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On Deficit Bias and Immigration

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Department of Economics
Discussion Paper Series
No. 15/08

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September 2014

Abstract

How much can governments shift the cost of their expenditure from today's voters to tomorrow's generations of immigrants, without resorting to taxation that is explicitly discriminatory? I demonstrate that if their societies are absorbing continuous flows of new immigrants, we should expect governments that represent the interests of today's population to choose policies that shift some portion of the tax burden to the future, even if that population is altruistically linked to future generations. To measure the deficit bias, I analyse the dynamic behavior of an optimal growth model with overlapping dynasties and factor taxation, calibrated for the US economy, and consider the welfare implications for today's population and their descendants of intertemporal shifts in the tax rates on labour and capital as well as transfer payments. Models with overlapping infinite-lived dynasties allow for a very clear distinction between natural population growth (an increase in the size of existing dynasties) and immigration (the addition of new dynasties). They also provide an alternative to the strict dichotomy between models with overlapping generations, where agents disregard the impact of their choices on future generations, and the quasi-Ricardian world of infinite-lived dynasties with representative agents that fully participate in both the economy and the political system in every period. The trajectory of the debt burden predicted by the model is a good match for the rise in US Federal Government debt since the early 1980's, as well as the increases in debt projected by the Congressional Budget Office over the next few decades.

JEL classification: E62, F22, H62

Keywords: Immigration; Fiscal Policy; Public Debt

*I would like to thank Saqib Jafarey, Jonathan Gillingham, Yishay Maoz, Phillip Murfitt, Gareth Myles, Juan Paez-Farrell, Joseph Pearlman, Chris Tsoukis and Amos Witztum, as well as seminar participants at City University London, London Metropolitan University, Moscow Higher School of Economics, the University of Exeter, the University of Loughborough, the University of Reading, and particpants at the 2012 Royal Economic Socity Annual Meetings at the University of Cambridge for helpful suggestions and comments on an earlier draft. This research is funded by ESRC/HM Treasury/HM Revenue and Customs grant RES-194-23-0020. Initial funding by the Israel Science Foundation, Grant No. 49/06 is also gratefully acknowledged.

1 Introduction

Ordinarily, in an economy in which taxes are distortionary, heavy reliance on deficit finance to fund government expenditure combined with sustained increases in unfunded liabilities, relative to the size of the economy, might be hard to reconcile with the prescriptions of optimal fiscal policy. This is particularly the case if the very high tax rates that will ultimately be needed to finance the increasing burden of debt are associated with significant excess burdens. Yet it is precisely these types of fiscally imbalanced policies that both national and local governments throughout much of the developed world have been pursuing for decades. This paper examines how the existence of immigrant flows may encourage a government to favor deficit finance and low taxes for long periods of time, even if such policies will eventually necessitate far higher tax rates in the future, to finance the accumulated debt alongside other public expenditures.

In this paper I demonstrate that if their societies are absorbing new immigrants, we should expect governments that represent the interests of today's population to choose policies that shift some portion of the tax burden to the future, even if that population is altruistically linked to future generations. The model I build to demonstrate and measure this bias in favour of deficits is a simple optimal growth model with overlapping dynasties, factor taxation and public debt, calibrated for the US economy.

In 1946, a year after the end of World War II, gross US federal debt reached 119.0% of GDP. For thirty-five years, the debt burden declined steadily, reaching only 31.0% in 1981. Since then, during the three decades that followed, the debt has more than tripled and has exceeded 100% since 2012. Publicly held, or net, debt has risen nearly as fast; from 24.6% of annual GDP in 1981, it reached 72.3% at the end of 2013.[1] All indications suggest the debt burden, by either measure, will continue to grow for the foreseeable future.

Each year, the US Congressional Budget Office produces two different estimates of future spending, revenue, and the predicted trajectory of US Federal Government publicly held debt for the decades to come. The first is the Extended Baseline Forecast, which is premised on four main assumptions: that the Federal Government will contain entitlement spending, particularly spending on Medicare; that growth in non-entitlement spending will no longer keep pace with the growth in the economy as it has in the past; that temporary tax cuts which are set to expire will no longer be renewed even if they have been renewed more than once in the past; and that future tax brackets will be automatically indexed to inflation, as they have been since 1985, but not adjusted to reflect real income growth in the economy. Though the population is aging and the bill for Medicare is driving total expenditure higher, the Extended Baseline Forecast for 2014 shows revenue growing as well (Figure 1), particularly because of its assumption of limited indexing. Meanwhile, Figure 2 shows publicly held debt as forecast in 2014 increasing but at a slower pace, reaching 100% of GDP by 2036, and 225% by 2089.

Along with the Extended Baseline Forecast, the CBO produces an Alternative Fiscal Sce-

[1] Publicly held debt includes Federal Government debt held by foreign and international investors, domestic publicly held debt, outside the Federal Reserve, federal debt held by Federal Reserve. Gross debt includes intergovernmental holding of debt as well, particularly in the Social Security Trust Fund, reflecting a portion of the unfunded liabilities of the Federal government.

nario. Here the CBO assumes Medicare costs will rise much as they have in the past; that those temporary tax cuts which are typically renewed as a matter of course will again not be allowed to expire; and that Federal spending other than Medicare and Social Security will continue to grow at the same rate as the economy. Most important, it assumes that as incomes rise faster than prices, Congress will prevent so-called 'real bracket creep' from turning increasing numbers of people into high marginal rate tax payers. In this scenario, public debt grows along an explosive path. In 2009 the Alternative Fiscal Scenario had the debt burden reaching 223% of GDP by 2040, and 767% of GDP by 2083. The 2010 estimate predicted the debt reaching 233% by 2040 and 947% by 2084. In 2011, the CBO predicted the debt to GDP ratio would reach 195% by 2036, but declined to extrapolate any further, arguing in effect that the economy simply could not sustain a debt burden any higher. By 2014 the predicted accumulation of debt in the Alternative Fiscal Scenario had slowed slightly, exceeding 200% in 2045 and as debt service spirals higher, 250%—after 2050—the CBO's new threshold of unsustainability.

One way to distinguish between the two sets of predictions is that under the Extended Baseline Forecast, while tax revenue so far has proven inadequate to preclude the rise in debt over the previous thirty years, tax rates will rise in the near future in part to pay for entitlements and also to finance interest payments on the higher level of debt. Under the Alternative Fiscal Scenario, the rise in tax rates is postponed indefinitely. Yet unless the US defaults or repudiates its debt, or economic growth rates are far higher than anticipated, in this scenario too, if the debt burden is ever to stabilize, taxes will eventually rise, and possibly by a great deal more. In either case, this pattern of maintaining relatively low rates of taxation over long periods of time, even as the liabilities that will necessitate far higher future taxes to finance them continue to mount, is a puzzle. It contradicts some basic prescriptions of optimal fiscal policy: keep tax rates predictable and, in the case of distortionary taxes, smooth them over time to minimize the overall excess burden they generate.

There is a wide-ranging literature exploring the many reasons why governments, even abstracting from distributional issues, might not adopt first or even second-best fiscal policies. If agents are indifferent to the next generation's welfare, they will of course support policies that shift the burden of funding government expenditure to the future. Even if agents are not indifferent to their children's welfare, but some are bequest-constrained, as in Cukierman and Meltzer (1989), a constituency in favour of deficit finance can emerge. Rogoff (1990) proposed that in a society with asymmetric information, politicians have an incentive to spend more and tax less prior to an election. Voters, according to Rogoff, are not irrational, but lack the opportunity either to directly observe the competence of their leaders, or to judge the appropriateness of the policies they pursue. Similarly, Lizzeri (1999) and Battagliani and Coate (2008) demonstrate that voters or legislators may support benefits for themselves while treating the future tax burden as a commons. Finally, politicians may choose to increase the debt burden while in power as a device to control or tie the hands of possible successor governments, as in Persson and Svensson (1989) and Tabellini and Alesina (1990).

Yet government budgets are not always in deficit, and even when they are, in years when economic growth is sufficiently high the debt burden still declines. The US and most other advanced nations emerged from World War II with extraordinarily high debt burdens that they immediately set about paying down through a combination of primary surpluses, real growth, and liquidation though a mixture of high inflation and financial repression (Reinhart and Sbrancia, 2011). Why did governments choose to pay down debts until sometime between the mid-1970's and the early 1980's? As early as 1977, Buchanan and Wagner argued that the widespread adoption of Keynesian analysis provided intellectual cover for policy makers to indulge their inclination to spend but not to tax.[2] An alternative explanation, popular with political commentators and journalists, combines intergenerational conflict and shifting cultural norms. According to this 'selfish generation' hypothesis, today's adults, particularly members of the cohorts born during the post-war baby boom, are less willing to sacrifice for the benefit of future generations, including their own children.[3] My explanation does not rely on intergenerational selfishness, but argues that voters tolerate higher deficit spending only because they understand that their own children will not inherit the burden of it alone, but will share it with future immigrants.

During the 1970's, the rate of net migration to the United States averaged less than 1.9 per thousand. It rose to an average of just under 2.8 during the 1980's, and then to just over 4.3 during the 1990's, before receding to just under 3.2 per thousand during the first decade of this century. Net migration has been higher in the past, averaging 6.4 per thousand during the first decade of the twentieth century.[4] Yet the impact of immigration on the future composition of the population is a function not only of the rate at which new immigrants arrive, but also of the demographic characteristics of the society that absorbs them. Hence, the prevailing high birth rates between 1870 and 1910 meant that though the United States experienced rates of net migration that have never since been repeated, the share of the population that was foreign-born actually shrank over those four decades, from 14.4% to 13.3%.[5] A century later, the foreign-born share of the population rose from 5.4% in 1970 to 13.1% in 2010, and it is predicted to reach 19% by 2050. By then the US population is projected to grow from 304 million to 438 million, with nearly the entire increase comprised of future immigrants or their descendants.[6]

Others before have drawn a possible connection between growing intergenerational imbalances and immigration. To consider how much existing patterns of immigration might ame-

[2]In their view, Keynesians came to dominate economic policymaking soon after the end of World War II, their growing influence culminating in passage of the tax cut of 1964. Nonetheless, in the years that followed the debt burden continued to decline, albeit more slowly. Buchanan and Wagner, 1977, pg 48.

[3]See David Brooks, The Geezers' Crusade, *The New York Times*, February 2, 2010 Tuesday, pg 27; Ed Howker and Shiv Malik, 2010, *Jilted Generation*, Icon Books, London; Laurence J. Kotlikoff and Scott Burns, 2004, *The Coming Generational Storm*, MIT Press, Cambridge MA; David Willetts, 2010, *The Pinch*, Atlantic Books, London.

[4]Calculations based on Campbell Gibson, 1975, "The Contribution of Immigration to United States Population Growth: 1790- 1970" *International Migration Review* 9(2):157-177 and United States Bureau of the Census, 1975, *Historical Statistics of the United States: Colonial Times to 1970*, Washington, D.C.

[5]Steven Ruggles, J. Trent Alexander, Katie Genadek, Ronald Goeken, Matthew B. Schroeder, and Matthew Sobek. 2012. Integrated Public Use Microdata Series: Version 5.0. Minneapolis: University of Minnesota.

[6]Jeffrey S. Passel and D'Vera Cohn, "U.S. Population Projections: 2005–2050," *Pew Research Center, Social and Demographic Reports*, 2008, p. 2.

liorate the fiscal imbalances in the United States, Auerbach and Oreopoulos (1999) consider how much a suspension of all future immigration might exacerbate them. Using a generational accounting framework, their findings suggest only a limited role for immigration. By contrast Bonin *et al.* (2000) find that if the present pattern of immigration to Germany is maintained, the arrival of immigrants does partly reduce, though certainly does not eliminate, fiscal imbalances borne by future generations of natives. Fehr *et al.* (2004) find that doubling immigration rates will only slightly mitigate future tax rises in the European Union, Japan, and the US. Storesletten (2000) found that high-skilled professional workers entering the United States in their early 40's generate such high tax revenue that their arrival alone could rebalance fiscal policy at the time—provided that the number of immigrants rose by 40%, and more crucially, that all of them fit this very narrow profile. Other types of immigrants are not nearly as helpful to public finances, and low-skilled immigrants generate net losses. Storesletten (2004) finds that with its more generous welfare payments, relatively high unemployment, and the low labor force participation rates that prevail for its immigrants, immigration to Sweden generates a net loss.

The best feature of these last papers is the well-articulated age structures of the populations being modeled, something that the overlapping generations structure on which they are based easily accommodates. At the same time these overlapping generations models exclude intergenerational altruistic links. In essence everyone in these models begins life as an immigrant—the new born offspring of a native and newly arrived adult immigrants differ only in the shape and length of their earnings profile. Otherwise, long-run fiscal imbalances affect each of these groups in similar ways. By adopting an overlapping dynasties approach, I assume that if members of one generation already resident in the country benefit from unfunded tax cuts, they can use bequests to share their gain with their descendents, and also compensate them for both the higher tax burden and any additional dead weight losses that financing the additional debt might entail.

In Section 2, I present the overlapping dynasties model, which features a continuous inflow of infinite-lived optimizing agents.[7] Government consumption, transfers, and debt service are financed by taxation on both capital and labor, as well as new bond issuance. In Section 3, I calibrate the model to match some of the main features of the US economy. While immigration may create a bias in favour of deficit finance, the crucial element in determining both the scope and scale of any benefit natives and other long standing residents derive from such policies is the trajectory of taxes during both the periods when the debt is still accumulating and after it is ultimately stabilised. In Section 4, I start my analysis by first considering the simplest case, in which government consumption as a share of output remains constant, similar to the experience of the United States during the last half century, but transfer payments increase, as they are expected to for the next several decades while public debt accumulates. The debt is ultimately stabilised when the tax on labour earnings is raised to not only pay for the continuing flow of government expenditure but also to service the higher stock of debt. In a deterministic economy, and in the absence of immigration, the intertemporal shifts in either the tax rate on

[7] The original version of the overlapping dynasties model was developed by Weil (1989).

wages or transfer payments is welfare neutral—i.e., Ricardian equivalence prevails.

Immigration alters these calculations. The anticipation that new people will join the economy in the future, and assume responsibility for financing a share of however much debt the government has accumulated in the interim, creates an incentive on the part of the initial population to postpone taxes for as long as possible. Indeed, this effect is expressed through the way higher public debt raises the rate of return on the economy's asset returns. Ben-Gad (2004) demonstrates how the continuous flow of immigrants raises the rate of return for native-owned capital and generates an immigration surplus. Here higher levels of debt amplify this effect.

In Section 5 I consider the behaviour of the model when it is the tax rate on capital that is first lowered and then raised to new, higher, levels. First, any deviations from a policy that smooths a distortionary tax implies an overall increase in its associated excess burden. Second, because the supply of capital is inelastic in the short run but infinitely elastic in the long run, the opposite policy of immediate increases in tax rates can be welfare-improving, provided the surpluses are used to reduce public debt and facilitate lower rates of taxation in the future. The impact of immigration flows, even at very low levels, can easily overwhelm both these effects. The native population, though it pays a disproportionate share of the taxes levied on asset income—immigrants may arrive with few assets but still have an incentive to save and invest, particularly during the interim when the rate of return net of taxes is particularly elevated—can still benefit from deficit finance even if it implies higher rates of tax in the future.

There are, however, two profound differences between shifting taxes on labour over time and taxes on capital. Here, because of the endogeneity of capital, there is a maximum amount of debt the economy can sustain if only increases in the tax on assets are used to balance budgets in the long term. Furthermore, for a given rate of immigration and time horizon before fiscal consolidation is enacted, the optimal policy of initial tax cuts and subsequant debt accumulation usually falls short of this theoretical maximum. Instead, policy makers focused on serving the interests of the people already resident in the country choose policies that balance the desired shift in the tax burden towards future immigrants, against the efficiency losses generated by deviating from a policy of tax smoothing or of exploiting the lump-sum nature of short-term capital taxation. This trade-off also means that the scope for improving native welfare through this channel is more limited, though the optimal level of debt implied here is still very high.

In Section 6 I consider the behaviour of the model when deficit finance is accompanied by a shift in the the tax burden between the two factors of production. First, cuts in the tax on labour or higher transfer payments generate prolonged deficits, but the government ultimately relies on higher taxes on asset income to achieve budget balance. I also consider the opposite—lower capital taxation is balanced by eventually higher taxes on wages. As one might expect, the latter case generates particularly high welfare gains for natives when more of the tax burden is shifted to new immigrants whose income relies more heavily on wages.[8] Natives enjoy a secondary efficiency gain of permanently reducing highly distortionary taxation. Yet even in

[8]In the overlapping dynasty model presented below, the population absorbing new immigrants are themselves members of families that have accumulated through past immigration starting in the infinite past. I use the term natives as shorthand to refer to all previous cohorts of immigrants and their descendants as distinct from new arrivals.

