bequests (see (6)). Total assets of agents alive at the end of period $t+1$ satisfies

$$\mathcal{A}(t+1) = \sum_{k=1}^{2}\sum_{a=21}^{90} \mathrm{a}(a,t+1,k)N(a,t+1,k), \tag{11}$$

i.e., having more people is equivalent to having fewer people who each have more time. Since fertility rates don't enter into production functions, we circumvent the problem of steady-state incompatibility.

which includes the assets and numbers of period $t+1$ immigrants.

2.3 The production sector

Each region produces one good. Aggregate output in period t $Y(t)$ is produced via a Cobb-Douglas technology that uses capital $K(t)$ and skill-specific labor $L(k,t)$, i.e.,

$$Y(t) = \phi K(t)^{\alpha} L(1,t)^{\beta_l} L(2,t)^{\beta_h} \tag{12}$$

where α corresponds to the share of capital in production, β_l corresponds to the share of low-skilled labor input, β_h corresponds to the share of high-skilled labor input, and $\alpha+\beta_l+\beta_h=1$. The parameter ϕ references total factor productivity.

The assumption of constant returns to scale is standard and required for the ultimate convergence to a steady state, which is needed to solve our model's transition path. But the assumption is also strong. Entertaining increasing returns to scale, which China, at least, appears to be exploiting in its development success must, unfortunately, remain a goal for future work.

Corporate tax revenues are defined as

$$T^k(t) = \tau^k(t)[Y(t) - \sum_{k=1}^{2} w(k,t)L(k,t) - \delta_K K(t)] \tag{13}$$

where $\tau^k(t)$ is the corporate tax rate. Thus, we get the following factor prices

$$\begin{aligned} w(1,t) &= \beta_l \phi K(t)^{\alpha} L(1,t)^{\beta_l - 1} L(2,t)^{\beta_h} & (14) \\ w(2,t) &= \beta_2 \phi K(t)^{\alpha} L(1,t)^{\beta_l} L(2,t)^{\beta_h - 1} & (15) \\ r(t) &= (1-\tau^k(t)) \left(\alpha \phi K(t)^{\alpha-1} L(1,t)^{\beta_l} L(2,t)^{\beta_h} - \delta_K\right). & (16) \end{aligned}$$

2.4 The government sector

Each region's government issues additional debt, $\Delta B(t)$, and collects taxes from households and companies to finance outlays for general government expenditures $C^g(t)$, general-revenue financed social benefits $SB(t)$ (i.e. pension, healthcare, and disability benefits) and interest on existing debt:

$$\Delta B(t) + \sum_{k=1}^{2}\sum_{a=21}^{90} T(a,t,k)N(a,t,k) + T^k(t) = C^g(t) + \varrho SB(t) + r(t)B(t), \tag{17}$$

where ϱ denotes the share of these transfer payments that are financed by general revenues.

Note that in order to generate realistic marginal and average corporate tax rates a fraction of gross corporate tax revenues $T^k(t)$ is rebated to households and included in $T(a,t,k)$ as a lump-sum transfer. The progressivity of wage taxation is modelled after Auerbach and Kotlikoff (1987), with marginal wage tax rates rising linearly with the wage-tax base. $PY(t)$ defines the aggregate payroll-tax base, which differs from total labor earnings due to the ceiling on taxable wages. This ceiling is fixed at 290, 200, 150, 300, and 300 percent of average income in the U.S., Europe, Japan+, China, and India, respectively. Average employer plus employee payroll tax rates $\hat{\tau}^p(t)$ for the pension, healthcare, and disability transfer programs are determined based on each region's transfer-program-specific budget, taking into account general revenue finance, i.e.

$$\hat{\tau}^p(t)PY(t) = (1-\varrho)SB(t), \tag{18}$$

Due to contribution ceilings, individual payroll-tax rates can differ from the average payroll tax rate. Above the contribution ceiling, marginal social security contributions are zero and average social security contributions fall with the agent's income. To accommodate this non-convexity in the budget constraint, we assume that the highest earnings class in each region pays payroll taxes up to the relevant ceilings, but faces no payroll taxation at the margin.

If an agent retired in year i at the exogenously set retirement age $\bar{a}(i)$, her pension benefit $Pen(a,t,k)$ in year $t \geq i$ when she is age $a \geq \bar{a}(i)$ is assumed to depend linearly on her average earnings during her working life $\bar{W}(i,\cdot)$:

$$Pen(a,t,\cdot) = \nu_0 + \nu_1 \times \bar{W}(i,k). \tag{19}$$

The region-specific parameters ν_0, ν_1 for the U.S., Europe and Japan+ were chosen to match replacement rates reported in OECD (2007). In China and India, only a fraction of public employees are covered by the public pension system. But spending on civil service pensions in China and India amounts to 2-3 percent of GDP (see World Bank 2005). Since we do not distinguish between covered and non-covered employment in our model, we assume a pension-replacement rate of 40 percent of average pre-retirement earnings. The rate is far too low for covered employees and far too high for non-covered employees, but it results in realistic aggregate pension expenditures in the two countries.

General government expenditures $C^g(t)$ consist of government purchases of goods and services, including educational expenditures and health outlays. Over the transition, we keep age-specific per capita purchases fixed in efficiency terms so that aggregate expenditures adjust due to population dynamics.[6]

Age-specific health outlays per capita also grow with GDP per capita. However, in the U.S., Europe, and Japan+ we assume an additional growth rate of 2.0 percent per year during the first 20 years of the transition and of 1.0 percent between 2025 and 2035.[7] In China and India, age-specific healthcare outlays per capita are assumed to grow at a faster pace: During the first 40 years of the transition there is an additional annual growth rate of four percent. Note that while we treat 80 percent of health benefits as government consumption and 20 percent as fungible transfers to households, disability benefits are modeled exclusively as fungible transfers to households.

During the transition, the governments in the U.S., Europe, Japan+ and India maintain their initial debt-to-output ratios over time. In these regions we keep the ratio of wage-tax to consumption-tax revenue fixed each year and balance the government's annual budget (17) by adjusting the intercept in our linear equation determining the average wage-tax rate as well as the consumption-tax rate. In the case of China, we fix the initial wage and consumption tax rates and adjust government's debt to balance the annual budget during the first 10 years of the transition. After this period we adopt the same policy as in the other regions, i.e. maintaining the debt-to-output ratio over time and endogenously adjusting the wage and consumption tax

[6]Implicitly, we assume that additive separability of preferences in public consumption goods. But since the latter is constant during the transition, we can omit it in (1).

[7]As shown in Hagist and Kotlikoff (2009), this is a rather conservative assumption concerning future growth in benefit levels.

rates.

2.5 Solution algorithm

Given initial individual asset holdings, our initial guesses of tax rates/tax function parameters as well as of the time paths of capital stocks, wage rates and marginal products of capital, we first calculate the world interest rate from the first order condition in the US. Given the new path for the interest rate, we can update the capital stocks in all regions except the U.S. Afterwards we solve for household consumption, saving, and labor supply decisions.

Aggregating individual labor supplies in each year provides new time paths of aggregate region-specific labor supplies. Next we we aggregate agent-specific assets at each date to determine a time-path of aggregate world-wide asset holdings. Given capital demand in Europe, Japan+, China and India, we can calculate the new capital stock in the U.S. as the difference between world-wide asset holdings and capital demand in the remaining regions. The new values for the aggregate supplies of capital in the U.S. and labor in each region in each year are then weighted with the initial guesses of these variables to form new guesses of their time paths.

The next step in our overall solution algorithm is to calculate new wage rates and uses the annual revenues and Social Security benefit payments implied by the household decisions to update annual tax rates/tax parameters. We also update corporate tax transfers to households.

The algorithm then iterates until the region-specific time paths of capital stocks and labor supplies converge to a fixed point.

We give our economy 300 years to reach to a steady state. In fact, our model reaches a steady state to many decimal places decades prior to year 300. It also converges very tightly around the equilibrium transition path.

3 Calibration

The following sections highlight our model's calibration. Fehr et al. (2008) provide a detailed discussion of our population projections and the specification of production, preference and policy parameters.

3.1 Population projections

This section describes our data set for the benchmark population in the year 2000 and the transition.[8] The main data source for our population data is the medium variant of the United Nations population projections (UNPD 2007). In the case of Taiwan we had to rely on national population statistics provided by the Statistical Office (CEPD 2007). However, part of the raw data was only supplied in aggregates. In addition, the specific structure of our population model imposed certain restrictions on our data set.

To specify the current and future demographic structure of each region we start with year-2000 age-specific population and age-specific net-immigration counts. Each cohort in our model is split into two skill classes k. We assume for the U.S., Europe and Japan+ that 30 percent of each cohort belong to the high-skilled class and the remaining 70 percent to the low-skilled class. This is in line with figures on educational attainment from Barro and Lee (2001) for the three-region agglomerate as well as with the latest figures for the U.S. from the U.S. Census Bureau (2008). In China and India, we assume that 25 percent belong to the high-skilled class, and the rest are low-skilled.