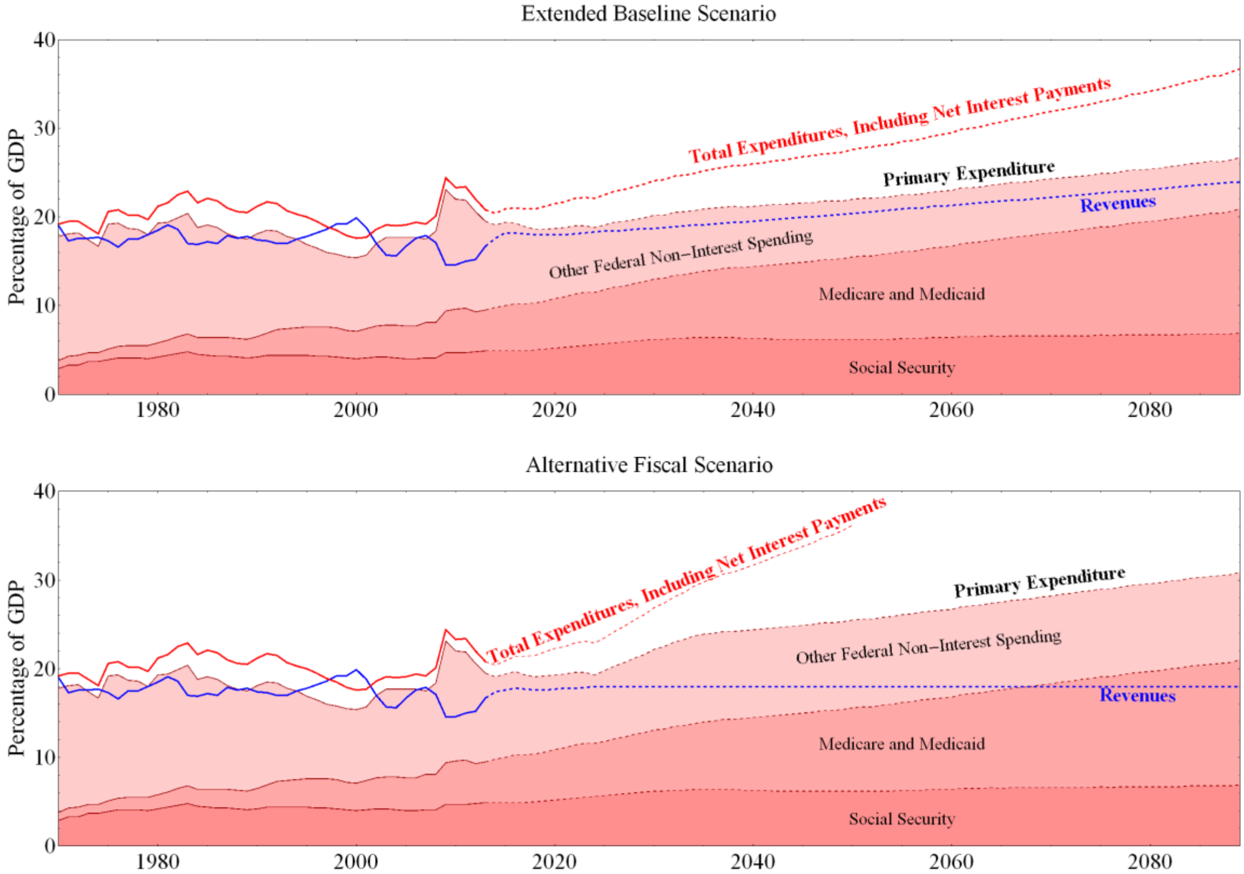

Figure 1: US federal budgets from 1970 to 2013 with forecasts using extended baseline and alternative fiscal scenarios generated by the Congressional Budget Office for 2014 to 2089.

the former case, provided immigration is sufficiently high, the shift from labour taxation to capital taxation generates small welfare gains for natives as long as policy makers allow debt to accumulate in the interim.

I make no effort to model the migration decision itself. For the United States as well as Western Europe and the rest of the developed world, the marginal supply of potential immigrants from impoverished foreign countries is very large. Furthermore, even the prospect of inheriting a portion of the growing national debt is unlikely to deter many people from the world's poorest countries from seeking a better life through migration.

2 The Basic Model

Consider an economy that is closed in every way but one: new people—adult immigrants—are arriving from abroad at a continuous rate of $m(t)$. These new immigrants are founding members of new infinite-lived dynasties, each indexed by $s \in \mathbb{R}$, the date at which the dynasties' founding members crossed the international frontier to instantaneously join the economy as workers, consumers, and savers. The economic environment is assumed to be deterministic, and the behavior of each agent, including each new immigrant and all of his or her descendants, can be characterized as the maximization of a dynasty's infinite horizon discounted utility function

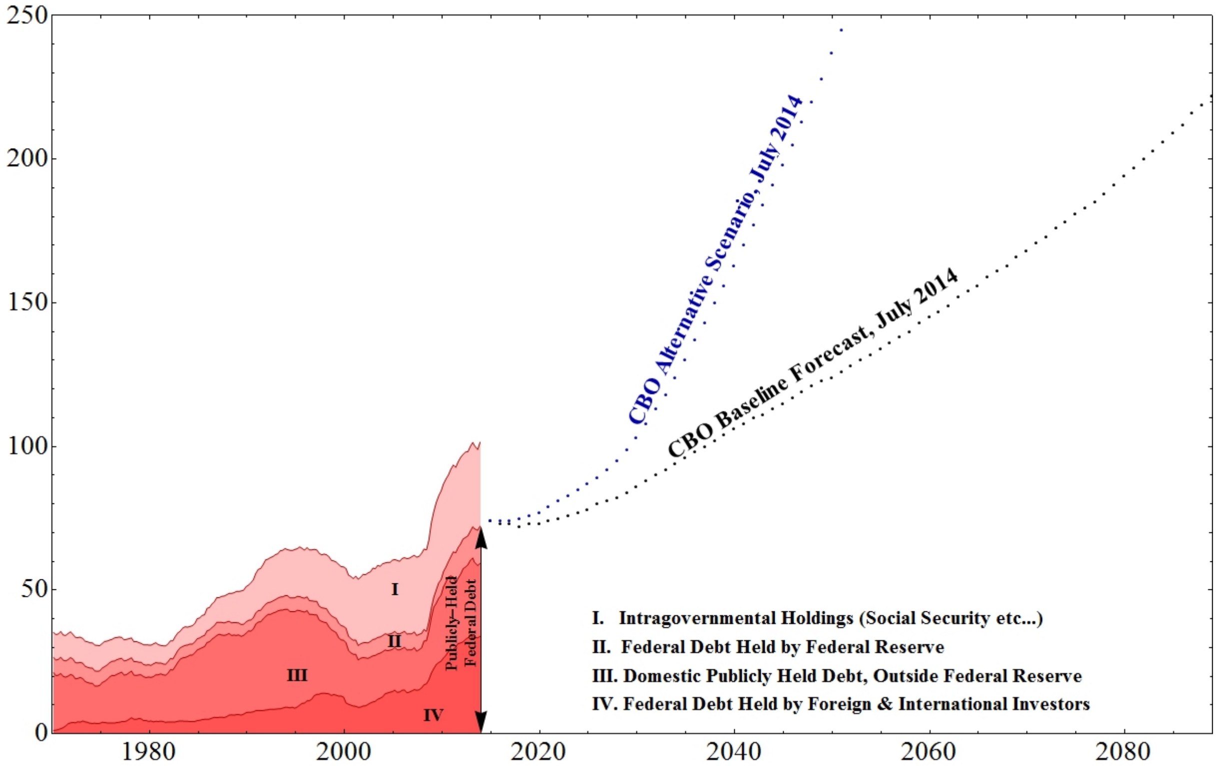

Figure 2: US federal debt held by the public from 1970 to 2013 with forecasts using extended baseline and alternative fiscal scenarios generated by the Congressional Budget Office for 2014 to 2089.

beginning at time s:

$$\max_{c,h} \int_s^\infty e^{(\rho-n)(s-t)} \ln c\,(s,t)\,dt, \tag{1}$$

subject to a time t budget constraint:

$$\dot{a}(s,t) = (1-\tau_h(t))\,w(t)\phi\,(s,t) + ((1-\tau_k(t))\,r(t) - n)\,a(s,t) - c(s,t) + q(s,t)\ \forall s, t \geq s, \tag{2}$$

and the transversality condition:

$$\lim_{t\to\infty} e^{-\int_s^t ((1-\tau_k(v))r(v)-n)dv} a(s,t) = 0\ \forall s, t \geq s, \tag{3}$$

where ρ is the subjective discount rate, n is the rate of natural population growth (the rate at which each dynasty itself is growing), $c(s,t)$, $q(s,t)$ and $a\,(s,t)$ are consumption, income received from government transfer payments, and holdings of assets for the members of dynasties of vintage s at time $t \geq s$, and $r(t)$ is the rate of return on assets at time t.[9] The assets $a\,(s,t)$ for each household are the sum of holdings of physical capital $k(s,t)$ and government debt $b(s,t)$, and the returns on these assets are taxed at the rate of $\tau_k\,(t)$. Labour supply is inelastically supplied and normalised to one. It earns an economy-wide wage rate of $w(t)$ multiplied by

[9] As in Ben-Gad (2004) and (2008), I assume complete intergenerational altruism, but otherwise this is most similar to Canova and Ravn's (2000) framework for analyzing the impact of German reunification. By contrast, in Zak *et al.* (2002) agents live only two periods, and in Storesletten (2000) agents enjoy long but finite lives.

$\phi(s,t)$ which represents the time t productivity of workers who are members of vintage s households. These earnings are taxed at the rate $\tau_h(t)$. Taxes as well as the proceeds from the sale of government debt, net of the payment of interest and principal, finance both the transfer payments and government consumption—the latter I assume to be a share $g(t)$ of domestic output, net of capital depreciation. The solution to the optimization problem yields the evolution of consumption for each individual dynasty s over time:

$$c(s,t) = c(s,s)\, e^{\rho(s-t)} e^{\int_s^t (1-\tau_k(v))r(v)dv}. \tag{4}$$

I assume that productivity is the product of two components, an economy wide trend growing at rate x, and a static term associated with the members of each dynasty of vintage s, so that $\phi(s,t) = \xi(s)\, e^{xt}$. The economy-wide feasibility and government's budget constraints are

$$\dot{K}(t) = (1-g(t))\left(F\left(K(t), e^{xt}\Xi(t)\right) - \delta K(t)\right) - \delta K(t) - C(t) + P(t)\, m(t)\, k(t,t), \tag{5}$$

$$\begin{aligned}\dot{B}(t) = {} & g(t)\left(F\left(K(t), e^{xt}\Xi(t)\right) - \delta K(t)\right) + Q(t) - \tau_h(t)w(t)e^{xt}\Xi(t) \\ & -\tau_k(t)r(t)\left[K(t) + B(t)\right] + r(t)B(t) + P(t)\, m(t)\, b(t,t),\end{aligned} \tag{6}$$

where $C(t) = e^{nt}\int_{-\infty}^{t} e^{\int_0^s m(v)dv} m(s)\, c(s,t)ds$ represents aggregate consumption, $B(t) = e^{nt}\int_{-\infty}^{t} e^{\int_0^s m(v)dv} m(s)\, b(s,t)ds$ publicly held government debt, $Q(t) = e^{nt}\int_{-\infty}^{t} e^{\int_0^s m(v)dv} m(s)\, q(s,t)ds$ aggregate transfer payments, $\Xi(t) = e^{nt}\int_{-\infty}^{t} e^{\int_0^s m(v)dv} m(s)\, \xi(s)ds$ a weighted aggregation of productivity across the different dynasties and $P(t) = e^{nt}\int_{-\infty}^{t} e^{\int_0^s m(v)dv} m(s)\, ds$ the size of the population. The function $F: \mathbb{R}^2_{++} \to \mathbb{R}_{++}$ is homogeneous of degree one, and describes how the inputs, aggregate capital $K(t) = e^{nt}\int_{-\infty}^{t} e^{\int_0^s m(v)dv} m(s)\, k(s,t)ds$, which depreciates at the rate δ, and aggregate effective labor $e^{xt}\Xi(t)$, produce a single good that is either consumed by households or the government or invested in the production of more capital. The terms $b(t,t)$ and $k(t,t)$ represent any assets, in the form of either bonds or capital, that new immigrants arriving at time t may import with them.

Assume transfer payments evolve over time according to $q(s,t) = \varrho(t)\, \xi(s)\, e^{xt}$ (transfer payments directly relate to the amount paid in contributions through the tax on labour earnings). Then, integrating the first order conditions of the individual maximization problem and the time t budget constraint over time, the consumption rule for dynasty s at time t is:

$$c(s,t) = \frac{\rho - n}{1+\theta}\left(\xi(s)\, \omega(t) + a(s,t)\right) \quad \forall s, t \geq s, \tag{7}$$

where $\omega(t) = \int_t^\infty e^{xu - \int_t^u ((1-\tau_k(v))r(v)-n)dv}\left[(1-\tau_h(u))\, w(u) + \varrho(u)\right] w(u)du$ is the component of households' present discounted value of net labor and transfer income from time t forward shared across the economy.

Aggregating (7) over all dynasties that have arrived by time t, differentiating with respect to t, and substituting (5) and (6), aggregate consumption evolves according to:

$$\begin{aligned}\dot{C}(t) = {} & \left[(1-\tau_k(t))\, r(t) - \rho + n\right] C(t) + m(t)\, P(t)\, \frac{C(t)}{\Xi(t)}\xi(t) \\ & + \frac{\rho - n}{1+\theta}\, P(t)\, m(t)\left[b(t,t) + k(t,t) - \frac{B(t)}{\Xi(t)}\xi(t) - \frac{K(t)}{\Xi(t)}\xi(t)\right].\end{aligned} \tag{8}$$

Rewriting (8), (5) and (6) in terms of stationary per-capita variables:

$$\dot{\tilde{c}}\,(t) = [(1-\tau_k\,(t))\,r(t) - \rho - x]\,\tilde{c}\,(t) - (\rho - n)\,m\,(t)\,\frac{P\,(t)\,\xi\,(t)}{\Xi\,(t)}\left(\beta\,(t)\,\tilde{b}\,(t) + \kappa\,(t)\,\tilde{k}\,(t)\right), \quad (9)$$

$$\dot{\tilde{k}}\,(t) = (1-g(t))\left[F\left(\tilde{k}(t),1\right) - \delta\right] - (n+x)\,\tilde{k}(t) - \tilde{c}(t) - m\,(t)\,\frac{P\,(t)\,\xi\,(t)}{\Xi\,(t)}\kappa(t)\tilde{k}(t), \quad (10)$$

$$\begin{aligned}\dot{\tilde{b}}\,(t) \quad &= \quad g(t)\left[F\left(\tilde{k}(t),1\right) - \delta\tilde{k}(t)\right] + \tilde{q}\,(t) - \tau_h(t)w(t) - \tau_k(t)r(t)\tilde{k}\,(t) \\ &\quad + ((1-\tau_k(t))\,r(t) - n - x)\,\tilde{b}(t) - m\,(t)\,\frac{P\,(t)\,\xi\,(t)}{\Xi\,(t)}\beta\,(t)\,\tilde{b}\,(t)\,,\end{aligned} \quad (11)$$

where $\tilde{c}\,(t)=\frac{C(t)}{e^{xt}\Xi(t)}$, $\tilde{k}\,(t)=\frac{K(t)}{e^{xt}\Xi(t)}$, $\tilde{b}\,(t)=\frac{B(t)}{e^{xt}\Xi(t)}$, $\tilde{q}\,(t)=\frac{Q(t)}{e^{xt}\Xi(t)}$, $\kappa(t) = \frac{k(t)-k(t,t)}{k(t)}$ is the fractional difference between per-capita physical capital and the physical capital owned by new immigrants at the moment of their arrival, and $\beta(t) = \frac{b(t)-b(t,t)}{b(t)}$ the analogous terms for government debt. Both input factors receive their marginal products:

$$r(t) = F_k\left(\tilde{k}(t),1\right) - \delta, \quad (12)$$

$$w(t) = F_\psi\left(\tilde{k}(t),1\right). \quad (13)$$

The present value of future government borrowing is limited by a transversality condition:

$$\lim_{t\to\infty} e^{-\int_0^t (1-\tau_k(v))r(v)dv} B(t), \quad (14)$$

which implies that the time-discounted budget must remain balanced over the long run. In terms of per-capita stationary variables this is:

$$\tilde{b}(0) = \int_0^\infty e^{-\int_0^t (1-\tau_k(v))r(v)dv}\left[\tau_h(t)w(t) + \tau_k(t)r(t)\tilde{k}\,(t) - g(t)\left[F\left(\tilde{k}(t),1\right) - \delta\tilde{k}(t)\right]\right]dt. \quad (15)$$

The system (9), (10) and (11), together with the government's long-run budget constraint (15), describes the behavior of the economy, where the products of $m\,(t)$ with $\frac{P(t)\xi(t)}{\Xi(t)}$ and both $\kappa\,(t)$ and $\beta\,(t)$ regulate the impact of immigration on the economy. If $\beta\,(t)$=0 and $\kappa\,(t)$=0, new immigrants are identical to members of the already resident population, and changes in the rate of immigration have no effect on per-capita variables in this model.