Given the population age structure in year 2000 as well as projected future fertility, mortality, and net immigration rates, we compute the population vector $N(a,t,k)$ for the years t between 2001 and 2050. After year 2050, fertility rates are endogenously adjusted in line with zero population growth and a stable population age structure.

Table 1 compares the actual projected and simulated changes over time in fertility rates, life expectancies, total populations and population age structures. Note that the model does remarkably well in matching each of the demographic projections in each country. Due to relatively high fertility and net immigration, the U.S. population is projected to increase from 304 million in 2008 to 404 million in 2050. In the EMU, the population falls until mid-century from 312 to 308 million. In Japan+, the population falls from 207 million to 181 million. In contrast, the

[8] Although the economic model starts in year 2008, we chose year 2000 as the initial year for the population projections due to data availability.

Table 1: Comparing actual and simulated population projections

Country	U.S.		EU		Japan+		China		India	
Year	2008*	2050	2008*	2050	2008*	2050	2008*	2050	2008*	2050
Fertility Rate										
Model	2.06	1.85	1.51	1.82	1.55	1.75	1.66	1.85	2.80	1.85
Official	2.05	1.85	1.50	1.85	1.53	1.73	1.73	1.85	2.81	1.85
Life Expectancy at Birth										
Model	82.0	83.8	82.6	84.6	84.5	87.3	76.5	80.2	64.6	75.3
Official	78.2	83.1	79.7	84.3	81.2	86.7	73.0	79.3	64.7	75.6
Total Population (in Millions)										
Model	303.6	403.6	312.0	308.3	206.9	181.4	1314.2	1401.5	1184.9	1643.9
Official	299.8	402.4	312.2	312.9	205.6	172.6	1313.0	1408.8	1134.4	1658.3
Age Structure (in Percent of total Population)										
0-15 Years										
Model	20.3	17.8	15.6	15.0	14.7	13.7	20.2	16.3	32.0	18.2
Official	20.8	17.3	15.6	14.5	15.5	10.7	21.6	15.3	33.0	18.2
15-64 Years										
Model	67.4	62.0	67.0	57.5	64.2	53.1	72.9	61.6	63.4	66.1
Official	66.9	61.7	66.8	55.9	68.5	52.6	70.7	61.0	62.0	67.3
65-90 Years										
Model	12.4	20.1	17.4	27.5	21.2	33.2	6.9	22.0	4.6	15.7
Official	12.3	21.0	17.6	29.6	16.0	36.7	7.7	23.7	5.0	14.5

* Year 2005 in the official population data

Chinese population increases from roughly 1.31 billion to 1.40 billion, and the population in India increases from 1.18 billion in 2008 to 1.64 billion in 2050; i.e., India becomes the most populous country in the world.

As one would expect, the population share of those 65 and older increases in all five regions. There are, however, major differences in the aging process across the regions. First, whereas the share of the working-age population increases in India until 2050, it decreases modestly in the U.S., but more substantially in Europe, China and Japan+. Second, the share of elderly increases to a much larger extent in Japan+ and China compared to India, Europe, and the U.S.

3.2 Production, preference and policy parameters

Table 2 shows the parameters of our production technology.

Table 3 reports values of preference and policy parameters. The time-preference rates in the

Table 2: Production Technology Parameters

	Symbol	Value
Capital share in production	α	0.35
Share of specific labor inputs		
Low- and medium-skill ($k = 1$)	β_l	0.40
High-skill ($k = 2$)	β_h	0.25
Technology coefficient	ϕ	1.68
Depreciation rate	δ_K	0.075

five regions were set to match the model's 2008 region-specific ratios of private consumption to GDP in the developed regions. Given this time preference rate, we increased general public expenditures in order to reduce private consumption in China and India. The time preference rate in China is assumed to grow to the U.S. value of 0.01 during the first 25 years of the transition path. The intertemporal elasticity of substitution, the elasticity of substitution between consumption and leisure, and the leisure preference parameters are taken from Kotlikoff et al. (2007).

Table 3: Preference, Productivity and Policy Parameters

	Symbol	U.S.	EU	Japan+	China	India
Time preference rate	δ	0.01	-0.02	-0.02	-0.07	-0.026
Intertemporal elasticity of substitution	γ			0.25		
Intratemporal elasticity of substitution between consumption and leisure	ρ			0.4		
Leisure preference parameter	ε			1.5		
Shift parameter for productivity	ξ	1.00	0.60	0.47	0.06	0.035
Technical progress	λ			0.01		
Capital tax rate (in %)	τ^r	11.0	14.0	8.0	3.0	3.0
Debt (in % of national income)	B/Y	70.0	76.0	146.0	21.0	72.0
Age of retirement	$\bar{a}$	63	60	60	60	60

The age- and year-specific productivity profile of an age a individual in period i

$$E(a, i) = \xi(i) e^{4.47+0.033(a-20)-0.00067(a-20)^2} (1 + \lambda)^{a-21},$$

is taken – apart from the term $\xi(i)$ – from Auerbach and Kotlikoff (1987). Note that the higher is the rate of technological change, λ, the steeper is the age-ability profile. This captures the role of technical progress in influencing not just the level, but also the shape of longitudinal age-earnings profiles. The labor productivity parameter ξ is normalized at 1 for the U.S. The initial values of this parameter for the other four regions are set to match the 2008 relative values of GDP and are gradually raised to 1 for each successive cohort of new worker cohorts over time. For Europe and Japan+ we assume this adjustment occurs over the 10 years between 2009 and 2018. For China we assume it takes 15 years. Since during the last four decades India made little progress in increasing even elementary educational attainment, see Bosworth and Collins (2008), this period in India is set to 75 years. Once the phase-in period is complete, it takes another 40 years until all cohorts of workers have the same labor productivity.

The model's debt-to-GDP levels were set according to total government debt reported by the World Bank (2010). The maximum ages of retirement are taken from OECD (2006) for the U.S. and Europe and from SSA (2010) for Japan+, China, and India. We calibrated the endogenous consumption and wage tax rates and set the personal capital income tax rates in order to yield the structure of indirect and direct tax revenues reported in OECD (2010b) for the U.S., the Europe, and Japan+ and in IMF Fiscal Affairs Department (2010) for China and India. Our wage tax systems are assumed to be progressive, with the parameters of each region's tax system set to generate what appears to be realistic average and marginal tax rates.

In calibrating health expenditures in our model, we apply the Japanese age-specific government healthcare expenditure profile for Japan+ as well as China and India. In the case of Europe, we use the German profile. For the U.S. our profile comes from Hagist and Kotlikoff (2009). We assume uniform disability expenditures by age for ages between 21 and 64 in the U.S., Europe, and Japan+. We don't model separate disability programs for China and India. In the case of the U.S., Europe, and Japan+, total social insurance outlays for pensions, disability, and health, measured as a share of GDP are set to accord with the values reported in OECD (2010c). In calibrating social security contribution rates, we assume that 75 percent of overall healthcare benefits in the U.S. and 25 percent in Japan+ are financed by general taxes. In Europe, we assume that 20 percent of the outlays of all three social security systems (health, pension, disability) are financed by general taxes. Calibration of social insurance outlays in

China and India is based on ILO (2010).

We use the German age-specific education profile (due to data availability) for all regions in the model and rescale it to get realistic education outlays in year 2008 in each region (see below). In addition to these parameter values, our model requires an initial distribution of assets by age and income class for each region. Our model requires an initial distribution of assets by age and income class for each region. These profiles are adopted from each region's data[9]. We scaled these age-asset profiles to produce realistic capital-output ratios in our five regions.

4 Findings

4.1 Initial equilibrium and baseline path

Table 4 compares simulated with observed macro variables in the initial equilibrium in 2008. The official GDP figures are taken from World Bank (2010). The model's values for consumption, government purchases, and investment come very close to their official counterparts. Note, however, that the higher values for government expenditures in China and India in our model come from the assumed larger government sector needed, as previously indicated, to generate realistic ratios of private consumption to national income. Our model matches the very high rate of private consumption in the U.S. and the high rates of domestic investment in China and India. We were not, however, able to reach such high investment rates as reported in the official data. The model does very well in matching relative GDP levels (measured in PPP). The disaggregation of public goods is based, in part, on World Bank (2010) and OECD (2010a) data on education outlays and, in part, on the aforementioned assumption that 80 percent of government health expenditures is government consumption. General public expenditures is calculated as a residual.

Our model's trade balances agree in sign, but not in size with actual trade balances, particularly

[9]Data on Japanese net worth were provided by Statistics Bureau Japan (2002) and are used for the profiles in Japan+, China and India. The European profiles were adjusted to German data provided by Reinhold Schnabel. U.S. data were derived from the 1998 Survey of Consumer Finances reported in Kennickell, Starr-McCluer and Surette (2000). The age-asset profiles for the specific income classes were scaled according to relative wealth in a steady-state run of our model.