Finally, the production function takes the Cobb-Douglas form:

$$F\left(K(t), e^{xt}\Xi(t)\right) = K(t)^\alpha\left(e^{xt}\Xi(t)\right)^{1-\alpha}.$$

3 Calibrating the Model

Nearly fifty years after its passage, the provisions of the Hart-Cellar Immigration Act of 1965 still form the basis of present US immigration policy. The act removed the country quotas first enacted in the Immigration Restriction Act of 1921, and made the category of family unification, first introduced in the McCarran-Walter Immigration Act of 1952, the main route for permanent settlement in the United States. Though it followed passage of the Civil Rights

Act of 1964 and coincided with the largest expansion in the scope of the welfare state since the Great Depression, particularly the creation of the Medicare and Medicaid programmes, at the time Hart-Cellar was not perceived as a major shift in overall US policy. Instead the expectation was that rather than changing the magnitude of immigration flows, its main effect would be to remove the preference for immigrants from the countries of Northwestern Europe, and thereby enable the large numbers of Americans with roots in Southern and Eastern Europe, particularly Greece, Italy, and Poland, to sponsor the immigration of the close family members they had left behind as well as other relatives.[10] Indeed, if during the fourteen years from 1952 through 1965 the annual rate of net migration to the United States averaged 1.81 per thousand, during the subsequent fourteen-year period from 1966 through 1979 the average rate had increased only to 1.95.

Beginning in 1980, the rate of immigration rose sharply, initially the result of a large increase in the number of refugees and asylum seekers from Cuba and Indochina, and passage of the Refugee Act that same year. Subsequent legislation, including the Immigration Reform and Control Act of 1986, provided an amnesty to three million undocumented aliens already in the country, and the Immigration Act of 1990 had the effect of increasing legal immigration by thirty-five percent. From 1992 the US also began granting 65,000 H1-B visas to workers with special skills, particularly in the fields of science and technology, and from 2001 through 2003 the programme was expanded to 195,000 per annum.[11] The rate of net migration rose to an average of 2.76 per thousand during the 1980's and 4.43 per thousand during the 1990's.

Yet it is important to emphasise that it is not the rising rate of immigration alone, but rather its juxtaposition against a declining rate of natural population growth, as seen in Figure 3, that generated or reinforced a bias in favour of deficit finance. From its post-war maximum of just over 16.4 per thousand in 1947, the rate of natural increase had dropped to just under 5.5 by 1973, and it is projected to continue to decline till the middle of the century. Immigration is already the direct source of nearly forty percent of US population growth, and it will exceed fifty percent sometime between 2027 and 2038. As in Figure 4, aside from the two year period during 2006 and 2007, since 1972 the total fertility rate in the United States has fallen below the replacement rate of 2.11 per thousand, and the projections prepared by the US Census suggest it will continue to drop. Indeed, only the population momentum generated by the large cohorts born during the quarter century that followed World War II ensures that despite below-replacement fertility, the birth rate still exceeds the death rate. Furthermore, the predictions for relatively high rates of natural population growth coincide with the high and median projections regarding immigration flows, and reflect the relatively high fertility rates among immigrants. This means these numbers understate the full contribution new immigrants make to long-run population growth and the future composition of the population, as they abstract from differences in total fertility rates between natives and immigrants. For example, new immigrants who arrived between 1980 and 2005 and their US-born descendants account for 58% of the 68 million additional people added to the United States population during that period, equivalent

[10]Michael S. Teitelbaum and Jay Winter, 1998, *A Question of Numbers*, Hill and Wang, New York, pg 140.

[11]Though these visas are only granted for three years, they are renewable and visa-holders are permitted to simultaneously apply for permanent residence without prejudicing their status.

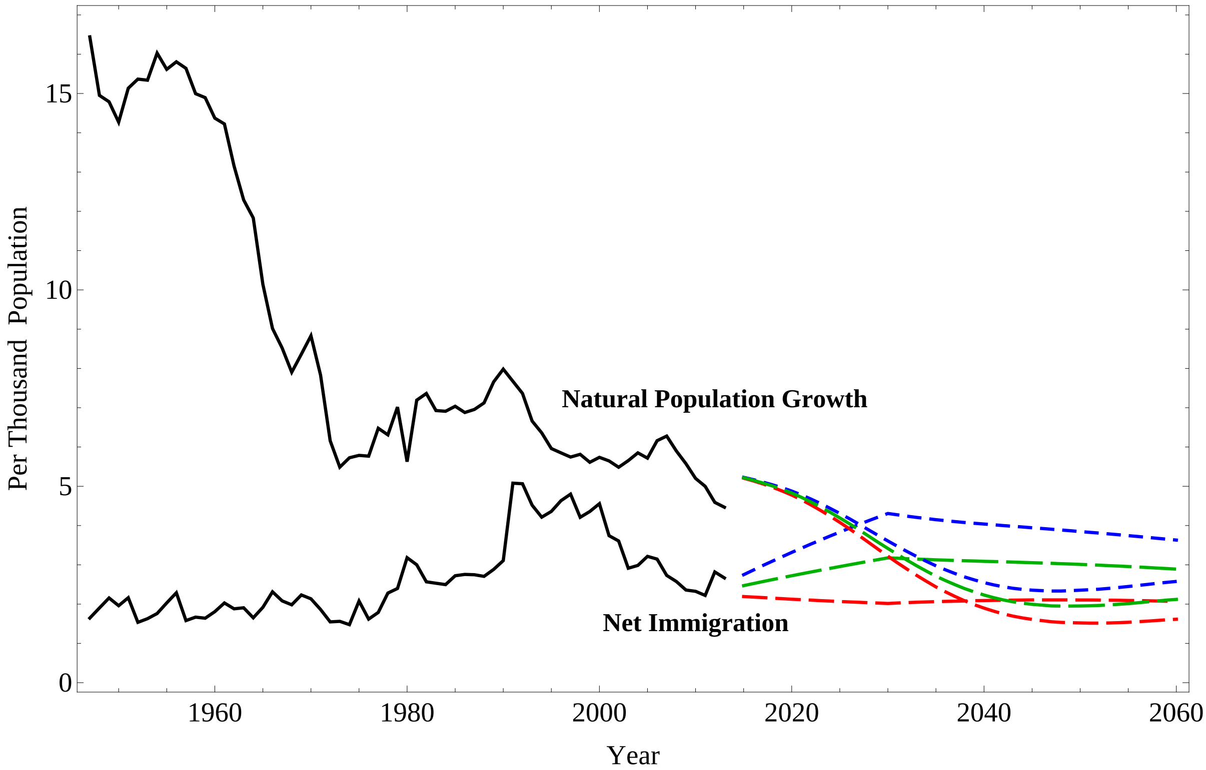

Figure 3: Annual rates of population change per thousand from 1947 to 2013 and Projections of the Population and Components of Change for the United States: 2015 to 2060. US Census Low Migration Projection (NP2012-T1L) in red, Medium Migration Projection (NP2012-T1) in green, and High Migration Projection (NP2012-T1H) in Blue. *Sources*: OECD and US Census 2012 National Projections.

to an annual rate of immigration of 6.0 per thousand.[12] If, as predicted, this trend accelerates so that the equivalent share from 2005-2050 is 82%, the equivalent rate of net migration will amount to 8.4 per thousand, assuming the overall rate of population growth remains the same.[13] When determining what fiscal policy is most advantageous for the population already resident in the country, it is important to remember that because immigrants are generally younger than the population that absorbs them, and in the United States their rates of total fertility are higher as well, the effective rate of immigration, in terms of their impact on the future size and composition of the population, is much larger than the published annual rates of net migration would imply.

I follow the procedure in Mendoza *et al.* (1994), Cooley and Prescott (1995) and Gomme and Rupert (2007) to calculate the tax rates on labour earnings (total compensation) and on the return to capital (which includes the implicit return on the stock of consumer durables), except that in Figure 5 the tax is imposed on returns net of depreciation. Given the tax rates, initial ratios of consumption, public debt and capital to output, as well as government consumption to net output g, the capital share in output α, the rate of natural population growth and the

[12] Jeffrey S. Passel and D'Vera Cohn, 2008, p. 2.
[13] *Ibid.*

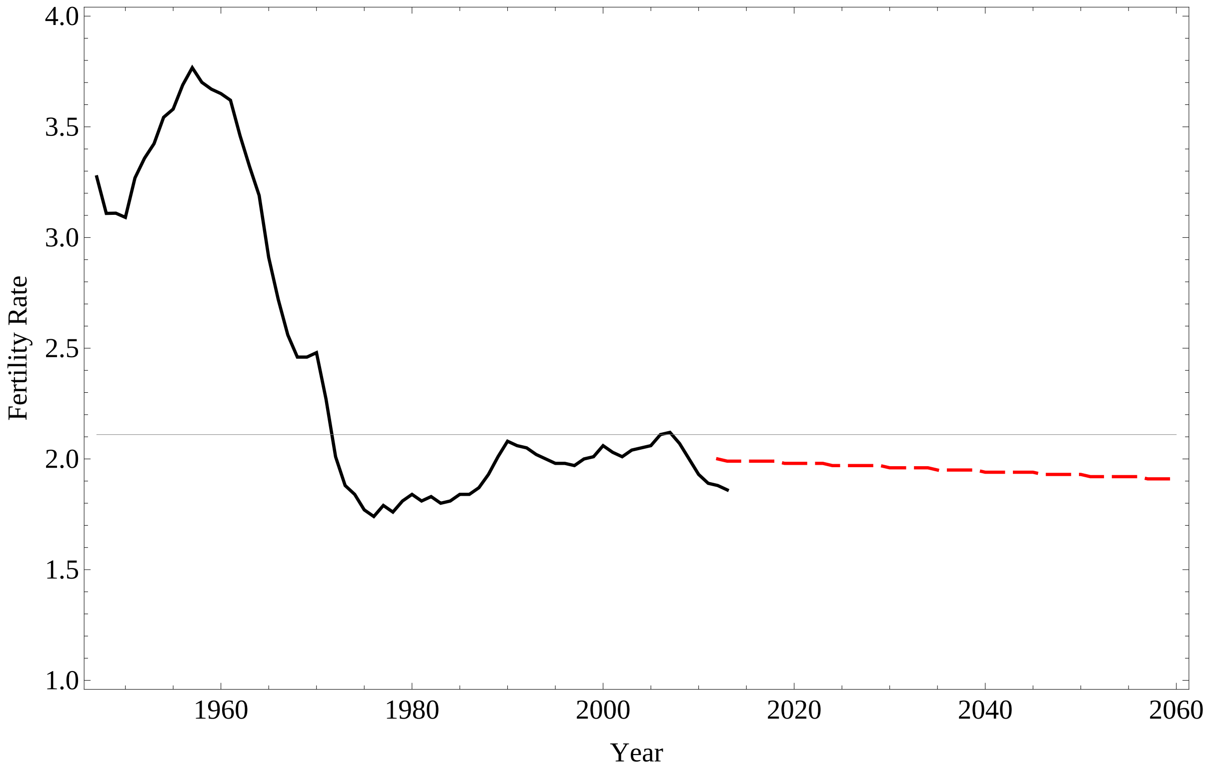

Figure 4: Total rate of fertility in the United States from 1947 to 2013 and US Census Projections for 2012 to 2060. *Sources*: OECD and US Census 2012 National Projections.

different rates of immigration chosen for the simulation, I solve (9), (10) and (11) in steady state to obtain the parameter values δ and ρ as well as the initial level of transfers.

My hypothesis is that as the source of population growth has shifted from one driven by the excess of births to deaths in the native population to one increasingly reliant on higher rates of immigration, and subsequent above-average birth rates among those newly arrived, a bias in favour of deficit funding on the part of the native population emerges. Such a change is inevitably driven by subtle shifts in attitudes and a consequent process of gradual adjustment I find it convenient to choose a specific date as a starting point for this policy in my analysis.

It took time before the changes in immigration policy signified by passage of Hart-Cellar in 1965 became apparent. Similarly, the passage of legislation that year which expanded the scope of welfare spending generated, along with changing demographics, a gradual rise in transfer payments over decades rather than one sharp increase. Indeed, the debt-to-GDP ratio continued its postwar decline before stabilising during the late 1970's. Furthermore, although the growing gap between expenditures on transfer payments and tax receipts on labour earnings is what largely drives projections of future exponential growth in the debt burden, until very recently, both rose in tandem. Instead, from the early 1980's onward, it is the tax rate on capital, which declines sharply in Figure 5, that generated most of the increase in debt in Figure 2. Therefore, to calibrate the parameters of the model, including the overall rate of population growth, I use long-run averages for the years between 1966 and 2012, but to set the initial value of the tax rate on capital income, I average over the period between 1966 to 1980. As the aim of this work

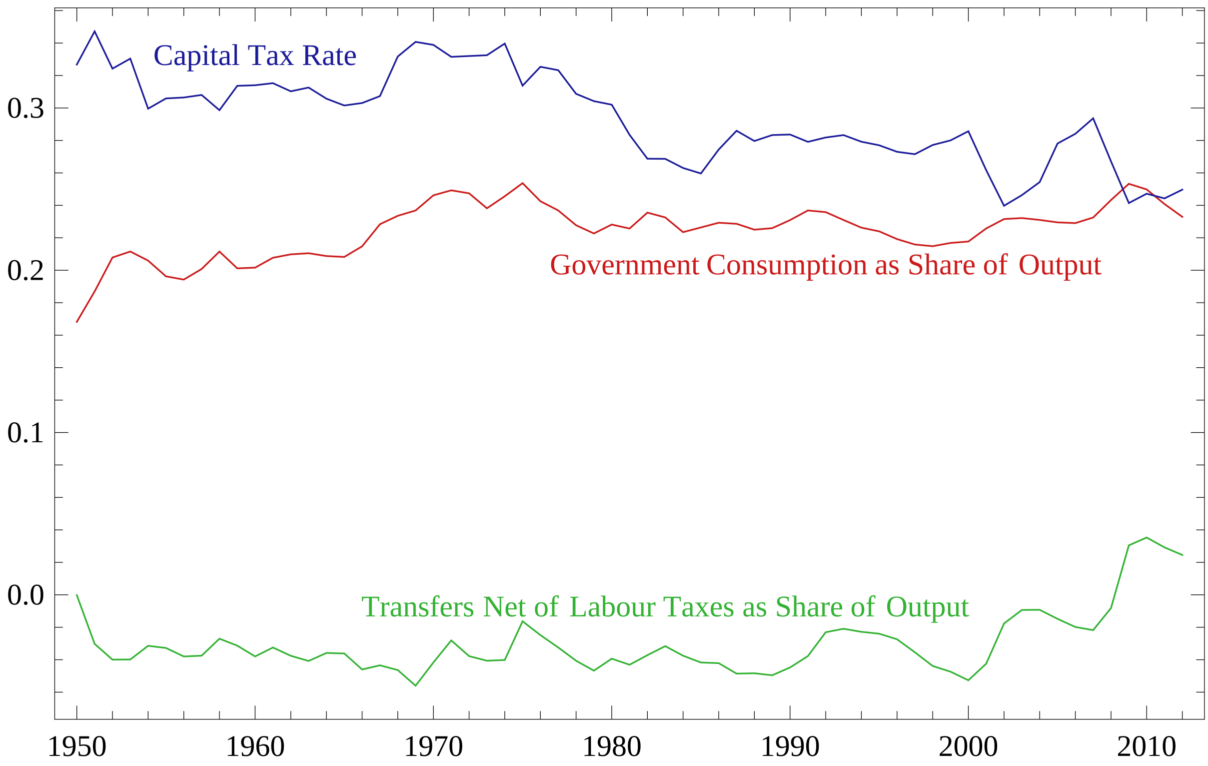

Figure 5: The average rates of tax on income from capital and income from labour earnings in the United States, 1970-2012 are imputed using National Accounts data following the procedure outlined in Gomme and Rupert (2007). Government expenditure (Federal, State and Local), is a share of output, where output includes imputed services from consumer durables.

is to explain both the rise in United States public debt over recent decades, and its projected increase in the decades to come, I solve for steady state values that are consistent with the ratio of public debt to output during 1981, rather than taking an average across the entire period. Labour supply in the model is inelastic, so the value of transfers, net of tax receipts from labour earnings, serves as a residual, and is set to ensure that for the different rates of immigration, the government's budget is initially balanced.