Table 4: The year 2008 of the baseline path

	Model					Official				
	U.S.	EU	Japan+	China	India	U.S.	Europe	Japan+	China	India
Gross Domestic Product[a]										
Private consumption	72.6	57.8	59.6	39.0	60.3	71.2	56.4	56.0	36.8	58.1
Government purchases of goods and services	16.9	20.8	17.8	32.6	24.1	15.8	20.4	17.5	13.0	11.7
Domestic investment	18.9	16.3	12.9	24.6	22.9	18.0	22.2	25.3	42.5	35.6
Trade Balance	-8.4	5.1	9.7	3.8	-7.4	-5.1	1.0	1.2	7.7	-5.4
Current account	-6.5	4.5	8.9	2.8	-9.8	-4.9	-0.6	2.5	9.4	-3.0
Relative GDP levels (PPP)	1.00	0.70	0.42	0.55	0.24	1.00	0.78	0.41	0.57	0.24
Government Indicators[a]										
Social benefits	15.0	19.7	15.0	4.4	3.4	14.7	19.7	15.5	4.3	3.1
Social insurance revenues	9.5	15.8	13.6	4.4	3.4					
Payroll tax rate[b]	14.7	28.1	21.4	6.8	5.2	15.3		23.6	36.0	36.1
Tax revenues[a]	19.1	22.7	23.3	31.7	24.4	19.6	24.2	17.8	16.3	12.3
Direct taxes	11.7	11.0	12.5	8.3	7.8	11.8	11.8	9.3	4.7	6.3
Wage taxes	7.4	6.3	7.8	4.8	3.3					
Capital taxes	1.8	2.2	1.5	0.4	0.4					
Corporate taxes	2.5	2.4	3.3	3.2	4.1					
Indirect taxes	7.4	11.8	10.7	23.4	16.5	7.8	12.4	8.5	11.6	6.0
Wage-tax rates[b]										
Average	11.5	9.8	12.0	7.4	5.2					
Marginal	11.9	10.1	12.2	7.4	5.2					
Consumption tax rate[b]	10.2	20.4	18.0	60.1	27.4					
Capital-output ratio	2.3	2.5	2.4	2.6	2.4					

[a] In percent of GDP; [b] In percent.

in Europe and Japan+. Recall that our model excludes a large part of the world, so we would not expect not too much concurrence with respect to our model's trade balances and current accounts and those in the data. As already explained above, outlays of the social security systems were calibrated to yield the official values from OECD (2010c) and ILO (2010). The official contribution rates for pensions, health-care and disability were taken from SSA (2009) for the U.S. and from SSA (2010) for Japan+, China and India.[10] Obviously, our pension and health insurance contribution rates in China and India deviate from official figures. Our model assumes that all households in all regions are covered by the government's pension and health system. However, only about 20-30 percent of the people above the legal retirement age in China and India are effectively covered by public pensions and only about 6 percent of the population in India and about 24 percent of the Chinese population have formal health coverage (ILO 2010).

Note that we match the figures official figures for corporate tax revenues quite closely. The simulated revenues are already reported net of lump-sum rebates which amount to 60, 40 and 35 percent of the respective revenues in the U.S., Europe and Japan+. In China there are no rebates and in India 20 percent of revenues are rebated.

Table 5 reports the development of the macroeconomic variables as well as average effective wage tax rates in the baseline path from 2008 until 2060 for the five regions. All indexes for the five regions are expressed relative to year-2008 values in the U.S. The U.S. economy grows much faster over the coming decades compared to Europe and Japan+. While U.S. GDP expands by a factor of 2.4, GDP increases by a factor of only 1.9 in both Europe and Japan+ through 2060. These differences mainly reflect demographic differences, particularly the absolute population decline in Europe and Japan+.

However, due to the major productivity increases assumed to arise in China and India, today's developing regions become the largest economies by 2060. For example, China's GDP starts at 55 percent of the U.S. value, but overtakes the U.S. after 2020. In 2060, China's GDP exceeds the U.S. GDP by a factor of 2.8. Thanks to India's slower productivity growth, its GDP level in

[10] The official tax revenue data come from OECD (2010b) for U.S., Europe and Japan+ and from IMF Fiscal Affairs Department (2010) for China and India.

Table 5: Country-specific simulation results of the baseline path

	Year	GDP	Capital Stock	Labor Demand Low	Labor Demand High	Corporate Tax[a]	Wage Tax[a]	Pay-roll Tax[a]	Consump-tion Tax [a]
U.S.	2008	1.00	1.00	1.00	1.00	35.00	11.50	14.71	10.22
	2020	1.19	0.98	1.32	1.31	35.00	14.10	20.00	13.60
	2040	1.63	1.19	1.96	1.91	35.00	18.04	24.71	10.22
	2060	2.40	1.97	2.74	2.64	35.00	18.00	24.15	24.88
	2100	4.09	3.63	4.45	4.32	35.00	18.90	26.96	31.77
EU	2008	0.79	0.85	0.75	0.79	25.00	9.77	24.33	20.36
	2020	0.87	0.78	0.92	0.91	25.00	9.81	30.37	19.17
	2040	1.10	0.88	1.23	1.29	25.00	10.43	38.57	19.19
	2060	1.51	1.34	1.60	1.66	25.00	10.69	36.65	22.03
	2100	2.45	2.34	2.49	2.57	25.00	11.33	36.83	27.01
Japan+	2008	0.42	0.44	0.41	0.42	30.00	11.96	21.43	18.03
	2020	0.44	0.38	0.47	0.48	30.00	11.54	27.90	15.53
	2040	0.59	0.45	0.69	0.67	30.00	13.12	31.66	17.58
	2060	0.79	0.67	0.88	0.84	30.00	12.51	29.68	17.35
	2100	1.08	1.00	1.15	1.12	30.00	12.89	30.37	18.62
China	2008	0.55	0.62	0.58	0.45	20.00	7.37	6.80	60.08
	2020	1.34	1.25	1.59	1.16	20.00	6.58	8.31	56.94
	2040	4.11	3.42	5.36	3.57	20.00	6.71	14.01	46.27
	2060	6.62	6.10	8.45	5.14	20.00	7.01	6.00	41.57
	2100	9.48	9.41	11.54	7.18	20.00	7.38	12.50	46.04
India	2008	0.24	0.25	0.26	0.20	30.00	5.20	5.21	27.36
	2020	0.49	0.43	0.60	0.46	30.00	3.96	5.94	24.40
	2040	1.97	1.51	2.61	1.87	30.00	3.99	7.91	25.26
	2060	4.65	3.98	5.98	3.98	30.00	4.05	3.36	23.83
	2100	10.22	9.45	13.05	7.91	30.00	4.40	9.12	20.30

[a] in percent

2060 is only 70 percent of China's GDP. But nevertheless, India's GDP exceeds the U.S. level by a factor of 1.9. Together, China and India account for almost 71 percent of total 5-region GDP in 2060. In 2008, their share amounted to only 26 percent.

The growth of output can be explained, in part, by the growth of inputs as shown in Table 5. Capital stocks in each region grow almost in lockstep with the respective GDP. Equilibrium labor demand (and supply) rise both because of technical progress (the expansion of effective time available to successive cohorts) and changes in labor supply. In the other regions, this growth also reflects changes in labor productivity as successive new cohorts of workers gradually attain U.S. productivity levels. Consequently, effective labor supply increases very rapidly in China between 2008 and 2040 and in India between 2040 and 2060.

Table 6 decomposes each region's GDP into its components. It's clear that trade and current account deficits can be very sizeable for decades before they reverse their sign and that their pattern is not easily forecast, i.e., there are a host of complex, interconnected factors determining their time paths including inter-regional differences in saving behavior, demographics, and fiscal policies.

Table 6: GDP and its components in the baseline path

	Year	Consumption /GDP[a]	Investment /GDP[a]	Gov. Purchases /GDP[a]	Trade Balance /GDP[a]	Current Account /GDP[a]
U.S.	2008	72.6	18.9	16.9	-8.4	-6.5
	2020	67.1	13.8	18.6	0.6	0.5
	2040	57.8	15.2	22.3	4.7	-3.9
	2060	47.2	19.9	22.3	10.5	-7.7
	2100	38.7	17.9	22.5	20.9	-1.2
EU	2008	57.8	16.3	20.8	5.1	4.5
	2020	61.6	14.8	22.1	1.4	5.2
	2040	65.5	16.3	26.0	-7.8	0.0
	2060	58.5	20.3	27.0	-5.8	-3.7
	2100	50.6	19.3	26.9	3.2	-1.3
Japan+	2008	59.6	12.9	17.8	9.7	8.9
	2020	66.6	15.6	20.2	-2.4	1.3
	2040	66.9	15.3	22.7	-4.9	4.0
	2060	64.7	19.0	23.5	-7.2	-0.1
	2100	62.1	18.1	23.9	-4.1	-0.9
China	2008	39.0	24.6	32.6	3.8	2.8
	2020	36.5	31.2	31.8	0.4	-0.5
	2040	46.0	20.8	35.0	-1.8	1.3
	2060	53.5	21.3	30.4	-5.3	-0.3
	2100	50.9	19.7	31.4	-2.1	-3.7
India	2008	60.3	23.0	24.1	-7.4	-9.8
	2020	51.5	28.9	22.5	-2.9	-10.1
	2040	50.1	22.6	21.5	5.7	-0.7
	2060	53.9	22.7	18.2	5.2	5.6
	2100	68.7	19.1	18.9	-6.8	4.3

[a] in percent

Consider next how average effective wage tax rates evolve. As indicated in Table 5, this tax rate comprises the payroll tax rate, the average wage (labor income) tax rate, and the average consumption tax rate.[11] All five regions experience dramatic increases over time in tax rates. In the U.S., the average wage tax collected via the income tax rise from 11 percent to 18 percent between 2008 and 2060. Payroll tax rates rise from 15 percent to 24 percent, and consumption taxes, which also effectively tax labor supply, more than double, rising from 10 percent to 25 percent. The total effective average tax rate on labor supply equals the sum of the wage tax, the payroll tax, and the ratio of the consumption rate to 1 plus the consumption tax rate. In 2060, the total effective average tax on U.S. labor supply rises to 62 percent, compared with 35 percent in 2008. This is a larger percentage increase than in Europe, which starts with a 51 percent average rate and ends up in 2060 with an 65 percent average rate. In Japan+, the average effective wage tax rate rises from 49 percent to 57 percent.

These tax hikes can be explained as follows. First, all three regions have very significant pay-go social insurance programs whose benefits are disproportionately distributed to the elderly. Given the dramatic aging (see Table 1) now underway, one would expect major tax increases simply to finance these benefits. Second, healthcare benefit levels have risen and can be expected to continue to rise much faster than per capita GDP in each of the three regions. Recall that we are assuming for the U.S., Europe, and Japan+ a growth rate in healthcare benefit levels that is two percentage points higher than the growth rate of per capita GDP until 2025 and one percentage point higher for the following 10 years.

The consumption tax rate in China starts out extremely high, but declines through time thanks, in part, to the aging of China which helps expand the consumption tax base. The very high initial level of consumption taxation is our proxy means for capturing the Chinese government's ability to commandeer large shares of output and investment them. By 2060, the total effective average wage tax rate in China is 42 percent. For its part, India faces relatively moderate declines in its tax rates through time.

In modeling China's and India's fiscal finances, we assume that, over time, as the entire labor force becomes fully productive and as these fully productive generations retire, their higher

[11]Consumption tax rates are expressed here on a tax inclusive basis to make it comparable to payroll and wage tax rates.

earnings histories will translate into higher old age healthcare and pension benefits to be paid by the government. As indicated, we assume a very sizable growth rate in healthcare benefit levels (4 percentage points above the growth rate of per capita GDP) for the next four decades in these two regions. Our rationale is that these countries are starting out with very low levels of healthcare benefits; and their governments will face strong pressure from their populations to improve this situation.

Table 7: The Global Net (of Corporate Tax) Rate of Return and U.S. Wage Rates

	Interest	Wage Rates*	
Year	Rate	Low	High
2008	4.9	1.00	1.50
2020	7.0	0.90	1.36
2040	8.6	0.83	1.28
2060	7.2	0.88	1.37
2100	6.3	0.92	1.43

* at age 21 per unit of effective time

Changes in the global interest rate – the net of corporate-tax return to capital no matter where it is allocated together with the U.S. pre-tax wage rate are shown in Table 7. The general pattern is one of higher real interest rates and lower real wages through time.

Although population aging in a closed life-cycle economy would normally lead to capital deepening, as the ratio of elderly with assets accumulated for retirement increases relative to the number of workers. Such capital deepending would reduce real interest rates and raise real wages. But the economy being modeled here is open and experiencing (in China and India) rapid growth in labor productivity. Moreove, the aging that's arising is occuring in the context of ever greater intergenerational redistribution, which crowds out how much capital households bring into old age?

But why should more labor supply in China and India affect U.S. wage rates? The answer is through the global interest rate. If more labor in Asia relative to the amount of capital in use in Asia reduces the global interest rate, firms operating in the U.S. will substitute capital for labor and that will depress U.S. wages by enough to equate labor supply with labor demand.

Table 7 foresees a good-sized reduction in the real wages per unit of effective time of U.S. workers' wages between 2008 and 2060 – 12 percent for low-skilled workers and 9 percent for high-skilled workers.

4.2 Simulating the Elimination of the U.S. Corporate Income Tax

Table 8 shows year-specific changes (relative to their baseline values) of key variables from eliminating the U.S. corporate income tax starting in 2010. The figures not in parentheses are those from using consumption taxation to make up for lost corporate tax revenue. The figures in parentheses assume wage taxation is used to cover losses in corporate tax revenues.

To isolate the pure effects of eliminating the corporate income tax, the simulations assume the same path of government spending on consumption and transfer payments as arises in the baseline path of the economy. This is an important modeling decision. Were we, instead, to let government spending stay fixed as a share of GDP, our results would conflate the effects of tax reform with the impact of increasing government spending. Doing the later would understate the beneficial impact of eliminating the corporate income tax shown in Table 8.

As a glance down the table's columns indicates, the consumption- and wage-tax finance impacts are quite similiar except for changes in the consumption and wage tax rates themselves. First and foremost, eliminating the corporate income tax produces a very major increase in the capital stock – by almost one quarter in the short run, rising to over one third by 2030. This is fueled, in part, by capital inflows and, in part, by a higher rate of domestic saving in the immediate aftermath of the reform. GDP rises initially by 8 percent compared to its baseline value. It remains 8 to 10 percent higher than its baseline path values through 2050 and by 2100 is still 8 percent larger than it would otherwise have been. With wage taxes used to make up the loss in corporate revenue, the level of GDP is higher in some years than with consumption taxation.

Under consumption-tax finance, the consumption tax rate rises by 3.4 percentage points initially, but by only .9 percentage points in 2100. Under wage-tax finance, there is also a 3.4 percentage-point hike in the average wage tax rate and a .7 percentage point increase in 2100.

For the other regions of the world, the good U.S. economic news is bad news. They each

Table 8: Simulation Results of Eliminating U.S. Corporate Tax, Financed by Consumption (Wage) Tax