Following the example of Cooley and Prescott (1995) and Gomme and Rupert (2007), henceforth output Y includes both gross domestic product and the imputed services from consumer durables. Between 1966 and 2012 this measure of output was on average 8.07% higher than GDP alone. During this same period, the capital-output ratio K/Y averaged 3.061, consumption as a share of output C/Y averaged 0.586, and the rate at which real per-capita output grew, x, averaged 0.019 per annum. The share of government consumption and investment g out of net output (including services from consumer durables but excluding depreciation of fixed assets) averaged 0.220. The share of capital income in output, including net interest payments, profits, and rental income, as well as the identical share of proprietors' income together averaged 0.376. I use that for the value of α. In 1981, the stock of US public debt corresponded to 24.6% of GDP, which implies a debt-to-output ratio of 0.227, in terms of our more broadly defined output. Between 1966 and 1981 the imputed tax rates on income from capital in Figure

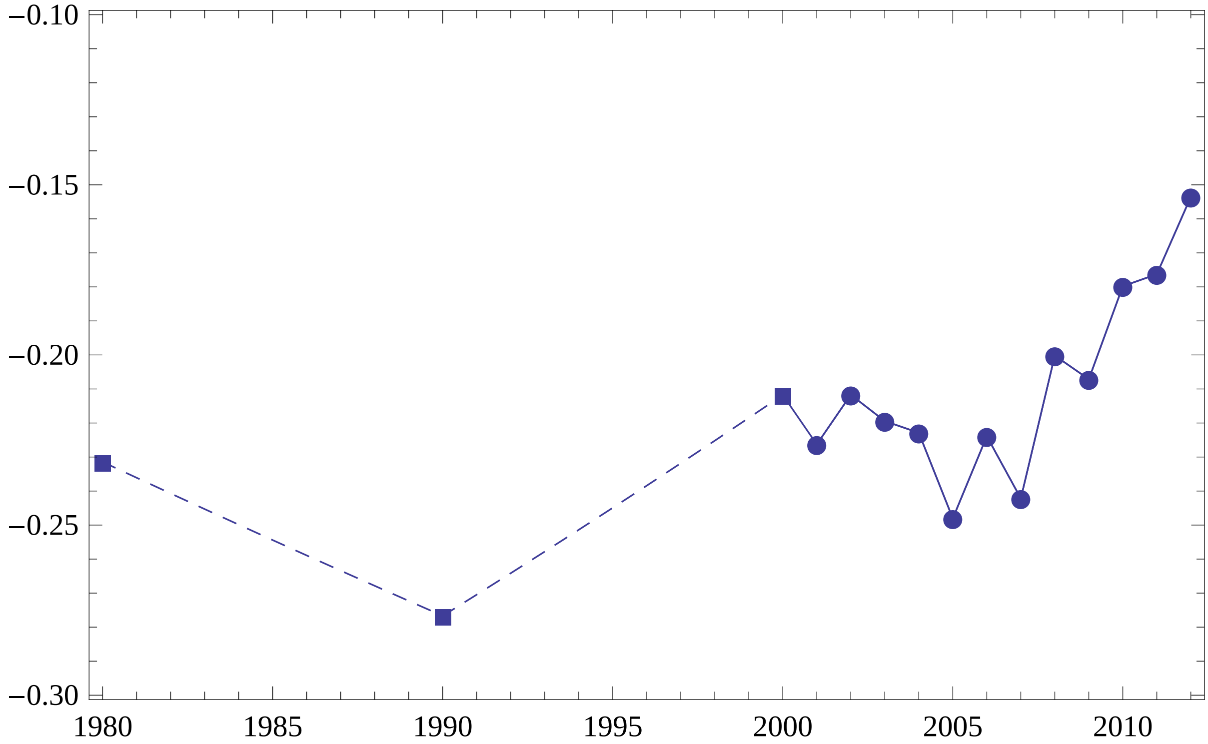

Figure 6: Difference in imputed wage rates for new immigrants (five years or less in the United States) in the work force and all other workers aged 16 to 64, controlling for age. Data from 5% public use micro samples for the years 1980, 1990 and 2000, and survey data from the American Community Survey for each of the years from 2001 to 2012. *Data Source*: Steven Ruggles, J. Trent Alexander, Katie Genadek, Ronald Goeken, Matthew B. Schroeder, and Matthew Sobek. Integrated Public Use Microdata Series: Version 5.0 [Machine-readable database]. Minneapolis: University of Minnesota, 2010.

5 averaged 0.320, and the average imputed tax rate on labour income between 1966 and 2012 was 0.242.

As natural population growth declined and immigration rose, the overall growth rate declined gradually, varying between 7.3 and 14.0 per thousand and averaging 10.3. In my analysis, I fix the overall rate of population growth at this average rate throughout, and vary the share of that growth generated by immigration. I assume κ=1 and β=1—immigrants arrive in the United States after having exhausted during their passage whatever capital they might have owned, and do not arrive owning US government debt.

Finally, I assume the term $\xi(t)$ which captures the productivity of new immigrants of vintage t relative to the veteran population, evolves according to $\xi(t) = e^{-\int_0^t \gamma(v)dv}$. If both the rate of immigration $m\left(t\right)$ and the parameter $\gamma\left(v\right)$ are constant, the difference between the productivity of newly arrived immigrants and the average productivity of the entire stock of workers that had previously joined the economy is equal to $\gamma/\left(\gamma - m\right)$. To determine this value, I use the 5% public use micro samples for the years 1980, 1990 and 2000, and survey data from the American Community Survey for each of the years from 2001 to 2012, to estimate simple wage equations in semi-logarithmic form for people between the ages of 16 and 64 who report being in the labour force. The wage rate is approximated by reported annual income from wages divided by the usual number of hours worked in a week. Controlling for age, and interpolating the results for the years between 1980 and 1990 and then from 1990 to 2000 in Figure 6, the imputed wage rate for newly arrived immigrants (five years or less in the United States) is on average 23.4% below that of all other workers. Rather than fixing the value of γ to one value, in each simulation, as the rate of net migration is varied, γ is set to match this finding. To better understand the role this factor plays in my results, I also simulate the model when the value of the productivity differential $\gamma / (\gamma - m)$ is set equal to zero.

4 Intertemporal Shifts in Labour Taxation and Transfers

I start with labour taxation and transfers because intertemporal shifts in either are the simplest to interpret. This is because transfer payments and tax revenue collected on labour earnings enter the model directly only through (11), and only affect the behaviour of the economy through the changes generated by the difference between them in the size of the public debt. In fact, only when the economy is absorbing new immigrants does the rate of tax on labour earnings, transfers or the size of the debt in (9) affect consumption, investment or the rate of return to capital.

Government spending on transfer payments has risen steadily for decades, from 5.63% of total output in 1966 to 16.7% in 2012. Yet as Figure 5 demonstrates, only in recent years has the tax revenue collected on labour earnings failed to keep pace. Nonetheless, as the average age of the population continues to rise, it is the expectation that the gap between the two will continue to widen that drives projected future increases in debt in Figure 2. In all likelihood, any policy of fiscal consolidation designed to eventually stabilise the burden of debt will involve increases in the tax rate on wage income (through higher FICA contributions to stabilise the Social Security Trust Fund) rather than cuts to the overall amount spent on transfer programmes, so my analysis focuses on this scenario. However, it is important to emphasise that here, unlike in the sections that follow, this distinction is not overly important. Instead it is the difference between what the government spends on transfer payments and the revenue it raises by taxing labour income that determines the trajectory of debt and its subsequent impact on welfare.

In keeping with the time scales in Figures 1 and 2, I assume a very high degree of policy stickiness—the period between the initial rise in transfers until the moment of fiscal consolidations when taxes must rise to satisfy (15) lasts $T = 40$ years. This baseline case roughly matches a rise in transfer spending, net of labour tax receipts, that commence at the beginning of this decade, with debt accruing faster than the growth rate of the economy till mid-century in 2050, when according to the Alternative Fiscal Scenario published by the CBO the debt will exceed what it deems to be the unsustainable level corresponding to 250% of output. I also consider larger values of $T = 55$ and $T = 70$, to enable ready comparisons with the policy of shifting the tax rate on capital income in Section 5—a policy that began in the early 1980's and was responsible for most of the increase in the debt so far.

To offer but one example, suppose spending on transfers in (11) permanently increases by the equivalent of one and a half percent of initial output. The payments accrue to the population already resident at the moment the policy changes, but in subsequent years, as new immigrants arrive, they too receive these payments, which increase at a fixed rate to keep pace with the growing population and the economy's exogenous long-run growth rate. The more time elapses before the tax on wages is raised to stabilise the debt, the more debt accumulates and the larger the corresponding tax increase necessary to exactly satisfy the transversality condition (3) and the government's intertemporal budget constraint (15). That means that after the fiscal consolidation in period T, the new long-run tax rate on wages is adjusted permanently to continue funding the higher transfer payments as well as the fixed share of government expenditure in net output, and to service both the stock of pre-existing public debt and any additional public debt that has accumulated in the interim. I set the difference in relative productivity between the general population and newly arrived immigrants to $\gamma/(\gamma-m)$=-0.234 as implied by Figure 6, but for the purposes of comparison I also consider the case where there is no productivity differential and $\gamma/(\gamma-m)$=0, and consider rates of immigration m that range between zero and ten per thousand, implying in the latter case that nearly all population growth is generated by net migration.

For each value of T and rate of immigration m, the third column in Table 1 lists the changes to the debt burden by period T.[14] After $T = 40$ years, the additional accumulated debt is equivalent to 102.0% of output if the rate of immigration is zero, but climbs in small increments as the rate of immigration is increased to 104.0% if the rate of immigration is ten per thousand. The fourth column captures the small changes to the long-run debt burden, if any, that occur after T as the capital stock and output converge. The differences here are even smaller, varying between the same 102.0% of output if immigration is zero and 103.5% when it is ten. The stabilisation of the debt burden is accomplished by raising the rate of tax on labour from its initial value of 0.242 from T onwards, and the new tax rates that accompany fiscal consolidation are listed in the fifth column and range from 0.306 to 0.308. If we raise the value of T to 55 years, so that the increase in transfer payments either commences fifteen years earlier or fiscal consolidation is postponed by an additional fifteen years, the economy accumulates additional long-run debt that range between 174.5% and 179.3% of output, and the corresponding labour tax rates necessary to service it ranges between 0.335 and 0.340. Increase the value of T to 70 and the corresponding increments to the debt burden and long-run tax rates range between 279.2% and 292.3%, and 0.376 and 0.388, respectively.

A country that receives no new immigrants is very different from one absorbing them at the rate of one percent per year. Yet those differences are hardly manifested in the behaviour of additional accumulation of debt or new tax rates presented above. Certainly in this example, it cannot be said that the flow of immigrants serves to dilute public debt. Furthermore, a comparison of the upper and lower halves of Table 1 demonstrates that changing the value of $\gamma/(\gamma-m)$ to zero so that all workers, including new immigrants, are equally productive

[14]To capture the non-linearities of transition paths, I assemble Padé approximants of order (2,1) using first, second and third order perturbations.

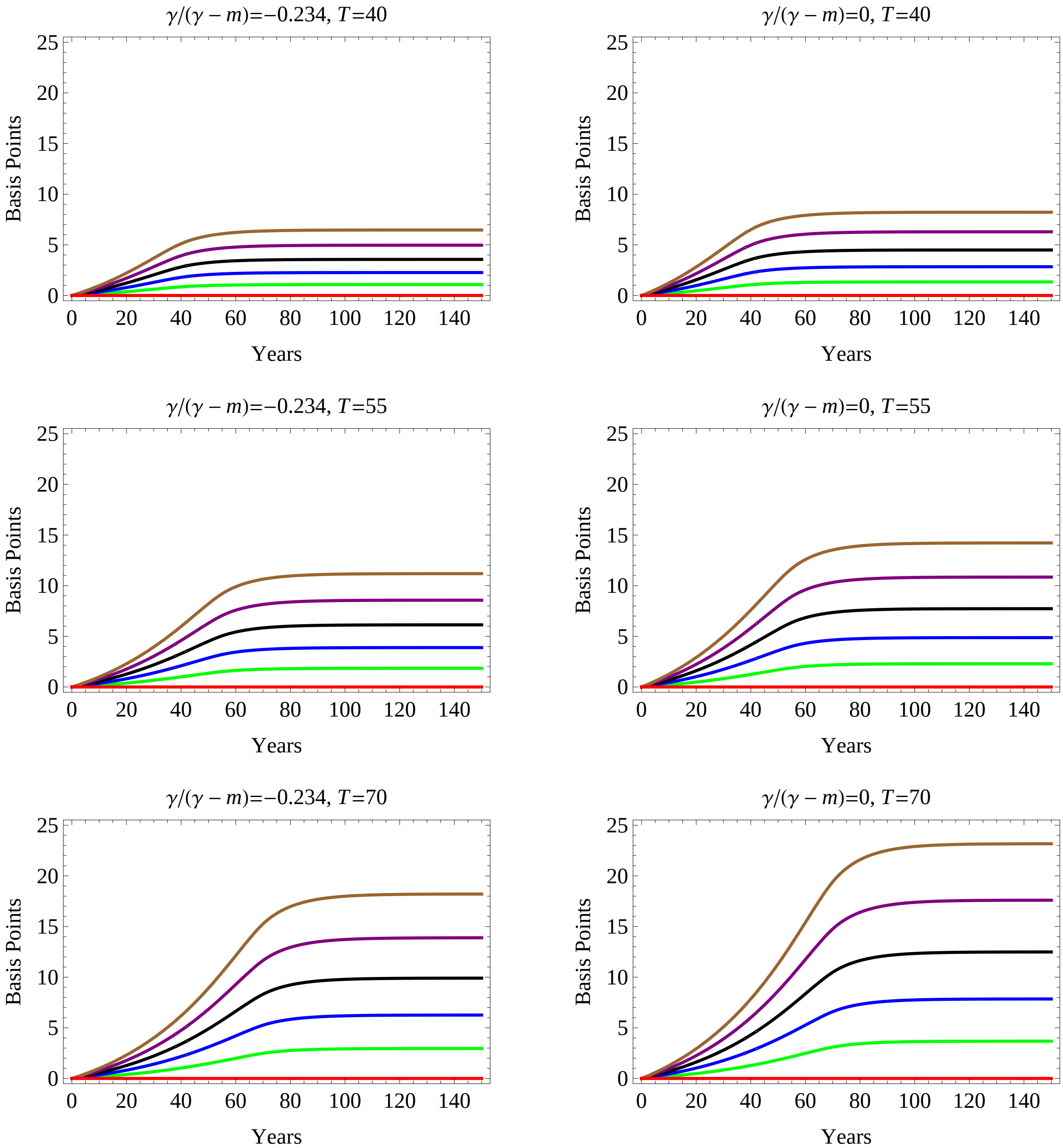

Figure 7: Increasing transfer payments by 1.5% of output and then raising tax rate on wage earnings in T=40, 55 or 70 years. Impulse responses for net the rate of return, change in basis points, for different annual rates of immigration per thousand of zero: red, two: green, four: blue, six: black, eight: purple, ten: brown. Overall rate of population change is 10.3 per thousand.

does not alter this pattern. Yet though differences in rates of immigration barely alter the path of debt or subsequant tax rates on labour earnings, it is the rate of immigration that determines the impact upon the welfare of the population already resident in the country of a policy to permanently increase transfer payments for all, while resorting to deficit finance over a prolonged period to pay for them.

To demonstrate, I plot the impulse responses in Figure 7 for the rate of return on assets following the increase in transfer spending. Note how in each example the magnitude of the response directly relates to the rate of immigration. To see why, note that the last term in (9), $\kappa(t)\,\tilde{k}(t)$ where $\kappa(t) > 0$, multiplied by the rate of immigration $m(t)$ and corrected by the term that governs the relative productivity of new immigrants $\frac{P(t)\xi(t)}{\Xi(t)}$, captures the dynamic form of the immigration surplus—a measure of how the supply of labour provided by immigrant workers complements the stock of native-owned capital and raises its rate of return. For our baseline case, where $T = 40$ and $\gamma/(\gamma - m) =$- 0.234, each unit increment in the underlying rate of immigration, from zero to ten per thousand, corresponds to between one and a half and two basis points in the long-run response of the rate of return on assets that follows the increase in spending of one and a half percent of output. These higher rates of return boost the growth rate of each household's consumption in (4). This effect might seem small, but it is cumulative, and by reinforcing the immigration surplus it generates a large enough wealth effect, that upon impact, consumption in the sixth (penultimate) column of Table 1 increases despite the anticipated rise in interest rates.

This does not mean that the boost to the immigration surplus is a Pareto improving shift towards dynamic efficiency. The rate of return to capital is always higher than the growth rate of the economy. Instead, new immigrants pay higher taxes on the wages they receive to service the debt accumulated before they arrived. As public debt gradually crowds out some investment in physical capital, so pre-tax wages, upon which immigrants who arrive with few assets disproportionately rely, also decline.

By maximising the welfare of those resident at time t=0, I mean maximising the intertemporal utility of the infinite-lived dynasties. It must be emphasized that this is not a mechanism for intergenerational redistribution or conflict. Policy makers are implicitly concerned not only with the welfare of today's population but with the welfare of all of its descendants. The only people whose interests I assume are ignored are those of the future immigrants yet to arrive in the country at the time when the policy is determined, as well as their descendents.[15]

To measure the welfare implications of these policies I compare the discounted welfare generated by the evolution of $c(0, t)$, the per-capita consumption of anyone already resident in the country at time t=0, against the discounted welfare generated by the analogous counterfactual

[15]Even if the policy were re-evaluated in each period, and immigration were the sole source of all population growth, it would take more than seventy years for the accumulated stock of new immigrants who arrive after t=0 to form a majority. Hence policies that serve the interests of the entire population when they are introduced, though not strictly time consistent because of the presence of capital in the economy, do benefit the majority of the population for far longer than the highest value of T in my simulations.

consumption path $\bar{c}(0,t)$, were the initial policy of budget balance to remain in force:

$$\int_0^\infty e^{(n-\rho)t} \ln c\,(0,t)\,dt = \int_0^\infty e^{(n-\rho)t} \ln \left[\left(1 + \frac{p_{m,\gamma,T}}{100} \right) \bar{c}(0,t) \right] dt. \tag{16}$$

The difference between the two, the welfare effect, is measured as a compensating differential—a permanent percentage $p_{m,\gamma,T}$ of consumption sufficient to compensate native households for not deviating from the baseline fiscal policy. Inserting (4) into (16) and solving for $p_{m,\gamma,T}$ yields:

$$p_{m,\gamma,T} = 100 \times \left(\frac{c\,(0,0)}{\bar{c}\,(0,0)} e^{(\rho-n)\int_0^\infty \int_0^t e^{(n-\rho)t}((1-\tau_k(v))r(v))dvdt - \frac{(1-\bar{\tau}_k)\bar{r}}{\rho-n}} - 1 \right). \tag{17}$$

The values of $p_{m,\gamma,T}$ that correspond to the policy of increased spending on transfers are listed in the last column of Table 1, and it is here where the changes to the rate of return to capital associated with different rates of immigration find their expression. For the baseline case where the debt is stabilised after forty years, the benefit that accrues to the native population is equivalent to a permanent increase in consumption of 0.159% if the rate of immigration is two per thousand. Double the rate of immigration to four per thousand and the benefit nearly doubles as well to 0.412%. Figure 8 illustrates the near linear relationship between the rate of immigration and the value of $p_{m,\gamma,T}$ associated with this particular policy. Increase the time span between the rise in expenditures and the rise in the taxes to pay for them by fifteen or thirty years, and the corresponding welfare benefit climbs to 0.216% and 0.417% or 0.273% and 0.522%. Eliminate the productivity gap between new immigrants and the general population in the right hand panel of Figure 8, and the bottom half of Table 1 raises the value of $p_{m,\gamma,T}$ as well. A rate of immigration of approximately four per thousand best matches the raw projections we see in Figure 3, but this might not be the number most relevant in the context of the model. If as explained in Section 3 we adjust the rate of migration to capture the higher fertility of new immigrants, the appropriate share of future population growth from 1980 onwards is at least 6.0 and perhaps as high as 8.4, and the welfare benefits natives enjoy as a result of this policy approach the equivalent of permanently raising consumption by one percent.

To achieve welfare gains significantly higher requires a far more aggressive degree of deficit spending. This is certainly a theoretical possibility—the red, green, blue, black, purple and brown curves, corresponding to annual rates of immigration of zero, two, four, six eight and ten per thousand, in the six panels in Figure 9 illustrate that for a given value of T, rate of migration m, and measure of relative productivity differential $\gamma/(\gamma-m)$, there is a nearly linear relationship between changes to the long-run debt burden and the corresponding welfare measure $p_{m,\gamma,T}$. The red curves are horizontal lines, as shifting transfers and labour taxes across time if the economy is not absorbing new immigrants is Ricardian neutral, but the slopes of the remaining curves are positive and increasing in the rate of immigration. A permanent increase in transfer payments that causes the debt burden to climb by 225% of output in the space of seventy years, a trajectory that matches the predictions of the CBO's Alternative Fiscal Scenario, corresponds to a welfare gain equivalent to a 0.6% increase in consumption if the effective rate of immigration is six per thousand, and 0.8% if the rate of immigration is eight. Assume the debt reaches 500% instead (setting aside the practical limitations of sustaining a debt of this magnitude), and the corresponding welfare measures are 1.2% and 1.6%. Note also

	New Immigrants Per Thousand	Δ Debt as Percent of Output at T :	Δ Debt as Percent of Output Long-Run	Labour Tax Rate after T	Initial Change in Native Consumption	Welfare as Percent of Permanent Consumption
		$100\times\Delta\frac{b(T)}{y(T)}$	$100\times\Delta\frac{b(\infty)}{y(\infty)}$	$\tau_h(t>T)$	$100\times\left(\frac{c(0,0)}{\bar{c}(0,0)}-1\right)$	$p_{m,\gamma,T}$
		Relative Productivity of New Immigrants, $\gamma/(\gamma-m)$ = -0.234				
$T=40$	0	102.0	102.0	0.306	0	0
	2	102.3	102.2	0.306	0.010	0.159
	4	102.7	102.5	0.307	0.020	0.309
	6	103.1	102.8	0.307	0.031	0.451
	8	103.6	103.2	0.308	0.044	0.587
	10	104.0	103.5	0.308	0.056	0.716
$T=55$	0	174.5	174.5	0.335	0	0
	2	175.7	175.3	0.335	0.013	0.216
	4	177.0	176.2	0.336	0.027	0.417
	6	178.4	177.2	0.337	0.043	0.605
	8	179.9	178.2	0.339	0.059	0.780
	10	181.5	179.3	0.340	0.077	0.943
$T=70$	0	279.2	279.2	0.376	0	0
	2	282.6	281.5	0.378	0.013	0.273
	4	286.3	283.9	0.380	0.027	0.522
	6	290.3	286.5	0.383	0.043	0.751
	8	294.7	289.3	0.385	0.059	0.961
	10	299.4	292.3	0.388	0.077	1.155
		Relative Productivity of New Immigrants, $\gamma/(\gamma-m)$ =0				
$T=40$	0	102.0	102.0	0.306	0	0
	2	102.3	102.2	0.306	0.012	0.194
	4	102.6	102.5	0.307	0.025	0.376
	6	103.0	102.8	0.307	0.040	0.547
	8	103.4	103.2	0.307	0.055	0.707
	10	103.9	103.5	0.308	0.072	0.857
$T=55$	0	174.5	174.5	0.335	0	0
	2	175.6	175.2	0.335	0.012	0.264
	4	176.9	175.9	0.336	0.026	0.506
	6	178.3	176.8	0.337	0.040	0.728
	8	179.9	177.8	0.339	0.056	0.933
	10	181.6	178.8	0.340	0.073	1.121
$T=70$	0	279.2	279.2	0.376	0	0
	2	282.6	281.2	0.378	0.012	0.333
	4	286.6	283.5	0.380	0.025	0.631
	6	290.9	286.1	0.383	0.040	0.900
	8	295.7	288.9	0.386	0.055	1.142
	10	301.0	292.0	0.389	0.072	1.362

Table 1: Increasing transfer payments by 1.5% of output and then raising tax rate on wage earnings in T=40, 55 or 70 years.

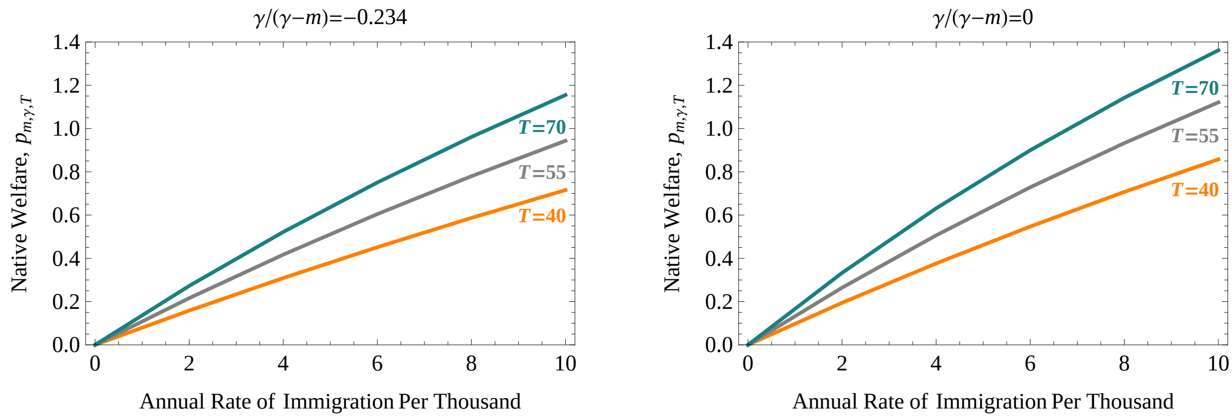

Figure 8: The values of the welfare measure for native households $p_{m,\gamma,T}$ that correspond to different rates of immigration after increasing transfer payments by 1.5% of output and then raising tax rate on wage earnings in T=40, 55 or 70 years.

that native workers stand to benefit more if the recent improvement in the relative productivity of immigrant workers as seen in Figure 6, continues. Were there no productivity gap between new immigrants and native workers, the welfare measures associated with reaching 250% in seventy years are 0.7% and 0.9%, again for rates of migration equivalent to six or eight per thousand. Finally, the longer a given tax cut prevails, the more natives benefit, but the larger the number of immigrant cohorts that arrive immediately after who also gain. This is why, as Figure 9 illustrates, natives benefit most from steeper tax cuts over shorter time spans rather than longer-lasting but more modest tax cuts. For a given long-run debt burden, the smaller the value of T, the higher values of $p_{m,\gamma,T}$.

What this means is that, if we assume immigrants' overall contribution to population growth implies an effective rate of immigration between 2011 and 2050 of about eight per thousand, that tax rates do not rise so that the debt is permitted to climb to 250% of output during these forty years (as predicted in the Alternative Fiscal Scenario in Figure 2), followed by a rise in the tax rate on labour earnings, the corresponding benefit to the native population will be equivalent to approximately a permanent 1.3% increase in consumption. And this is without considering how much transfer spending is skewed in favour of older natives rather than younger new immigrants. Were the debt to climb even faster the benefits could be larger still. We are left with a puzzle—from the perspective of the native population, the scope for increasing transfer payments and using deficit finance to enhance their own welfare is underutilised, or there are other constraints on the accumulation of debt beyond the scope of the model.

5 Intertemporal Shifts in Capital Taxation

In an optimal growth model, the long-run supply of capital is infinitely elastic, so fluctuations in the tax on income from capital have the greatest potential to increase excess burden. Nonetheless, when the economy is absorbing new immigrants the gains that accrue to the native

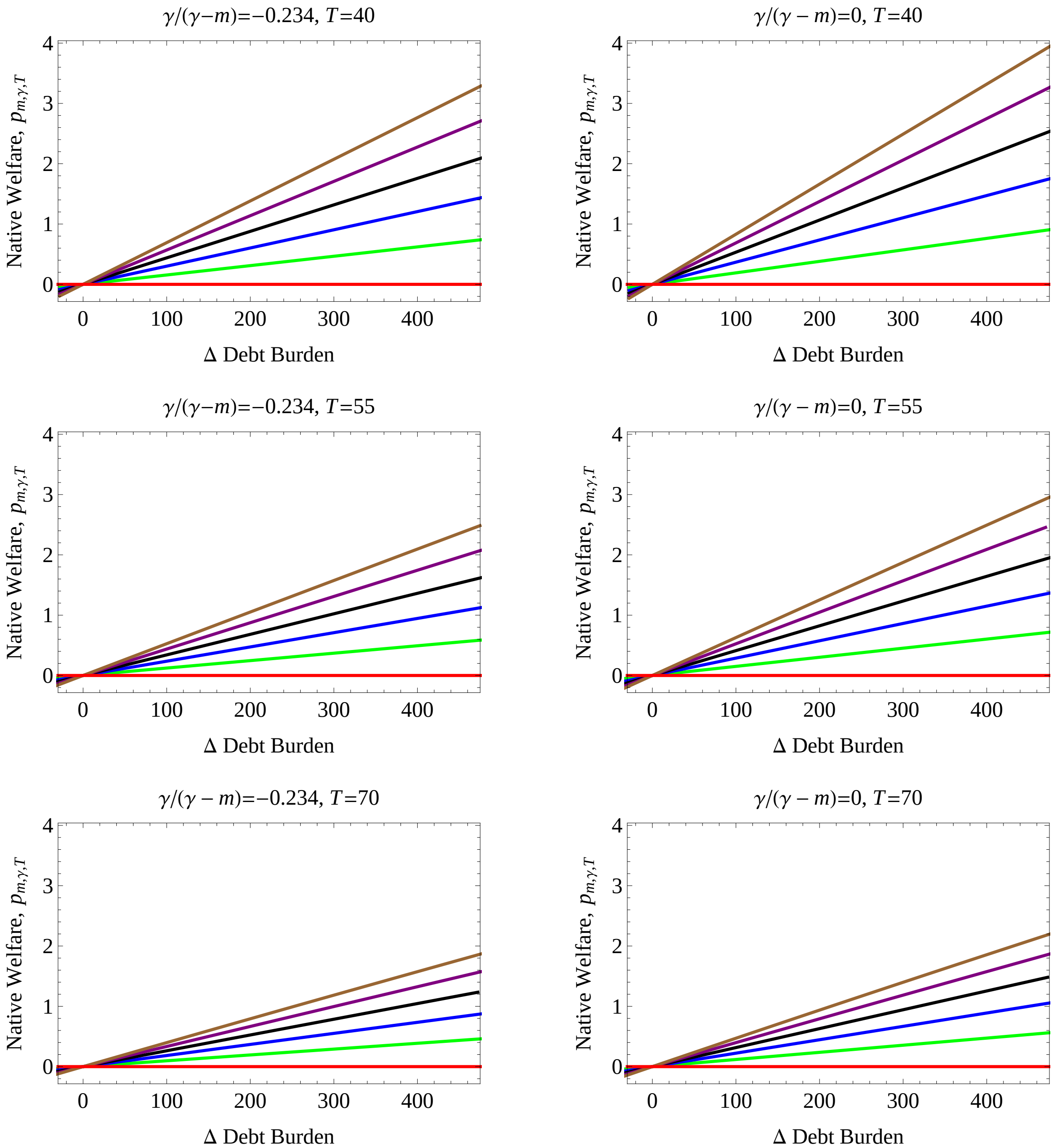

Figure 9: The values of the welfare measure for native households $p_{m,\gamma,T}$ and the long-term debt burden generated by increasing transfer payments and then raising the tax rate on wage earnings in T=40, 55 or 70 years. Impulse responses for net the rate of return, change in basis points, for different annual rates of immigration per thousand of zero: red, two: green, four: blue, six: black, eight: purple, ten: brown. Overall rate of population change is 10.3 per thousand.

population from shifting these taxes to the future will usually dominate the deadweight loss.

I calibrate the model by setting the tax rate on capital equal to 0.320, to match its average between 1966 and 1980. In the early 1980's this tax rate dropped quickly, and from 1981 till 2012, it averaged only 0.270. Were other taxes raised or spending reduced to compensate for the lost revenue, the policy change could be interpreted as simply reducing the relatively high excess burden associated with this tax. Instead, from 1981 onward (with a brief hiatus between 1994 and 2001) the debt burden has grown.

Consider the effect of lowering the tax rate on asset income from 0.32 to 0.27, starting in 1981 for T=40, 55 or 70 years. This is equivalent to assuming that a policy of fiscal consolidation to stabilise the government budget will commence either at the end of this decade in 2020, fifteen years later in 2035, or mid-century in 2050, when again, according to the Alternative Fiscal Scenario published by the CBO, the debt will exceed what it deems to be the unsustainable level corresponding to 250% of output.

Comparing the third and fourth columns in Tables 1 and 2, this policy generates changes in the debt burden that are roughly comparable to those associated with an increase in transfer spending of one and a half percent of output, particularly for higher values of T. However, there is an important difference: Unlike the case of intertemporal shifts in transfers and wage taxation, here the rate of return on capital is not only gradually and indirectly affected by the accumulation of debt through (11), but immediately and directly through (9). Hence the impulse responses in Figure 7 describing the behaviour of the net rate of return on assets bear little resemblance to those in Figure 10. The after-tax rate of return rises by approximately 39 basis points on impact. From this moment it begins to decline, the effect of the lower tax rate on savings and the accumulation of physical capital initially dominating any crowding out from the growing burden of public debt, before reversing direction again and increasing as the date T draws closer, and agents reduce investment in new capital in anticipation of the higher taxes they will soon pay. Though difficult to discern given the scale of the shifts in the impulse responses over time, comparing any two, the one that corresponds to a higher rate of immigration dominates its counterpart at every point in time. Ultimately, in the very long run, after all the fluctuations, if the rate of immigration is positive, higher debt translates into permanently higher rates of return, even after accounting for the higher taxes paid on it (listed in the sixth column of Table 2), but only after a period of transition that lasts for decades long after T. In the initial response to this type of policy, in contrast to cuts in labour taxes, here the substitution effect dominates any income effect—natives immediately lower consumption by 0.3 to 0.33% to take advantage of the higher rates of return.

Using the formula (17) to compute welfare, in the absence of immigration, there would be no justification visible in the last column of Table 2 for the policy adopted in the early 1980's of lowering the rate of taxation on asset income from 0.32 to 0.2, if in fact it is only to be raised sometime in the future. As the debt burden increases by 94.6%, 169.1% or 289.7% of output over the course of T=40, 55 or 70 years, the losses in welfare correspond to permanent drops of -0.178%, -0.295% or -0.488% in permanent consumption. Indeed, this particulary policy only generates positive values of $p_{m,\gamma,T}$ in Figure 11 if the annual rate of immigration is higher than two to three per thousand. The distortionary effect of allowing this tax to fluctuate so much overwhelms the benefits of sharing the higher future tax burden with immigrants.

To illustrate this trade-off, I plot the values of $p_{m,\gamma,T}$ in Figure 12 that correspond to different changes in the debt burden.[16] Unlike shifting the tax burden on labour earnings in Figure 9, here the relationship is no longer monotonic. Instead, for each length of time T, value of relative productivity $\gamma/(\gamma - m)$ and positive rate of immigration m, the value of $p_{m,\gamma,T}$ increases the larger the long-term debt burden, but only to a point, after which the values decline and some eventually become negative. For the native population, temporary tax cuts are generally beneficial but only to a point. Table 3 lists the long-term change in the debt burden and welfare effects that correspond to the maximum compensating differentials $p^*_{m,\gamma,T}$ for each curve in Figure 12 along with the change in debt at time T, the tax rates on capital that prevail both between time zero and T and after T, and the initial change in consumption chosen by natives on impact.