	Year	GDP[a]	Capital Stock[a]	Labor Demand[a] Low	Labor Demand[a] High	Corporate Tax Rate[b]	Consumption /GDP[b]	Investment /GDP[b]	Gov. Purchases /GDP[b]	Trade Balance /GDP[b]	Payroll Tax Rate[b]	Wage Tax Rate[b]	Consumption Tax Rate[b]
U.S.	2010	8.5 (7.9)	23.8 (23.2)	1.5 (0.7)	0.7 (0.2)	-35.0 (-35.0)	-7.4 (-6.4)	4.0 (3.9)	-1.3 (-1.2)	2.6 (1.8)	-1.3 (-1.2)	0.0 (3.4)	3.4 (0.0)
	2020	9.3 (8.9)	32.2 (31.3)	-0.8 (-1.1)	-2.2 (-2.1)	-35.0 (-35.0)	-5.0 (-4.8)	4.2 (4.1)	-1.6 (-1.5)	0.7 (0.6)	-2.3 (-2.3)	0.0 (3.1)	3.0 (0.0)
	2040	9.6 (9.8)	39.5 (39.3)	-3.2 (-2.9)	-5.0 (-4.3)	-35.0 (-35.0)	-0.4 (-1.4)	4.3 (4.3)	-1.9 (-2.0)	-2.1 (-1.5)	-3.0 (-3.1)	0.0 (1.8)	1.6 (0.0)
	2060	8.0 (8.3)	36.3 (36.4)	-4.2 (-3.9)	-5.8 (-5.3)	-35.0 (-35.0)	3.1 (1.9)	4.7 (4.6)	-1.6 (-1.7)	-4.5 (-3.8)	-2.1 (-2.2)	0.0 (1.1)	1.1 (0.0)
	2100	7.8 (8.0)	34.0 (34.1)	-3.6 (-3.5)	-5.0 (-4.8)	-35.0 (-35.0)	3.3 (2.8)	4.3 (4.2)	-1.6 (-1.7)	-3.9 (-3.7)	-2.2 (-2.2)	0.0 (0.7)	0.9 (0.0)
EU	2010	-3.6 (-3.5)	-11.1 (-10.8)	0.4 (0.4)	0.9 (1.0)	0.0 (0.0)	1.2 (1.0)	0.1 (-0.2)	0.8 (0.8)	-1.6 (-1.1)	1.0 (1.0)	0.3 (0.3)	0.4 (0.4)
	2020	-1.8 (-2.2)	-6.4 (-7.1)	0.4 (0.4)	1.0 (1.0)	0.0 (0.0)	0.5 (0.8)	0.2 (0.0)	0.4 (0.5)	-0.9 (-1.0)	0.8 (0.9)	0.1 (0.2)	0.2 (0.2)
	2040	0.1 (-0.3)	-1.1 (-1.9)	0.7 (0.5)	0.8 (0.7)	0.0 (0.0)	-0.7 (-0.3)	0.1 (0.1)	0.0 (0.1)	0.4 (0.0)	0.0 (0.2)	0.0 (0.0)	0.1(0.0)
	2060	0.5 (0.3)	0.4 (0.1)	0.5 (0.5)	0.5 (0.5)	0.0 (0.0)	-1.1 (-0.9)	0.0 (-0.1)	-0.1 (-0.1)	0.8 (0.7)	-0.3 (-0.2)	-0.1 (-0.1)	0.1 (0.1)
	2100	0.2 (0.1)	0.0 (-0.1)	0.3 (0.3)	0.3 (0.3)	0.0 (0.0)	-0.5 (-0.4)	0.0 (0.0)	-0.1 (0.0)	0.3 (0.3)	-0.1 (-0.1)	0.0 (0.0)	0.0 (0.0)
Japan+	2010	-3.9 (-3.6)	-11.5 (-11.0)	0.2 (0.5)	0.9 (0.9)	0.0 (0.0)	1.3 (1.1)	0.3 (0.0)	0.7 (0.7)	-1.8 (-1.3)	1.0 (0.9)	0.6 (0.7)	0.7 (0.8)
	2020	-1.8 (2.1)	-6.4 (-7.2)	0.4 (0.4)	0.8 (1.0)	0.0 (0.0)	0.5 (0.7)	0.2 (0.0)	0.4 (0.4)	-0.9 (-0.9)	0.7 (0.8)	0.3 (0.4)	0.4 (0.5)
	2040	0.2 (0.0)	-1.1 (-2.0)	0.7 (0.7)	1.0 (1.0)	0.0 (0.0)	-1.1 (-0.7)	0.1 (0.1)	0.0 (0.0)	0.7 (0.4)	0.0 (0.1)	0.0 (0.1)	0.2 (0.2)
	2060	0.8 (0.6)	0.6 (0.3)	0.7 (0.7)	0.7 (0.7)	0.0 (0.0)	-1.6 (-1.4)	-0.1 (-0.1)	-0.2 (-0.1)	1.3 (1.1)	-0.3 (-0.3)	-0.1 (0.0)	0.2 (0.2)
	2100	0.3 (0.3)	0.1 (0.0)	0.4 (0.4)	0.4 (0.4)	0.0 (0.0)	-0.8 (-0.7)	0.0 (0.0)	-0.1 (-0.1)	0.6 (0.6)	-0.1 (-0.1)	0.0 (0.0)	0.1 (0.1)
China	2010	-4.0 (-3.8)	-10.9 (-10.8)	0.2 (0.2)	0.4 (0.4)	0.0 (0.0)	0.3 (0.2)	-0.9 (-1.2)	1.3 (1.2)	-0.5 (-0.2)	0.3 (0.3)	0.3 (0.3)	2.0 (2.0)
	2020	-1.9 (-2.2)	-6.2 (-6.8)	0.4 (0.4)	0.7 (0.8)	0.0 (0.0)	-0.7 (-0.6)	-0.4 (-0.6)	0.6 (0.7)	0.1 (0.2)	0.2 (0.3)	0.1 (0.1)	1.5 (1.6)
	2040	-0.1 (-0.4)	-1.3 (-2.0)	0.4 (0.4)	0.6 (0.6)	0.0 (0.0)	-0.9 (-0.7)	0.0 (0.0)	0.0 (0.1)	0.4 (0.2)	0.0 (0.0)	0.0 (0.0)	0.4 (0.5)
	2060	0.4 (0.2)	0.3 (-0.1)	0.3 (0.3)	0.5 (0.4)	0.0 (0.0)	-0.9 (-0.7)	0.0 (0.0)	-0.1 (-0.1)	0.6 (0.5)	-0.1 (-0.1)	0.0 (0.0)	0.2 (0.2)
	2100	0.1 (0.0)	-0.1 (-0.2)	0.1 (0.1)	0.2 (0.2)	0.0 (0.0)	-0.2 (-0.1)	0.0 (0.0)	0.0 (0.0)	0.2 (0.1)	0.0 (0.0)	0.0 (0.0)	0.1 (0.0)
India	2010	-3.9 (-3.9)	-11.9 (-11.5)	0.0 (0.0)	0.5 (0.5)	0.0 (0.0)	0.5 (0.3)	-0.7 (-0.9)	1.0 (1.0)	-0.7 (-0.2)	0.3 (0.2)	0.3 (0.3)	1.4 (1.4)
	2020	-2.2 (-2.4)	-7.0 (-7.5)	0.3 (0.3)	0.2 (0.2)	0.0 (0.0)	-0.4 (-0.4)	-0.4 (-0.6)	0.5 (0.6)	0.1 (0.3)	0.2 (0.2)	0.2 (0.2)	1.1 (1.2)
	2040	-0.4 (-0.6)	-1.5 (-2.2)	0.3 (0.3)	0.4 (0.4)	0.0 (0.0)	-1.0 (-0.9)	0.0 (-0.1)	0.1 (0.1)	0.4 (0.4)	0.0 (0.0)	0.0 (0.0)	0.4 (0.5)
	2060	0.4 (0.3)	0.3 (-0.1)	0.4 (0.4)	0.6 (0.5)	0.0 (0.0)	-1.2 (-1.1)	0.0 (0.0)	-0.1 (0.0)	0.7 (0.6)	0.0 (0.0)	0.0 (0.0)	0.2 (0.2)
	2100	0.4 (0.3)	0. (0.1)	0.4 (0.4)	0.7 (0.7)	0.0 (0.0)	-0.9 (-0.9)	0.0 (0.0)	-0.1 (-0.1)	0.7 (0.7)	0.0 (0.0)	0.0 (0.0)	0.1 (0.1)

Changes to the respective baseline values in [a] percent or [b] percentage points.

experience an immediate 11 to 12 percent outflow of capital and a roughly 4 percent reduction in GDP. Their long-run output levels are, however, must less affected. Indeed, in 2100, GDP in the other four regions is within .4 percent of their baseline 2100 values.

Table 9 consider percentage changes in U.S. factor prices along the tax reform transition path. Again, the consumption-tax and wage-tax financed results are quite similar. The immediate impact is a 17 percent increase in the global net (of corporate tax) interest rate and a 7 percent increase in real wages of unskilled U.S. workers and an 8 percent increase in the real wage of skilled U.S. workers. Over time, the interest rate returns pretty close to its long-term value, whereas real wages ends up permanently higher – by 12 percent for unskilled U.S. workers and 13 percent for skilled U.S. workers. These changes in factor prices are beneficial to both the initial elderly and to young and future workers. This explains why the corporate tax's elimination can be a win-win for all Americans as shown in Table 10.

Table 9: U.S. Factor Prices when Eliminating U.S. Corporate Tax

		Interest[a]	Wage Rates[a,b]	
	Year	Rate	Low	High
Consumption Tax Finance	2010	17.3	7.0	7.9
	2020	8.6	10.3	11.8
	2040	2.0	13.1	15.3
	2060	0.1	12.6	14.6
	2100	0.3	11.8	13.5
		Interest[a]	Wage Rates[a,b]	
	Year	Rate	Low	High
Wage Tax Finance	2010	16.8	7.3	7.7
	2020	9.4	10.3	11.2
	2040	2.8	12.9	14.8
	2060	0.5	12.6	14.3
	2100	0.4	11.8	13.3

[a] Changes to respective baseline values in percent;

[b] At age 21 per unit of effective time

Consider first Table 10's wage-tax financed welfare changes. As is clear, all cohorts benefit, with those born after 2000 experiencing a huge 7 to 9 percent welfare gain depending on their skill group and their year of birth! Interestingly, the unskilled experience as large if not larger welfare gains than the high skilled even though their real wages don't necessarily rise by as much.

With consumption-tax finance, the welfare gains are slightly larger for younger and future cohorts. And there are welfare losses facing initial older generations, which can be close to 1 percent. But the gains to young and future generations are so large, that one could easily devise a compensation mechanism that ensured older generations did not lose from the elimination of the corporate income tax.