Once again the shapes of the red curves, this time in Figure 12, tells us what would be the optimal policy if the economy were not absorbing any immigrants at all. The logic of Harberger's triangle nearly prevails—as in Lucas and Stokey (1983), in their model without capital, the convexity of the excess burden with respect to the tax rate implies the best policy is to smooth the tax rate over time, and not depart from steady state. However, there are two reasons why slight deviations from tax smoothing will generate small welfare benefits here. First, the short-run supply of capital is inelastic, so the lump-sum property of taxing it immediately at a higher rate is beneficial, particularly if the additional revenue is applied to a partial redemption of public debt, enabling lower taxes in the future.[17] Second, the model is not calibrated around the Ramsey second-best optimal policy—the tax rate on capital is higher than the share of government expenditure in output.[18] Raising the tax rate from period zero to T means that in the long run the economy will converge closer to a steady state that is Ramsey-optimal. These two reasons are why, in the absence of immigration, a policy that raises the tax on capital income in the short run to redeem part of the debt generates a very small welfare benefit.

As in Section 4, here too the lower the value of T, the smaller the number of immigrants who experience the period of lower taxation, which is why *ceteris paribus*, the quick accumulation of extra debt through steep cuts in labour taxation dominates a more gradual policy of longer duration. Here, however, there is a countervailing tax smoothing argument in favour of accumulating debt more gradually, through smaller tax cuts of longer duration. That is why for a given change in the long-run burden of debt, the value of $p_{m,\gamma,T}$ in Figure 12 is much less

[16] The endogeneity of capital supply means there is a Laffer curve that describes the amount of revenue the government can raise through higher taxes on capital income, and this in turn implies an upper limit on the amount of debt the government can accumulate through a policy that shifts this tax rate alone across time. This means future tax rates can be set no higher than 0.79, a range sufficient to service maximum debts of between 574% (when immigration is ten per thousand and all workers are equally productive) and 622% of output. As before, I will assume debt can reach nearly that high—500%.

[17] This is a direct implication of *Theorem* 3 in Chamley (1986).

[18] Because government expenditure in not a fixed amount but a fraction g of net output, the second-best long-run optimal policy is not the familiar Chamley-Judd result of eliminating the tax on income from capital and placing the burden of government finance on labor, but rather to set all taxes equal to g. See Ben-Gad (2014).

sensitive to different values of T than it is in Figure 9.

Note also that the vertical scale for the panels in Figure 9 is about three times higher than in Figure 12, so overall there is far less scope for using deficit finance for the benefit of native households when policy makers are constrained to shifting the tax rate on capital income rather than labour across time. If the rate of immigration is only two per thousand, and the fiscal gap is closed in T=40 years, then cutting the tax rate on capital income from 0.32 to 0.299 maximises the welfare of the native population. The debt burden increases by 37.4% of output from its initial value 22.7% of output at T=40, and then gradually declines to 59.0% once the economy has fully converged to its new balanced growth path. The welfare benefit generated by this policy is small, equivalent to permanently increasing consumption by only 0.014%. If the rate of immigration is double, four instead of two per thousand, the maximum welfare benefit rises to 0.107%, which is attained by first lowering the tax rate to 0.267. If the rate of immigration is doubled once more to eight per thousand, then the value of $p^*_{m,\gamma,T}$ climbs to 0.510%. Higher values of T mean the long-run debt rises more even though tax rates fluctuate less, but the values of $p^*_{m,\gamma,T}$ do not change much unless we assume the productivity of new immigrants matches that of the absorbing population in the lower half of Table 3.

Table 3 describes the hypothetical behaviour of policy makers using intertemporal shifts in the burden of capital taxation over a fixed interval of time as a tool for improving the welfare of the native population when the economy is absorbing immigrants at different rates. By contrast, Table 2 provides a rough description of one element of recent US fiscal history, the reduction in the tax rate on capital income from about 0.320 to 0.27 during the early 1980's and the accumulation of debt that followed. Is there any relationship between them? Yes, particularly if we focus on the case where fiscal consolidation is postponed till $T = 70$. The policy that maximises native welfare lowers the tax rate on capital to 0.276 if the effective rate of immigration is equal to six per thousand and to 0.264 if immigration is eight per thousand. In Figure 13, I plot the behaviour of the debt burden, measured in terms of GDP (rather than output, which here includes services from consumption goods), that corresponds to each of the maximising policies in Table 3 for the case where T=70 and $\gamma/(\gamma - m)$=-0.234, against both the historical record and its predicted path according to the Alternative Fiscal Scenario produced by the CBO. Note that the path corresponding to an immigration rate of six per thousand best matches both, suggesting the model could provide at least some explanation for the persistence of the US fiscal gap both in the past and perhaps in the future.

6 Shifting Taxes Between Labour and Capital

Of course there is no reason to assume that if at a given moment policy makers choose to lower a particular tax, this is the tax that decades later will be adjusted to ultimately stabilise the government's finances. In this section, I briefly analyse the degree to which the qualitative and quantitative results in Section 4 or 5 might be altered when the government switches between the two tax instruments.

Just as in Figure 9, the panels in Figure 14 represent the relationship between changes in

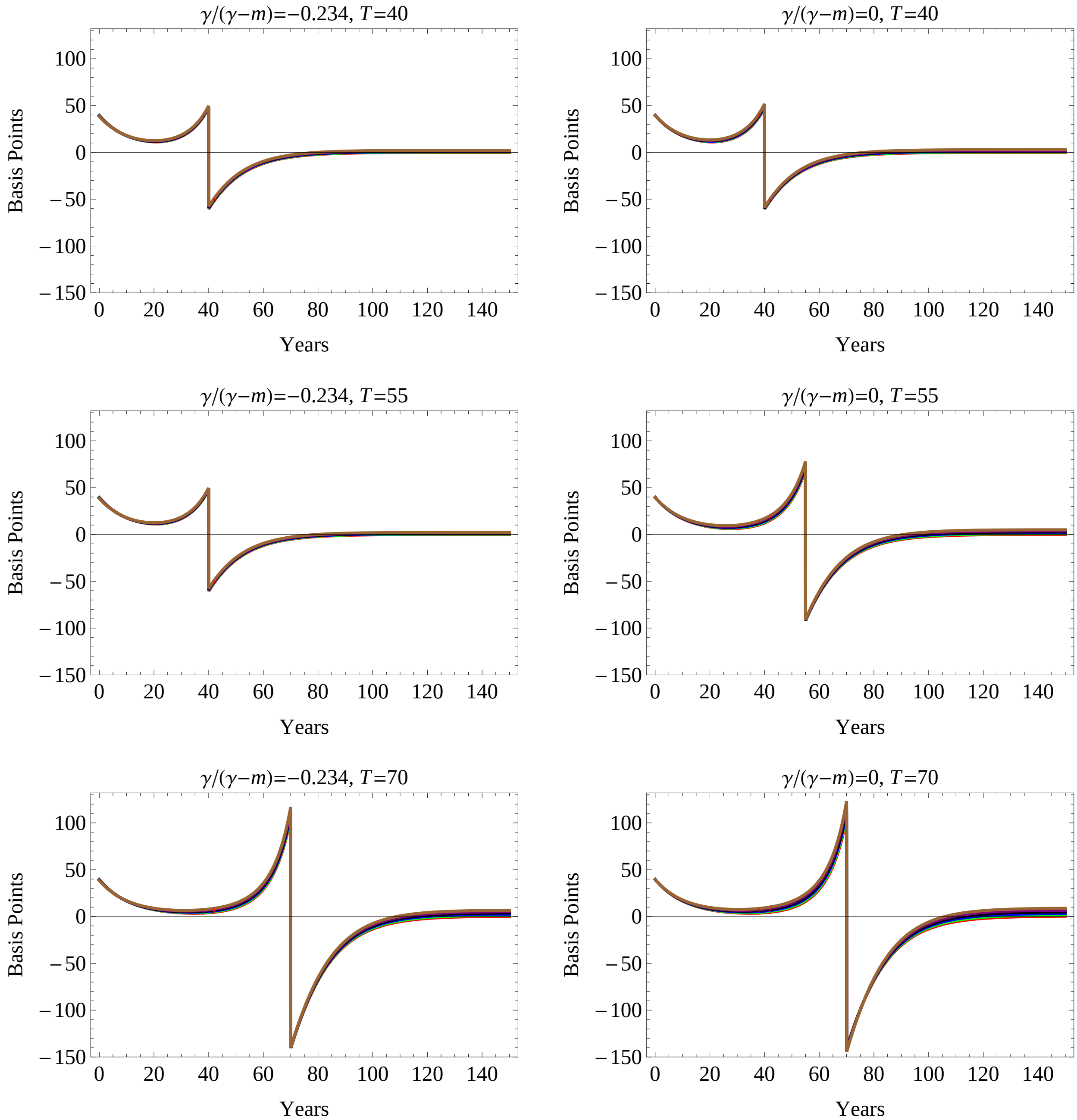

Figure 10: Temporarily lowering the tax rate on asset income for T=40, 55 or 70 years. Impulse responses for net the rate of return, change in basis points, for different annual rates of immigration per thousand of zero: red, two: green, four: blue, six: black, eight: purple, ten: brown. Overall rate of population change is 10.3 per thousand.

	New Immigrants Per Thousand	Δ Debt as Percent of Output at T :	Δ Debt as Percent of Output Long-Run	Capital Tax Rate after T	Initial Change in Native Consumption	Welfare as Percent of Permanent Consumption
		$100\times\Delta\frac{b(T)}{y(T)}$	$100\times\Delta\frac{b(\infty)}{y(\infty)}$	$\tau_k(t>T)$	$100\times\left(\frac{c(0,0)}{\bar{c}(0,0)}-1\right)$	$p_{m,\gamma,T}$
	Relative Productivity of New Immigrants, $\gamma/(\gamma-m)=-\ 0.234$					
$T=40$	0	94.6	89.0	0.405	−0.032	−0.178
	2	94.3	88.7	0.406	−0.032	−0.033
	4	94.0	88.5	0.406	−0.031	0.107
	6	93.8	88.2	0.407	−0.031	0.239
	8	93.6	88.0	0.407	−0.031	0.363
	10	93.3	87.8	0.408	−0.030	0.479
$T=55$	0	169.1	156.1	0.465	−0.033	−0.295
	2	169.1	156.0	0.466	−0.032	−0.090
	4	169.2	155.9	0.467	−0.032	0.106
	6	169.4	155.9	0.468	−0.032	0.285
	8	169.6	155.9	0.469	−0.031	0.451
	10	169.8	155.9	0.471	−0.031	0.604
$T=70$	0	289.7	261.7	0.550	−0.033	−0.488
	2	291.1	262.5	0.552	−0.033	−0.215
	4	292.8	263.5	0.555	−0.032	0.040
	6	294.8	264.7	0.558	−0.032	0.271
	8	297.0	266.0	0.561	−0.031	0.480
	10	299.4	267.5	0.564	−0.031	0.670
	Relative Productivity of New Immigrants, $\gamma/(\gamma-m)=0$					
$T=40$	0	94.6	89.0	0.405	−0.032	−0.178
	2	94.9	88.7	0.406	−0.032	−0.001
	4	95.2	88.5	0.406	−0.032	0.171
	6	95.6	88.2	0.407	−0.032	0.331
	8	95.9	88.0	0.407	−0.031	0.483
	10	96.3	87.8	0.408	−0.031	0.625
$T=55$	0	169.1	156.1	0.465	−0.033	−0.295
	2	170.2	156.7	0.466	−0.033	−0.045
	4	171.4	157.5	0.467	−0.032	0.192
	6	172.8	158.3	0.468	−0.032	0.409
	8	174.3	159.2	0.469	−0.032	0.609
	10	175.8	160.2	0.471	−0.032	0.794
$T=70$	0	289.7	261.7	0.550	−0.033	−0.488
	2	293.2	263.9	0.552	−0.033	−0.156
	4	297.2	266.4	0.555	−0.033	0.149
	6	301.7	269.2	0.559	−0.032	0.424
	8	306.7	272.4	0.562	−0.032	0.671
	10	312.1	275.8	0.566	−0.032	0.896

Table 2: The impact of temporarily lowering the tax rate on asset income by 5%.

	New Immigrants Per Thousand	Δ Debt as Percent of Output at T:	Δ Debt as Percent of Output Long-Run	Capital Tax Rate before T	Capital Tax Rate after T	Initial Change in Native Consumption	Welfare as Percent of Permanent Consumption
		$100{\times}\Delta\frac{b(T)}{y(T)}$	$100{\times}\Delta\frac{b(\infty)}{y(\infty)}$	$\tau_k(t<T)$	$\tau_k(t>T)$	$100\times\left(\frac{c(0,0)}{\bar{c}(0,0)}-1\right)$	$p^*_{m,\gamma,T}$
			Relative Productivity of New Immigrants, $\gamma/(\gamma-m)=-0.234$				
$T=40$	0	−21.7	−22.0	0.333	0.298	−22.0	0.009
	2	37.4	36.3	0.299	0.356	36.3	0.014
	4	100.3	94.0	0.267	0.411	94.0	0.107
	6	159.3	145.4	0.240	0.459	145.4	0.277
	8	221.6	198.0	0.214	0.506	198.0	0.510
	10	281.8	248.1	0.191	0.549	248.1	0.795
$T=55$	0	−14.4	−14.5	0.325	0.305	−14.5	0.004
	2	48.9	47.5	0.304	0.367	47.5	0.021
	4	127.6	119.5	0.281	0.435	119.5	0.121
	6	205.5	186.9	0.261	0.495	186.9	0.290
	8	275.5	245.8	0.245	0.545	245.8	0.514
	10	358.8	315.9	0.228	0.601	315.9	0.780
$T=70$	0	−9.2	−9.3	0.322	0.311	−9.3	0.002
	2	69.4	67.0	0.306	0.385	67.0	0.024
	4	160.1	149.1	0.290	0.461	149.1	0.123
	6	252.0	228.2	0.276	0.529	228.2	0.281
	8	342.9	305.1	0.264	0.590	305.1	0.484
	10	457.3	405.0	0.251	0.660	405.0	0.722
			Relative Productivity of New Immigrants, $\gamma/(\gamma-m)=0$				
$T=40$	0	−21.7	−22.0	0.333	0.298	−22.0	0.009
	2	52.8	50.8	0.291	0.370	50.8	0.028
	4	125.4	115.9	0.256	0.430	115.9	0.178
	6	199.1	178.5	0.225	0.485	178.5	0.436
	8	280.2	245.3	0.195	0.541	245.3	0.779
	10	350.7	303.6	0.173	0.587	303.6	1.189
$T=55$	0	−14.4	−14.5	0.325	0.305	−14.5	0.004
	2	72.2	69.2	0.297	0.387	69.2	0.037
	4	163.6	150.7	0.272	0.461	150.7	0.193
	6	258.2	230.5	0.250	0.528	230.5	0.445
	8	349.0	305.7	0.232	0.587	305.7	0.769
	10	455.2	396.5	0.214	0.651	396.5	1.148
$T=70$	0	−9.2	−9.3	0.322	0.311	−9.3	0.002
	2	91.2	87.2	0.302	0.404	87.2	0.041
	4	193.6	177.9	0.285	0.484	177.9	0.192
	6	309.3	275.7	0.269	0.563	275.7	0.424
	8	451.1	396.5	0.253	0.649	396.5	0.715
	10	521.8	460.3	0.247	0.688	460.3	1.050

Table 3: Temporarily lowering the tax rate on asset income to maximise welfare.

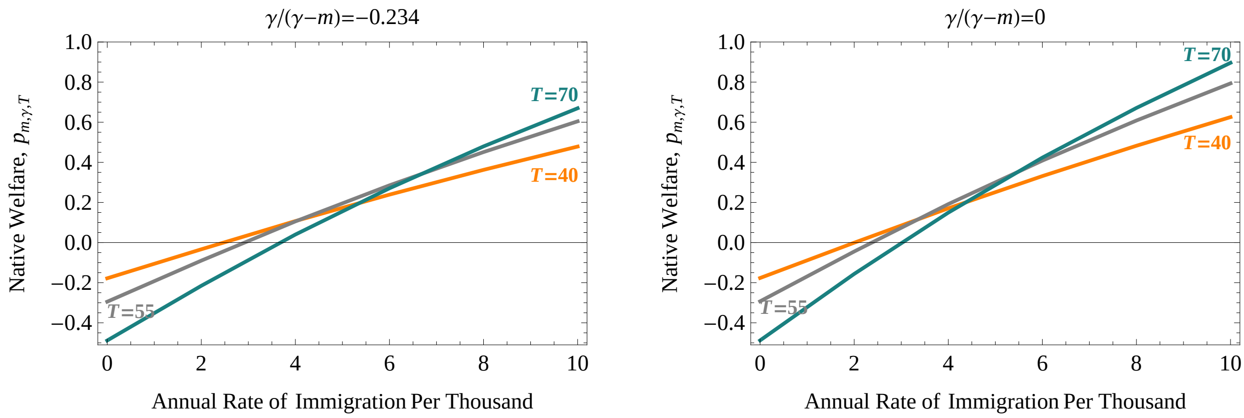

Figure 11: The values of the welfare measure for native households $p_{m,\gamma,T}$ that correspond to different rates of immigration after temporarily lowering the tax rate on asset income for T=40, 55 or 70 years.

the long-run debt burden following a sustained period when spending on transfer payments changes. The only difference is that now, rather than shifting the tax on labour earnings after T to satisfy (15), at time T = 40, 55, or 70 it is the tax rate on capital that changes. Given the way I calibrated the model, setting κ=1 and β=1, the incidence of the tax on asset income falls most heavily on natives and the tax on labour earnings on new immigrants, so any intratemporal shift in the burden from labour to capital is clearly not in the interests of the native population. Furthermore, the shift to higher capital taxation in the future entails an increase in the excess burden borne by everyone. Yet, even under these circumstances, provided the rate of immigration is sufficiently high, the value of $p_{m,\gamma,T}$ still increases if capital taxes ultimately rise to finance either more transfer spending or lower taxes on labour earnings, as long as the two changes are separated by a prolonged period of deficit finance.