Table 10: Welfare Effects of Eliminating U.S. Corporate Tax [a]

	Birth Year	U.S. Income Class 1	U.S. Income Class 2	EU Income Class 1	EU Income Class 2	Japan+ Income Class 1	Japan+ Income Class 2	China Income Class 1	China Income Class 2	India Income Class 1	India Income Class 2
Consumption Tax Finance	1940	-0.70	-0.66	0.28	0.20	0.54	0.46	0.21	0.02	0.32	0.13
	1980	3.74	4.05	-1.52	-1.77	0.54	0.46	-2.18	-2.57	-2.43	-2.78
	2000	8.09	8.39	-1.23	-1.38	-1.91	-2.17	-1.50	-1.36	-1.83	-1.76
	2010	9.08	9.31	-0.63	-0.73	-0.89	-1.06	-0.69	-0.69	-1.14	-1.10
	2020	9.09	9.22	-0.26	-0.31	-0.43	-0.60	-0.24	-0.32	-0.70	-0.72
	2030	8.61	8.66	-0.20	-0.23	-0.33	-0.47	-0.17	-0.28	-0.54	-0.59
	2050	8.50	8.51	-0.32	-0.37	-0.45	-0.54	-0.18	-0.27	-0.47	-0.54
	2100	9.07	9.08	-0.30	-0.35	-0.44	-0.51	-0.13	-0.20	-0.36	-0.53
	Birth Year	U.S. Income Class 1	U.S. Income Class 2	EU Income Class 1	EU Income Class 2	Japan+ Income Class 1	Japan+ Income Class 2	China Income Class 1	China Income Class 2	India Income Class 1	India Income Class 2
Wage Tax Finance	1940	0.35	0.27	0.30	0.22	0.57	0.49	0.27	0.06	0.33	0.13
	1980	3.31	3.38	-1.51	-1.78	-1.94	-2.22	-2.09	-2.52	-2.51	-2.90
	2000	7.19	7.28	-1.36	-1.54	-1.68	-1.63	-1.57	-1.39	-1.99	-1.91
	2010	8.35	8.42	-0.76	-0.90	-1.06	-1.18	-0.81	-0.77	-1.27	-1.22
	2020	8.55	8.56	-0.34	-0.41	-0.55	-0.70	-0.33	-0.38	-0.79	-0.79
	2030	8.18	8.13	-0.22	-0.28	-0.39	-0.52	-0.20	-0.28	-0.59	-0.62
	2050	8.18	8.12	-0.34	-0.40	-0.47	-0.55	-0.18	-0.24	-0.48	-0.54
	2100	8.86	8.82	-0.32	-0.36	-0.45	-0.52	-0.15	-0.21	-0.37	-0.52

[a] HEV in percent of (remaining) lifetime resources

However, what's good for the goose, in this case, the U.S., may not be good for the gander, in this case, the other regions. As Table 10 shows, eliminating the U.S. corporate income tax makes foreign young and future generations worse off by, in some cases, as much as 3 percent. I.e., eliminating the U.S. corporate income tax is, to a significant extent, a beggar-thy-neighbor policy.

As already discussed above, the findings are based on Mintz and Chen's (2011) calculated effective marginal corporate tax rates. The estimates of marginal corporate tax rates are quite high. For this reason we simulate the baseline path and the corporate tax reform again using Devereux and Bilicka's (2012) effective marginal corporate tax rates of 23 percent for the U.S., 18 percent for Europe, 27 percent for Japan+, 16 percent for China, and 21 percent for India. applying the corporate tax estimates from policmodel and the marginal tax the U.S. rate at 35 percent. Table 11 documents that we find qualitatively identical, but quantitatively more limited impacts of the reform in this case.

Table 11: Welfare Effects of Eliminating U.S. Corporate Tax (Devereux/Bilicka)[a]

		U.S.		EU		Japan+		China		India	
	Birth	Income Class		Income Class		Income Class		Income Class		Income Class	
	Year	1	2	1	2	1	2	1	2	1	2
Consumption Tax Finance	1940	-0.46	-0.43	0.17	0.12	0.34	0.29	0.10	-0.02	0.16	0.05
	1980	2.17	2.37	-0.91	-1.06	-1.17	-1.34	-1.36	-1.60	-1.47	-1.69
	2000	4.78	4.99	-0.74	-0.83	-0.92	-0.95	-0.94	-0.86	-1.12	-1.08
	2010	5.35	5.53	-0.37	-0.43	-0.54	-0.65	-0.43	-0.43	-0.70	-0.68
	2020	5.33	5.44	-0.15	-0.18	-0.25	-0.36	-0.15	-0.20	-0.44	-0.45
	2030	5.03	5.09	-0.12	-0.14	-0.20	-0.28	-0.11	-0.18	-0.34	-0.37
	2050	4.96	4.99	-0.20	-0.23	-0.28	-0.33	-0.12	-0.17	-0.30	-0.34
	2100	5.30	5.32	-0.19	-0.21	-0.27	-0.31	-0.09	-0.13	-0.23	-0.32
		U.S.		EU		Japan+		China		India	
	Birth	Income Class		Income Class		Income Class		Income Class		Income Class	
	Year	1	2	1	2	1	2	1	2	1	2
Wage Tax Finance	1940	0.22	0.17	0.19	0.13	0.36	0.31	0.14	0.01	0.17	0.04
	1980	1.88	1.92	-0.90	-1.07	-1.19	-2.22	-1.30	-1.56	-1.52	-1.76
	2000	4.16	4.23	-0.81	-0.93	-1.02	-1.63	-0.99	-0.88	-1.22	-1.17
	2010	4.85	4.91	-0.45	-0.53	-0.65	-1.18	-0.51	-0.49	-0.78	-0.75
	2020	4.96	4.98	-0.20	-0.24	-0.33	-0.70	-0.21	-0.24	-0.49	-0.49
	2030	4.73	4.72	-0.13	-0.17	-0.24	-0.52	-0.13	-0.18	-0.37	-0.38
	2050	4.73	4.71	-0.21	-0.25	-0.30	-0.55	-0.12	-0.16	-0.30	-0.33
	2100	5.14	5.13	-0.20	-0.23	-0.28	-0.52	-0.10	-0.13	-0.23	-0.32

[a] HEV in percent of (remaining) lifetime resources

4.3 Alternative Corporate Tax Reforms

In this section we consider three other corporate tax reforms where we always balance the budget with endogenous wage taxes. In the first case we assume that all countries introduce the same corporate tax system as the U.S. This means that all countries increase their marginal corporate tax rate to 35 percent and rebate 60 percent of resulting revenues to the respective households. The second reform considered in this section eliminates the corporate tax systems in all other countries except the U.S. Finally, we eliminate corporate tax systems all over the world.

Of course, if all other countries increase their corporation tax rates, this induces a shift of capital to the U.S. As a result, the upper part of Table 12 shows that the world interest rate decreases initially by 10 percent while wages increase by 3 percent. During the transition, capital accumulation is dampened so that interest rates increase again while wages fall. In the long run interest rates are 11 percent higher than in the baseline path and wages are 3 percent lower.

Higher corporate tax revenues reduce initially income taxes all over the world so that elderly cohorts experience an improvement in welfare as reported in the upper part of Table 13. In the medium and long run, however, income taxes have to increase again so that future cohorts are worse off. Note that welfare losses are much smaller in the U.S. due to capital inflows from abroad.

Next, we eliminate corporate taxes in all countries except the U.S. Now exactly the opposite happens. The world interest rate increases sharply initially and falls during the transition while wages fall sharply initially. Due to capital outflows U.S. citizens are worse off (except the elderly who benefit from higher interest rates). Note that China is also worse off thanks to its initially lowest corporate tax rate.

Table 12: Effects of Alternative Corporate Tax Reforms on U.S. Factor Prices

		Interest[a]	Wage Rates[a,b]	
	Year	Rate	Low	High
Equal Corporate Tax Rates	2010	-10.5	3.1	3.1
	2020	-3.0	1.0	1.0
	2040	5.5	-1.8	-2.0
	2060	11.1	-3.3	-3.6
	2100	11.1	-3.1	-3.3
No Corporate Tax Except US	2010	22.5	-5.3	-6.5
	2020	17.6	-4.7	-6.0
	2040	12.7	-3.7	-4.8
	2060	8.5	-2.5	-2.9
	2100	7.9	-2.2	-2.6
No Corporate Tax	2010	41.9	2.5	1.7
	2020	27.5	6.1	5.7
	2040	15.1	9.6	10.4
	2060	8.9	10.3	11.6
	2100	8.4	9.7	11.0
Corporate Tax-Base Broadening (Wage Tax Finance)	2010	12.7	5.7	6.2
	2020	7.2	8.0	8.8
	2040	2.2	9.4	11.3
	2060	0.5	9.9	11.0
	2100	0.6	9.3	9.3
Corporate Tax-Base Broadening (Consumption Tax Finance)	2010	12.9	5.6	6.2
	2020	7.0	8.1	8.9
	2040	2.1	10.3	11.3
	2060	0.6	9.9	10.9
	2100	0.8	9.3	10.0

[a] Changes to respective baseline values in percent;

[b] At age 21 per unit of effective time

Table 13: Welfare Effects of Alternative Corporate Tax Reforms[a]

	Birth	U.S. Income Class		EU Income Class		Japan+ Income Class		China Income Class		India Income Class	
	Year	1	2	1	2	1	2	1	2	1	2
Equal Corporate Tax Rates	1940	0.59	0.44	0.90	0.70	1.36	1.20	1.78	1.39	1.83	1.43
	1980	1.55	1.45	0.07	-0.58	0.79	0.45	-1.23	-2.19	-1.17	-1.82
	2000	0.32	0.38	-2.79	-3.48	-0.95	-0.12	-4.49	-3.14	-2.57	-2.35
	2010	-1.45	-1.31	-4.80	-5.82	-3.41	-1.97	-7.24	-5.99	-3.10	-2.61
	2020	-2.95	-2.67	-5.68	-6.71	-4.84	-3.71	-8.71	-7.13	-3.59	-2.75
	2030	-3.29	-2.89	-5.43	-6.25	-4.45	-3.57	-7.80	-5.97	-3.12	-1.98
	2050	-3.03	-2.53	-5.23	-5.84	-3.81	-3.10	-7.68	-5.87	-2.59	-1.08
	2100	-3.94	-3.41	-5.89	-6.37	-4.05	-3.41	-8.74	-7.02	-2.69	-0.12
No Corporate Tax Except US	1940	1.16	0.89	1.58	1.24	2.73	2.41	3.71	3.01	3.79	3.07
	1980	-2.12	-2.64	1.55	1.06	0.86	0.27	0.25	-0.89	0.06	-0.79
	2000	-3.51	-4.04	2.24	1.86	0.78	0.69	-1.34	-0.98	0.15	0.08
	2010	-3.28	-3.70	2.96	2.58	1.01	1.13	-1.57	-1.28	0.38	0.36
	2020	-2.57	-2.80	3.33	3.04	1.63	1.73	-1.23	-0.86	0.63	0.65
	2030	-2.00	-2.09	3.42	3.22	2.03	2.08	-0.45	-0.04	0.89	0.94
	2050	-2.27	-2.27	3.25	3.16	2.33	2.41	-0.13	0.30	1.12	1.18
	2100	-2.63	-2.58	2.93	2.97	2.15	2.24	-0.61	-0.18	1.19	1.52
No Corporate Tax	1940	1.59	1.22	2.13	1.67	3.76	3.33	5.17	4.20	5.26	4.28
	1980	1.66	1.27	0.25	-0.57	-0.99	-1.95	-1.42	-3.12	-2.14	-3.50
	2000	4.51	4.17	1.14	0.55	-0.83	-0.89	-2.82	-2.32	-1.72	-1.73
	2010	5.87	5.63	2.42	1.90	0.06	0.02	-2.31	-2.02	-0.78	-0.77
	2020	6.58	6.44	3.11	2.73	1.11	1.02	-1.53	-1.23	-0.09	-0.08
	2030	6.63	6.55	3.22	2.94	1.60	1.50	-0.67	-0.35	0.35	0.36
	2050	6.35	6.36	2.92	2.76	1.80	1.79	-0.37	-0.01	0.64	0.65
	2100	6.65	6.72	2.61	2.60	1.68	1.70	-0.77	-0.40	0.84	1.02
Corporate Tax-Base Broadening (Wage Tax Finance)	1940	0.11	0.08	-0.01	-0.02	0.04	0.01	-0.45	-0.51	-0.31	-0.37
	1980	3.34	3.37	-1.31	-1.43	-1.69	-1.84	-2.06	-2.32	-2.16	-2.40
	2000	6.37	6.28	-1.01	-1.09	-1.35	-1.33	-1.39	-1.25	-1.71	-1.63
	2010	7.21	7.06	-0.57	-0.62	-0.86	-0.97	-0.71	-0.69	-1.13	-1.08
	2020	7.37	7.15	-0.31	-0.35	-0.51	-0.63	-0.31	-0.36	-0.74	-0.73
	2030	7.03	6.77	-0.27	-0.31	-0.43	-0.54	-0.23	-0.29	-0.58	-0.60
	2050	6.95	6.68	-0.36	-0.41	-0.52	-0.59	-0.20	-0.25	-0.49	-0.53
	2100	7.31	7.03	-0.37	-0.42	-0.51	-0.57	-0.17	-0.21	-0.38	-0.50
Corporate Tax-Base Broadening (Consumption Tax Finance)	1940	-0.15	-0.14	-0.02	-0.03	0.03	0.01	-0.47	-0.52	-0.31	-0.37
	1980	3.47	3.55	-1.31	-1.42	-1.67	-1.82	-2.07	-2.32	-2.14	-2.36
	2000	6.43	6.36	-0.98	-1.05	-1.31	-1.30	-1.36	-1.24	-1.66	-1.59
	2010	7.11	6.96	-0.55	-0.60	-0.83	-0.95	-0.69	-0.67	-1.10	-1.05
	2020	7.18	6.95	-0.32	-0.36	-0.52	-0.63	-0.31	-0.36	-0.73	-0.72
	2030	6.85	6.57	-0.29	-0.33	-0.45	-0.55	-0.24	-0.31	-0.58	-0.60
	2050	6.72	6.41	-0.38	-0.42	-0.54	-0.60	-0.22	-0.26	-0.49	-0.53
	2100	7.00	6.66	-0.38	-0.43	-0.53	-0.59	-0.19	-0.21	-0.38	-0.49

[a] HEV in percent of (remaining) lifetime resources

Our next simulation considers what would happen if the other regions were to follow the U.S. lead in eliminating its corporate income tax and making up the loss of revenue with higher wage taxes. Remarkably, we still find a Pareto improvement from the perspective of U.S. generations and skill groups. The oldest low-skilled workers experience a 1.22 percent welfare gain. And these gains are larger for younger and future generations. Those born in 2100, for example, are better off by 6.72 percent on a lifetime basis. The welfare effects for skilled U.S. workers are similar. The losers from this policy, as table 13 makes clear, are older Japanese, Chinese, and Indian cohorts who lose the advantage of having relatively low corporate income tax rates.

5 Corporate Tax-Base Broadening

Table 14 shows the macroeconomic impact of our corporate-tax base-broadening simulations, letting either wage or consumption taxes to adjust each year to maintain the economy's debt-to-GDP ratio. The U.S. economy responds strongly to this policy. Output in both the short- and long-runs is roughly 6 percent larger, reflecting an initial 17 percent increase in the U.S. capital stock initially. In 2040, the U.S. capital stock is almost 30 percent higher. And at the end of the Century, it's 26 percent higher. These expansions in capital employed in the U.S. as well as U.S. domestic output come, as in our other policy runs, at the cost of capital outflows and reductions in foreign levels of GDP relative to what would otherwise arise.

Tables 12 and 13 show that the impact of our two base-broadening policies on factor prices and welfare levels. The remarkable thing is that the substantial, but still limited, roughly revenue-neutral reduction in the U.S. corporate tax rate tax produces transition paths that are pretty close to those arising under the complete elimination of the U.S. corporate income tax.

The speed of response to the policy change, here and elsewhere in the paper, may be viewed as overstated because the paper does not incorporate adjustment costs arising from installing more capital. Implementing adjustment costs is a challenging task for future work because it entails solving for each country's specific time path of q – the relative cost of an installed versus an uninstalled unit of capital. But including such adjustment costs would be very unlikely to alter the basic findings reported here. Yes, the economy would respond more slowly to reductions in

Table 14: Simulation Results of U.S. Corporate Tax-Base Broadening, Financed by Wage (Consumption) Tax