These caveats are important. If the rate of immigration is only two per thousand, lower spending on transfers and lower debt is the preferred policy; reducing excess burden dominates the small benefits that can be derived from shifting the tax burden to the future. Furthermore, the maximum values attained by $p_{m,\gamma,T}$ in Figure 14 are much lower than in Sections 4 or 5. The highest possible value of $p_{m,\gamma,T}$, equivalent to a 0.502% increase in consumption, is attained in the lowest right-hand panel of Figure 14, when transfer payments rise by 1.222% of output. After seventy years and after the debt burden has risen by 309.4% of output, the tax on capital must be raised to 0.612 to stabilise government finances. What if we reverse this sequence so that lower tax rates on asset income are eventually paid for with higher taxes on labour? Indeed, how much might natives stand to gain if sometime in the future, the instrument chosen to replace the revenue lost from the drop from 0.32 to 0.27 in the tax rate on capital since the early 1980's is an increase in the taxes on wages rather than capital income?

Even in the absence of immigration, shifting the burden of taxation from the infinitely elastic capital to inelastic labour—even if this is done with a very long lag and public debt accumulates in the interim—generates small reductions in the excess burden that yield welfare

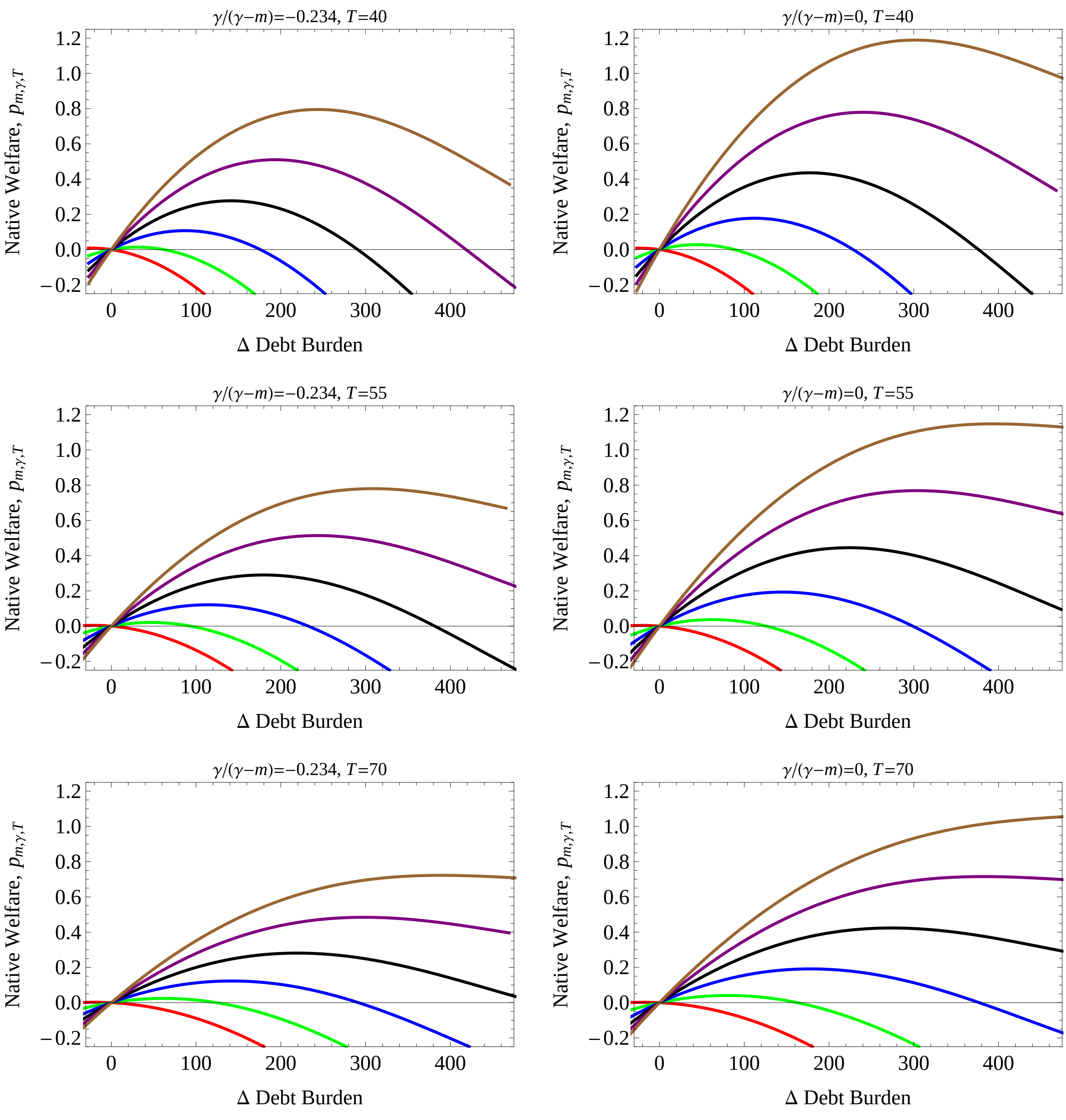

Figure 12: The values of the welfare measure for native households $p_{m,\gamma,T}$ and the long-term debt burden generated by temporarily lowering the tax rate on asset income for T=40, 55 or 70 years. Impulse responses for net the rate of return, change in basis points, for different annual rates of immigration per thousand of zero: red, two: green, four: blue, six: black, eight: purple, ten: brown. Overall rate of population change is 10.3 per thousand.

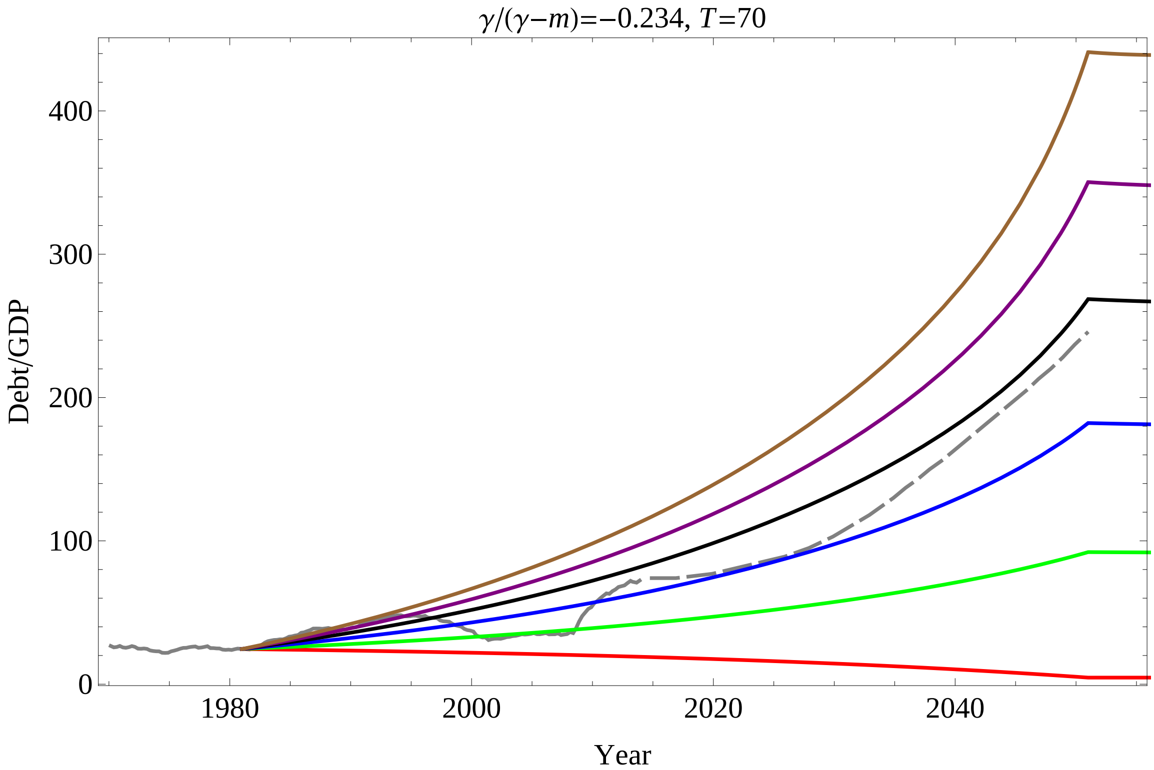

Figure 13: The trajectory of the ratio of bonds to GDP values generated by temporarily lowering the tax rate on asset income for T=70 years for different annual rates of immigration per thousand of zero: red, two: green, four: blue, six: black, eight: purple, ten: brown. Overall rate of population change is 10.3 per thousand. In the background in grey is the ratio of publicly-held debt to GDP from 1970 to 2013, and the CBO's Alternative Fiscal Scenario from 2014 to 2050.

benefits equivalent to permanently increasing consumption between 0.190% and 0.195%. Both this effect and the shift in the incidence of the tax from native-owned capital reinforce the benefit that accrues to the members of native households when taxes are postponed to the future. This is why the curves in Figure 15 are uniformly higher than their counterparts in Figure 11. Comparing the third and fourth columns in Table 2 and 4, the same decrease in the tax on capital also implies a smaller increase in the debt burden, because the permanently lowered tax on capital income incentivises higher investment.

Suppose again that once we factor in the difference in fertility rates between new immigrants and the general population, the contribution of international migration to population growth is equivalent to an effective rate of immigration of between six and eight per thousand. Assume as well that the current low tax rates on capital income introduced in the early 1980's are permanent. If the debt continues to rise until 2050, before the government stabilises its finances and does so by raising the tax on labour earnings, the value of $p_{m,\gamma,T}$ is between 0.803% and 0.977%, and possibly a bit more if the productivity of new immigrants continues to improve. From the perspective of the initial population, those whose families were already resident in the United States in 1981, this is a small but not inconsequential benefit. Along the way the

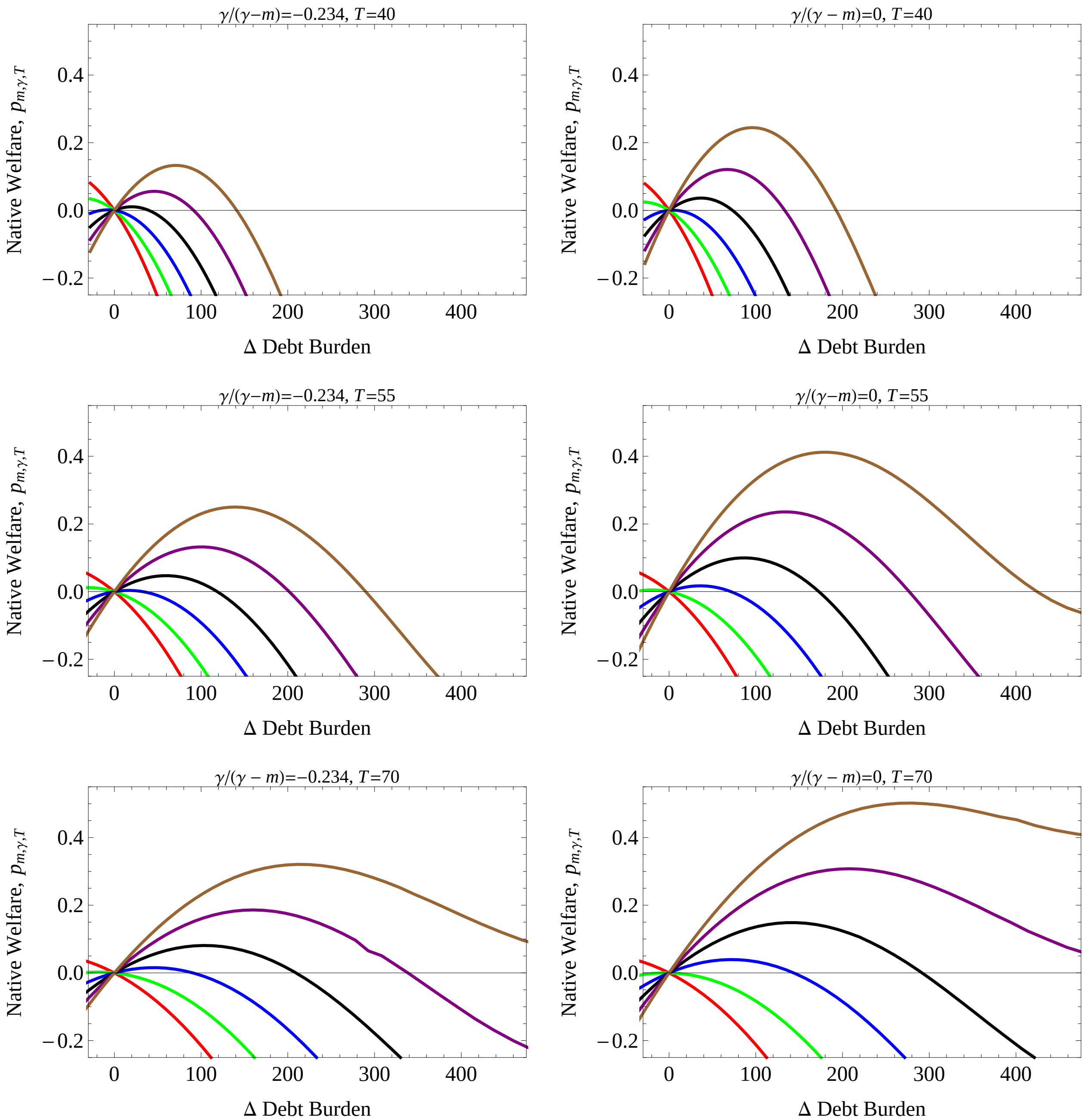

Figure 14: The values of the welfare measure for native households $p_{m,\gamma,T}$ and the long-term debt burden generated by increasing transfer payments and then raising the tax rate on asset income in T=40, 55 or 70 years. Impulse responses for net the rate of return, change in basis points, for different annual rates of immigration per thousand of zero: red, two: green, four: blue, six: black, eight: purple, ten: brown. Overall rate of population change is 10.3 per thousand.

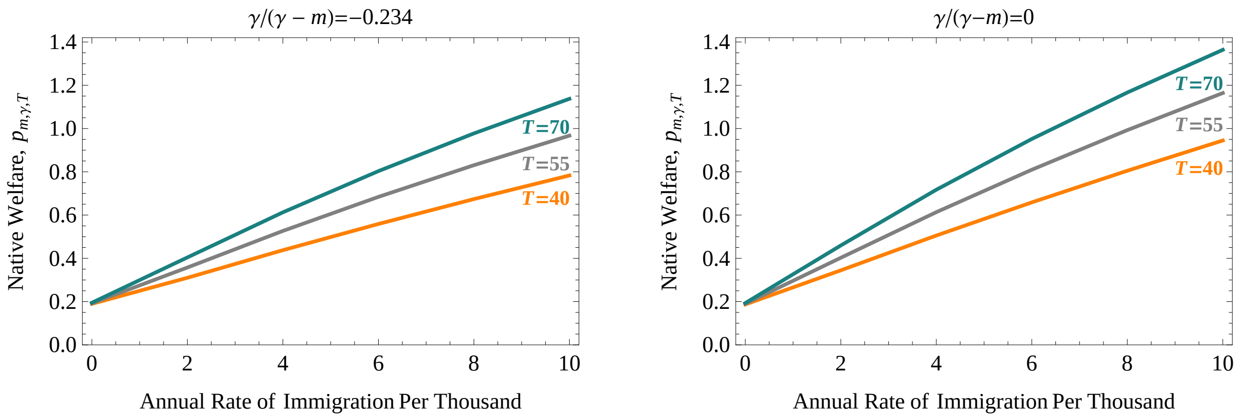

Figure 15: The values of the welfare measure for native households $p_{m,\gamma,T}$ that correspond to different rates of immigration after lowering the tax rate on asset income from 0.32 to 0.27 and then raising the tax rate on wage earnings after T=40, 55 or 70 years.

debt burden grows between 226.4% and 236.7% of output, and when added to the initial debt burden of 22.7% is a fairly close match to the projections of the Extended Baseline Scenario in Figure 2. Of course the monotonic relationship between more debt and higher values of $p_{m,\gamma,T}$ in Figure 16 leaves us with the same question first raised in Section 4. What are the additional objectives or constraints, absent from the model, that prevent policy makers from relying even more heavily on deficit finance than is already the case?