	Year	GDP[a]	Capital Stock[a]	Labor Demand[a] Low	Labor Demand[a] High	Corp-orate Tax Rate[b]	Consump-tion /GDP[b]	Invest-ment /GDP[b]	Gov. Pur-chases /GDP[b]	Trade Balance /GDP[b]	Payroll Tax Rate[b]	Wage Tax Rate[b]	Consump-tion Tax Rate[b]
U.S.	2010	5.6(5.9)	17.5(17.7)	0.0(0.3)	-0.5(-0.4)	-26.0(-26.0)	-2.6(-2.8)	3.1(3.1)	-0.9(-0.9)	0.3(0.6)	-0.8(-0.8)	1.1(0.0)	0.0(1.0)
	2020	6.6(6.7)	23.7(23.9)	-1.3(-1.2)	-2.0(-2.1)	-26.0(-26.0)	-1.6(-1.7)	3.2(3.2)	-1.1(-1.1)	-0.3(-0.3)	-1.1(-1.1)	0.7(0.0)	0.0(0.6)
	2040	7.4(7.2)	29.7(29.6)	-2.7(-2.9)	-3.6(-3.8)	-26.0(-26.0)	0.0(0.2)	3.3(3.3)	-1.5(-1.4)	-1.8(-2.1)	-1.2(-1.2)	-0.3(0.0)	0.0(-0.5)
	2060	6.3(6.3)	27.7(27.6)	-3.4(-3.4)	-4.2(-4.2)	-26.0(-26.0)	1.2(1.2)	3.5(3.6)	-1.3(-1.3)	-3.4(-3.5)	-0.6(-0.6)	-0.7(0.0)	0.0(-0.9)
	2100	6.1(6.2)	26.0(26.0)	-3.0(-2.9)	-3.7(-3.5)	-26.0(-26.0)	1.1(1.0)	3.2(3.2)	-1.3(-1.3)	-3.1(-2.9)	-0.6(-0.6)	-0.8(0.0)	0.0(-1.2)
EU	2010	-2.3(-2.3)	-8.0(-8.1)	0.8(0.8)	1.1(1.1)	0.0(0.0)	-0.1(-0.0)	-0.2(-0.1)	0.4(0.5)	-0.1(-0.3)	0.5(0.6)	0.2(0.2)	0.4(0.4)
	2020	-1.4(-1.4)	-5.3(-5.1)	0.6(0.6)	0.8(0.8)	0.0(0.0)	-0.1(-0.0)	0.0(0.0)	0.3(0.3)	-0.2(-0.2)	0.4(0.4)	0.1(0.0)	0.1(0.1)
	2040	-0.2(-0.1)	-1.6(-1.4)	0.5(0.5)	0.6(0.6)	0.0(0.0)	-0.2(-0.3)	0.0(0.0)	0.0(0.0)	0.1(0.2)	0.0(-0.0)	0.0(-0.0)	0.0(0.0)
	2060	0.2(0.2)	-0.1(-0.2)	0.4(0.4)	0.4(0.4)	0.0(0.0)	-0.3(-0.3)	0.0(-0.0)	-0.0(-0.0)	0.4(0.4)	-0.1(-0.1)	0.0(-0.0)	0.0(0.0)
	2100	0.1(0.0)	-0.3(-0.4)	0.3(0.3)	0.3(0.3)	0.0(0.0)	-0.1(-0.1)	0.0(-0.0)	-0.0(-0.0)	0.2(0.2)	0.0(-0.0)	0.0(-0.0)	0.0(0.0)
Japan+	2010	-2.5(-2.5)	-8.3(-8.4)	0.7(0.7)	1.0(1.0)	0.0(0.0)	-0.1(0.0)	-0.1(0.0)	0.4(0.4)	-0.3(-0.5)	0.5(0.6)	0.4(0.4)	0.7(0.6)
	2020	-1.4(-1.4)	-5.4(-5.2)	0.6(0.6)	0.9(0.9)	0.0(0.0)	-0.0(-0.1)	-0.1(0.0)	0.2(0.2)	-0.1(-0.1)	0.3(0.3)	0.3(0.2)	0.4(0.4)
	2040	-0.1(0.0)	-1.5(-1.3)	0.7(0.7)	0.8(0.8)	0.0(0.0)	-0.5(-0.6)	0.0(0.0)	0.0(0.0)	0.5(0.6)	-0.0(-0.0)	0.0(0.0)	0.2(0.2)
	2060	0.4(0.4)	0.1(0.0)	0.6(0.6)	0.7(0.7)	0.0(0.0)	-0.7(-0.7)	0.0(-0.1)	-0.1(0.0)	0.9(0.9)	-0.1(-0.1)	0.0(0.0)	0.1(0.1)
	2100	0.2(0.2)	-0.2(-0.3)	0.4(0.4)	0.5(0.5)	0.0(0.0)	-0.4(-0.3)	0.0(0.0)	0.0(0.0)	0.5(0.5)	-0.0(0.0)	0.0(0.0)	0.1(0.1)
China	2010	-2.8(-2.8)	-8.2(-8.3)	0.2(0.2)	0.4(0.4)	0.0(0.0)	-0.2(-0.2)	-0.9(-0.8)	0.9(0.9)	0.2(0.1)	0.2(0.2)	1.9(0.1)	0.1(1.9)
	2020	-1.5(-1.5)	-5.3(-5.1)	0.4(0.4)	0.6(0.6)	0.0(0.0)	-0.3(-0.4)	-0.5(-0.4)	0.4(0.4)	0.4(0.3)	0.1(0.1)	1.4(0.0)	0.1(1.4)
	2040	-0.2(-0.2)	-1.6(-1.4)	0.4(0.4)	0.6(0.6)	0.0(0.0)	-0.3(-0.4)	-0.1(-0.0)	0.0(0.0)	0.3(0.3)	0.0(0.0)	0.4(0.0)	0.0(0.4)
	2060	0.1(0.1)	-0.2(-0.2)	0.2(0.2)	0.4(0.4)	0.0(0.0)	-0.3(-0.3)	0.0(-0.0)	-0.0(0.0)	0.4(0.4)	-0.0(-0.0)	0.1(0.0)	-0.0(0.1)
	2100	-0.1(-0.1)	-0.4(-0.6)	0.1(0.1)	0.2(0.2)	0.0(0.0)	-0.0(-0.0)	0.0(-0.0)	0.0(0.0)	0.0(0.0)	0.0(0.0)	0.0(0.0)	0.0(0.0)
India	2010	-3.1(-3.1)	-8.9(-9.0)	0.2(0.2)	0.3(0.3)	0.0(0.0)	-0.2(-0.1)	-0.7(-0.6)	0.7(0.7)	0.2(0.0)	0.1(0.1)	0.2(0.2)	1.2(1.2)
	2020	-1.9(-1.8)	-5.8(-5.6)	0.2(0.2)	0.3(0.3)	0.0(0.0)	-0.3(-0.3)	-0.5(-0.4)	0.4(0.4)	0.4(0.3)	0.1(0.1)	0.1(0.1)	1.0(0.9)
	2040	-0.4(-0.4)	-1.8(-1.7)	0.3(0.3)	0.4(0.4)	0.0(0.0)	-0.4(-0.4)	0.0(-0.0)	0.0(0.0)	0.4(0.4)	0.0(0.0)	0.0(0.0)	0.4(0.4)
	2060	0.2(0.2)	-0.1(-0.2)	0.3(0.3)	0.5(0.5)	0.0(0.0)	-0.5(-0.5)	0.0(-0.0)	0.0(0.0)	0.6(0.6)	0.0(0.0)	0.0(0.0)	0.1(0.1)
	2100	0.2(0.2)	-0.1(-0.3)	0.3(0.3)	0.6(0.6)	0.0(0.0)	-0.5(-0.4)	0.0(-0.0)	0.0(0.0)	0.6(0.5)	0.0(0.0)	0.0(0.0)	0.0(0.0)

Changes to the respective baseline values in [a] percent or [b] percentage points.

marginal and average corporate income tax rates. And yes, these policies would produce capital gains to initial owners of capital, who are primarily older. But this would serve to even-out the welfare gains received be different generations.

6 Conclusions

This paper simulates corporate tax reform in the U.S. and abroad, including the complete elimination of the U.S. corporate income tax. Our life-cycle model is a simplified version of Fehr, Jokisch, and Kotlikoff (2008). It features a single good produced in five regions – the U.S., Europe, Japan+ (plus Korea and Taiwan), China, and India – with skilled and unskilled labor. It also closely models demographics, including age-specific birth and death rates, as well as each country's/region's fiscal policies.

We find that eliminating the U.S. corporate income tax with no changes in the corporate tax rates of the other regions can produce rapid and dramatic increases in U.S. domestic investment, output, real wages, and national saving. These economic improvements expand the economy's tax base over time, producing additional revenues that make up for a significant share of the loss in receipts from the corporate tax.

The simulated economic gains from eliminating the corporate tax, while insufficient to fully finance the corporate tax cut (i.e., there is no Laffer Curve, per se) are large enough to produce a Pareto improvement, with modest welfare gains accruing to early generations, both skilled and unskilled, and very sizable welfare gains experienced by young and future generations, both skilled and unskilled. Importantly, this result arises naturally with no special compensation mechanism required to transfer from winners to losers. Stated differently, in our model, eliminating the U.S. corporate income tax has the potential to raise the welfare of all US generations. Remarkably, this is true even if the other regions in our model follow America's lead and set their corporate tax rates to zero.

Finally, we find that corporate-tax base broadening that eliminates infra-marginal subsidies (loopholes) produces close to the same economic and welfare impacts for the U.S. as does eliminating the corporate income tax entirely. And, according to our simulations, this can be achieved on a roughly revenue-neutral basis with a 9 percent corporate tax rate.

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