Still, in Figure 16 we see once again a monotonic relationship between more debt and higher values of $p_{m,\gamma,T}$ as in Figure 9 in Section 4. Unlike the temporary reductions in the tax rate on capital income in Section 5, the permanent reductions here mean that as in Figure 9, there is a positive monotonic relationship between the increase in long-run debt and the values of $p_{m,\gamma,T}$ in Figure 16. In fact, because of the shift in incidence and the reduction in the excess burden of capital income tax, the slopes are steeper. As is Section 4, recent policy clearly benefits native households, but were this the only consideration for policy makers the debt would be climbing even faster.

7 Discussion

In each panel in Figures 9 and 12 all the curves associated with strictly positive rates of immigration decline monotonically to the left of zero on the horizontal axis. This means that if the economy is absorbing even small numbers of immigrants, temporarily raising a particular tax rate to accumulate surpluses before lowering that same tax after time $t = T$ reduces welfare for the initial population. Indeed, the higher the rate of immigration, the more such a policy shifts the tax burden from future immigrants and towards the initial population. Hence the higher the rate of immigration, the steeper declines in welfare the latter will experience. What this implies is that economies that are absorbing relatively larger numbers of new immigrants are unlikely to run sustained budget surpluses to enable future reductions in tax. Instead, as

	New Immigrants Per Thousand	Δ Debt as Percent of Output at T :	Δ Debt as Percent of Output Long-Run	Labour Tax Rate after T	Initial Change in Native Consumption	Welfare as Percent of Permanent Consumption
		$100\times\Delta\frac{b(T)}{y(T)}$	$100\times\Delta\frac{b(\infty)}{y(\infty)}$	$\tau_h(t>T)$	$100\times\left(\frac{c(0,0)}{\bar{c}(0,0)}-1\right)$	$p_{m,\gamma,T}$
	Relative Productivity of New Immigrants, $\gamma/(\gamma-m)$ = -0.234					
$T=40$	0	84.4	83.1	0.269	−0.033	0.190
	2	84.2	82.8	0.269	−0.033	0.310
	4	84.0	82.6	0.269	−0.032	0.438
	6	83.9	82.4	0.269	−0.032	0.559
	8	83.7	82.2	0.269	−0.031	0.674
	10	83.6	82.0	0.269	−0.031	0.783
$T=55$	0	143.9	141.7	0.292	−0.033	0.192
	2	144.0	141.6	0.292	−0.033	0.358
	4	144.2	141.5	0.292	−0.032	0.527
	6	144.5	141.5	0.293	−0.032	0.684
	8	144.8	141.5	0.293	−0.031	0.830
	10	145.2	141.6	0.294	−0.031	0.967
$T=70$	0	229.7	226.4	0.325	−0.033	0.195
	2	230.9	226.9	0.326	−0.033	0.404
	4	232.4	227.5	0.327	−0.032	0.613
	6	234.1	228.2	0.328	−0.032	0.803
	8	236.0	229.1	0.330	−0.031	0.977
	10	238.1	230.0	0.331	−0.031	1.137
	Relative Productivity of New Immigrants, $\gamma/(\gamma-m)$ =0					
$T=40$	0	84.4	83.1	0.269	−0.033	0.190
	2	84.7	83.3	0.269	−0.033	0.345
	4	85.0	83.5	0.269	−0.033	0.505
	6	85.4	83.7	0.270	−0.032	0.659
	8	85.8	84.0	0.270	−0.032	0.805
	10	86.2	84.3	0.270	−0.032	0.945
$T=55$	0	143.9	141.7	0.292	−0.033	0.192
	2	144.8	142.3	0.293	−0.033	0.403
	4	145.9	143.0	0.293	−0.033	0.613
	6	147.2	143.7	0.294	−0.032	0.810
	8	148.5	144.6	0.295	−0.032	0.993
	10	150.0	145.5	0.296	−0.032	1.164
$T=70$	0	229.7	226.5	0.325	−0.033	0.195
	2	232.4	228.0	0.327	−0.033	0.460
	4	235.5	229.9	0.328	−0.033	0.717
	6	239.0	231.9	0.330	−0.032	0.952
	8	242.9	234.2	0.333	−0.032	1.167
	10	247.1	236.7	0.335	−0.032	1.364

Table 4: The impact of permanently lowering the tax rate on asset income by 5% and then raising the tax rate on wage earnings from year T on.

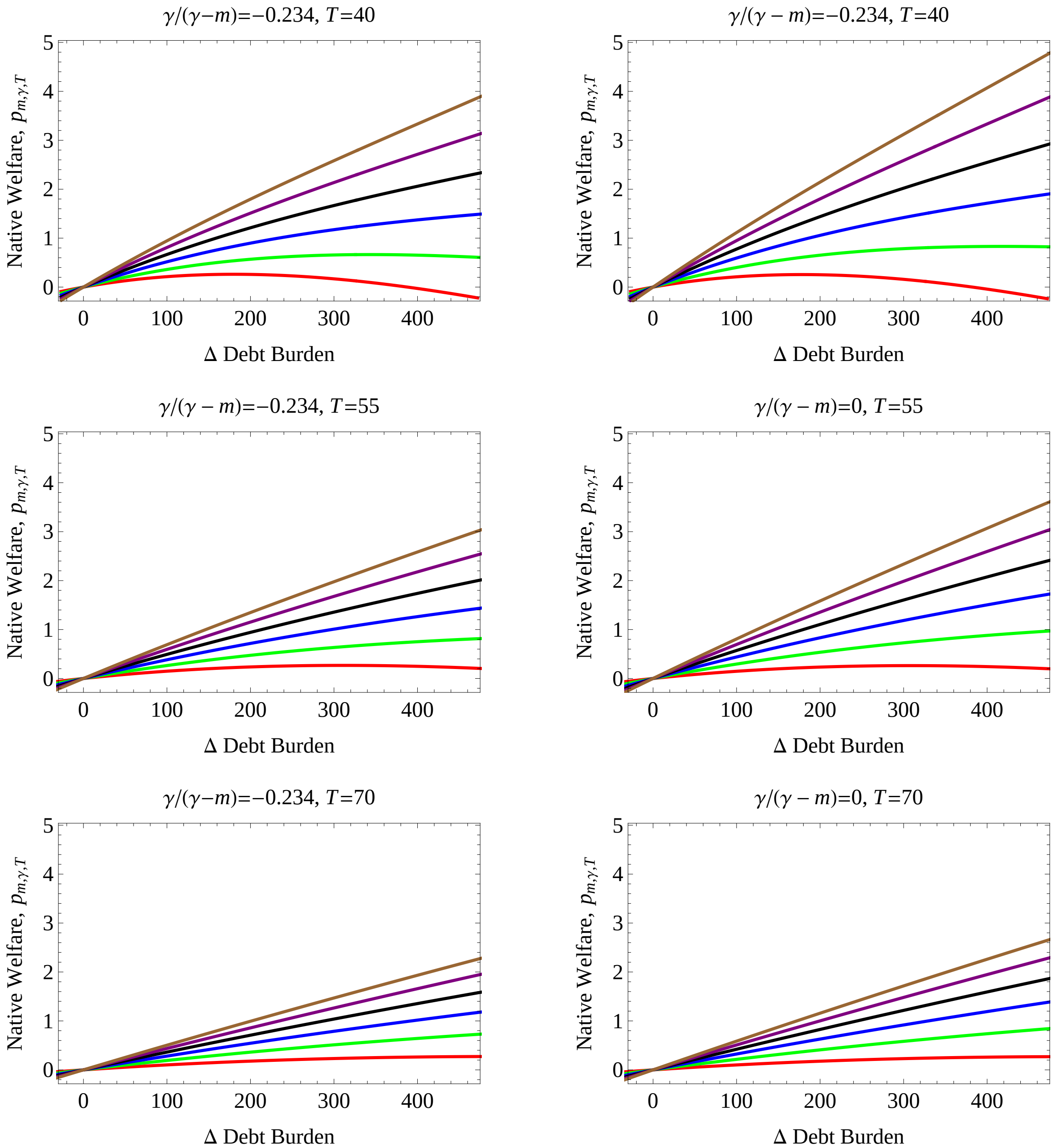

Figure 16: The values of the welfare measure for native households $p_{m,\gamma,T}$ and the long-term debt burden generated by permanently lowering the tax rate on asset income and then raising the rate of tax on wage earnings after T=40, 55 or 70 years. Impulse responses for net the rate of return, change in basis points, for different annual rates of immigration per thousand of zero: red, two: green, four: blue, six: black, eight: purple, ten: brown. Overall rate of population change is 10.3 per thousand.

I have demonstrated, we should expect to observe a bias in favour of postponing taxation and deficit finance.

From its entry into World War II at the end of 1941 to the year the war ended in 1945, the US Federal Government debt as a ratio of GDP climbed from 43.3% to 112.7%. From then on, every year but three (1949, 1954 and 1958) the debt-to-GDP ratio declined as the US government retired its wartime debt, until the end of 1974, when it reached a postwar low of 24.6%. During the remaining years of that decade, the debt burden was relatively stable.

The year 1981, the year President Ronald Reagan took office, was a turning point. In every one of the subsequent 13 years, the percentage of debt to GDP rose, until it had nearly doubled to 49.5% at the end of 1993. The tax rates on income from capital fell sharply, while the rise in the tax on labor income offset the growth in entitlement spending. The effects of persistent primary budget deficits were compounded by the doubling in interest payments from 1.5% to 3.0% of GDP. At first this was largely a by-product of the high interest rates introduced by the Federal Reserve, which reflected its Chairman Paul Volker's desire to lower inflation. Later, as the deficits accumulated, the increased interest payments were driven by the need to finance the growing stock of debt.

The debt burden was stable during 1994 and 1995, and then began to decline—dropping to 33.3% of GDP at the end of 2001. Interest payments tapered off as well, averaging 2.6% during this period, while faster growth in the US economy generated even faster growth in revenues. Most importantly, spending declined, particularly on defense. If during the period between 1981 and 1992 defense spending averaged 5.8% of GDP, during the first decade that followed the dissolution of the Soviet Union, defense spending dropped to only 3.6%. The attacks on the United States on September 11, 2001, and the subsequent wars in both Afghanistan and Iraq prompted quick increases in defense spending, though not a resumption of the rates of spending that preceded the end of the Cold War—from 2002 to 2013 spending on defense averaged 4.0% of GDP. At the same time revenue fell sharply, initially because President George W. Bush lowered tax rates, but later as a consequence of the recession that began in 2008. By the end of 2013 publicly-held debt was 72% of GDP.

Yet beyond all this, the most important and consistent feature of the US Federal budget during the last few decades is the growth in spending on entitlement programmes, whose main beneficiaries are the elderly. This is particularly the case for Medicare; and unlike the vagaries of war and recession, this growth was completely predictable—a consequence of increasing life expectancy and dropping fertility. Instead of accumulating sufficient surpluses to finance these liabilities we observe a shift towards deficit finance that immediately follows the rapid decline in both the rate of natural population growth in Figure 3 and the fertility rate in Figure 4. Passage of the Medicare Modernization Act at the end of 2003 extended coverage to include the cost of prescription drugs for the elderly from 2006 onward, and further exacerbated the fiscal gap.

Indeed, it bears emphasising that the initial post-war rise in the debt coincided with a sharp drop in the rate of natural population growth—concerns about a rapidly aging or even shrinking population had replaced earlier worries about overpopulation. By 1982 the US Census

Bureau was warning that the population was ageing rapidly and would begin contracting by the year 2050. A year earlier, the President and Congress appointed Alan Greenspan to chair The National Commission on Social Security Reform. The immediate task of the commission was to prevent the near-term insolvency of the Social Security Trust Fund, but also offered recommendations on how the programme could be stabilised for the long term, given the sharp drop in population growth. The commission's recommendations, which included a two-year rise in the retirement age to be implemented by 2026, were adopted in 1983, but did little to stabilise the programme's long-term prospects. This was also the last time major legislation was passed, despite the rising dependency ratio, that curtailed entitlement spending on the elderly.

Concerns about the size of the workforce and the sustainability of entitlement programmes was also part of the motivation behind the rise in 1978 of the mandatory retirement age permissable under US law from 65 years of age to 70.[19] By 1986 mandatory retirement was abolished completely. The same concerns were certainly also a factor in creating the consensus that favoured liberalising immigration policy during the Reagan and George H. W. Bush administrations, including passage of the Immigration Reform and Control Act of 1986.[20] Recent projections published by the US Census predict immigration will overtake the number of births over deaths as the source of future population growth sometime between 2027 and 2038.[21]

The simulations and welfare calculations in Sections 4 to 6 demonstrate that the model can explain at least part of the motivation behind not only the accumulation of public debt in the United States so far but even the more rapid accumulation predicted in the CBO's Alternative Fiscal Scenario. Indeed, in the absence of immigration, it is hard to rationalise the mere shifting of the tax burden, particularly on capital income, across time. When the economy is not absorbing new immigrants, the welfare loss is equivalent to lowering consumption by -0.488% if the policy persists to 2050 in Table 2.

8 Conclusion

The decision to leave tax rates low, particularly the tax rate on capital income, and as a consequence to continue to accumulate both formal debt and unfunded liabilities, is a political choice. I believe my model offers at least some insight as to why for the first time in US history, the debt burden has risen in a sustained manner during peace-time, and why there seems little immediate prospect of a change in direction. It is of course the case that the trajectory of US debt is the result of decision-making and political processes that are far more dynamic, and far more contingent on unforeseen circumstances, than I assume in my model. It is very unlikely that voters, or their representatives, are deliberately choosing policies that carefully weigh the costs and benefits of deficit finance, as rates of migration change, in the manner of the model. However, it is not too hard to imagine that concerns about the rising burden of debt, and its impact on the next generation, are likely to be less persuasive at a time when citizens are watching the composition of their societies being transformed so quickly. What my

[19]von Wachter (2009).

[20]Westoff (1986) and Wattenberg (1987).

[21]https://www.census.gov/newsroom/releases/archives/population/cb13-89.html

model demonstrates is merely that *ceteris paribus*, there is likely to be far greater willingness to defer taxes and rely on deficit spending during periods when immigration is a more prominent component of population growth.

That people voting for a set of tax policies in one period may not be exactly the same people who must pay these taxes in the next is not an uncommon feature in models associated with dynamic fiscal policy. What is different here is that by adopting the Weil (1989) framework, I provide an alternative to the strict dichotomy between models with overlapping generations, where agents disregard the impact of their choices on future generations, and the quasi-Ricardian world of infinite-lived dynasties in which agents are assumed to fully participate in both the economy and the political system in every period. In the case where taxation is distortionary, gone also is the option to simply choose the tax that redistributes the most income to those who can organize the most votes, while abstracting from deadweight loss. As recent experience has shown, prolonged reliance on deficit finance has real consequences. The higher rates of future taxation in my model are only one possible outcome, and clearly not the most dire.

The degree to which the policy choices made in any given period are informed by their effects on future generations is hardly straightforward, even if people never move between different political jurisdictions. Concern for one's own descendants is not the only form of intergenerational altruism. People without children may care deeply about the welfare of future members of the society in which they live, and do not necessarily support policies that maximise their own welfare at the expense of the young and the unborn:

> Society is indeed a contract......It is a partnership in all science; a partnership in all art; a partnership in every virtue, and in all perfection. As the ends of such a partnership cannot be obtained in many generations, it becomes a partnership not only between those who are living, but between those who are living, those who are dead, and those who are to be born. Each contract of each particular state is but a clause in the great primæval contract of eternal society,.....

Edmund Burke, *Reflections on The Revolution In France*, 1790.[22]

Yet most transfers between people, whether *inter vivos* or testamentary, take place between members of the same family. My contention is that immigration creates a certain bias irn favor of deficit finance, though this argument could be turned on its head; deficit finance is what generates a preference for accomodating more immigrants. This is certainly possible, in fact, as demonstrated in Ben-Gad (2004), the effect of immigration itself on factor returns generates an increasing immigration surplus for the native population, so we are left to wonder why immigration is not considerably higher. Perhaps one reason does follow directly from the model—the faster immigrants arrive, the more natives may want the government to issue bonds to cover immediate government expenditure, but also the greater the risk that the immigrants will acquire the political power to repudiate that very same debt.[23]

[22]http://www.gutenberg.org/files/15679/15679-h/15679-h.htm

[23]One paper in which the rate of immigration is endogenously determined by voters in the destination country

If immigration does indeed create a bias in favour of deficit finance, there is no reason to assume the phenomenon is isolated to the United States. In many developed countries, the transition from low rates of net migration and high rates of natural population growth to high net migration and low, even negative, rates of natural population growth has been far more extreme.

One last issue is emigration. At any given moment, migration flows at the national level tend to be one-way. Only occasionally do we observe so-called 'replacement migration' in which a country absorbs significant numbers of new workers even as its own native-born workers move elsewhere. Emigration could create a bias in favor of surpluses—tax people before they leave—but only if the rate of emigration does not exceed a certain threshold. If enough people are leaving, or anticipate they will, they may opt to avoid taxing themselves, and leave behind their share of the public debt to those who remain. Of course, at the sub-national and local level, simultaneous flows of inmigration and outmigration are the normal consequence of churning in the labor market. One implication is that as people become more mobile, we may expect the different regions within federal states and localities to acquire higher debt and unfunded liabilites.

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