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A structural decomposition of the U.S. trade balance: Productivity, demographics and fiscal policy ☆

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ABSTRACT

The US external deficits have been the most striking manifestation of global imbalances. This paper investigates the contribution of productivity growth, demographics and fiscal policy in accounting for the evolution of the US external imbalances against industrialized countries during the last three decades. Productivity growth plays a dominant role. Demographics explain a non-negligible and nearly permanent component of the US trade deficit. Furthermore, the international demographic transition is crucial for large US external imbalances to be consistent with the persistent decline of world real interest rates observed in the data. Fiscal policy is of minor importance.

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1. Introduction

After five consecutive years of record levels, the US trade deficit reached a maximum of 712.3 billion dollars in 2006, equivalent to more than 5% of GDP (Fig. 1).[1] The increasing relevance of China and other emerging countries as global economic players, as well as soaring oil prices, are among the recent developments that contributed to worsen the US external imbalance.[2] However, a significant portion of the overall US trade deficit displays a much more persistent nature. The current US trade balance vis-a-vis the other six major industrialized world economies (Canada, France, Germany, Italy, Japan and the United Kingdom—henceforth, the G6) is the result of a continuous deterioration that started roughly three

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[1] The numbers for the US current account balance are essentially identical. This anomaly is due to the fact that, in spite of being a net debtor, the US earns on its gross asset position a much higher return than what it pays off on its stock of gross liabilities (the "exorbitant privilege", in the words of Gourinchas and Rey, 2007a).

[2] Caballero et al. (2008) and Mendoza et al. (2009) argue that the combination of (i) lower barriers to international financial flows and (ii) less developed capital markets in emerging economies account for the excess supply of funds from outside the US, which relates to the "global saving glut" hypothesis (Bernanke, 2005).

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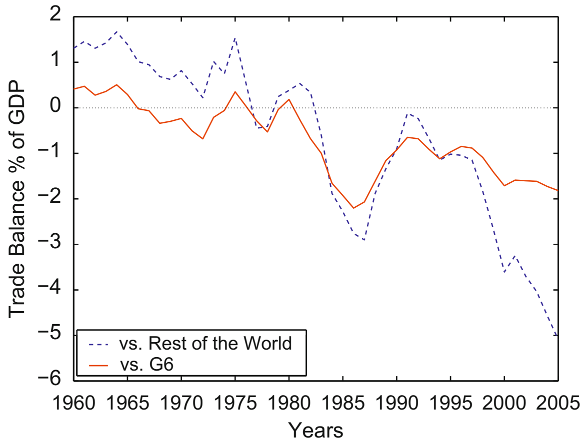

Fig. 1. Total US trade balance (blue dashed line) and US trade balance vis-a-vis the G6 (red continuous line). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

decades ago (Fig. 1). Understanding which factors drive the persistent imbalances among industrialized countries is a key economic question.

The empirical evidence in Lane and Milesi-Ferretti (2001) suggests that the level of external debt in industrialized countries depends on output per-capita, demographic indicators and government debt (Fig. 2 plots the evolution of these variables in the US and the G6). This paper provides a quantitative assessment of the relative importance of each of these factors in accounting for the dynamics of external imbalances between the US and the G6.

The bottom line is that the current levels of US external imbalances versus the G6 are mainly the manifestation of productivity growth and demographic differentials across the two regions. More precisely, the analysis yields two main quantitative results. First, productivity growth differentials explain most of the dynamics of the US trade balance. Second, demographic differentials generate a non-negligible and nearly permanent US trade deficit. The combination of these two factors essentially accounts for the entire evolution of US external imbalances. Importantly, the international demographic transition allows US external imbalances to coexist with declining world real interest rates, a notable feature of the data during the last two decades.

On a negative note, the results cast doubt on recent commentaries that government deficits in the US after 2000 may have substantially contributed to the widening of the US external imbalances (e.g. Chinn, 2005), at least vis-a-vis other industrialized countries. More expansionary fiscal policies in the G6 than in the US during recent years, not Ricardian equivalence, are responsible for this finding (bottom left panel of Fig. 2).

The analysis embeds the simple life-cycle structure of Gertler (1999) in a two-country world economy with time-varying productivity growth, demographic factors and fiscal policy. The model is tractable enough to illustrate analytically the main determinants of the trade balance and delivers quantitative predictions largely consistent with the data.

This organizing framework shares many similarities with standard open economy real business cycle models.[3] Incomplete international financial markets and permanent productivity shocks are crucial in that literature to match key international business cycle statistics (Baxter and Crucini, 1995). The same mechanism is at work here to account for the external imbalances between the US and G6.[4] Productivity growth differentials alone, however, do not explain the entire size of US external imbalances. In a closely related study, Chen et al. (2009) come to a similar conclusion. The main difference is that, in their work, time-varying depreciation and tax rates account for the fraction of external imbalances unexplained by productivity growth differentials. In this study, demographic factors constitute the missing link.

The model combines a random probability of surviving (as in Blanchard, 1985) with a random transition from employment into retirement. The resulting life-cycle dimension allows for the separate study of the effects of life expectancy and population growth rate differentials between the US and the G6 (top and bottom right panels of Fig. 2) on the trade balance between the two regions. The quantitative analysis highlights the predominant role of life expectancy in shaping the individual consumption-savings decisions. Countries where individuals live on average longer (the G6) are associated with higher saving rates and trade surpluses. This finding contrasts with the more traditional view (surveyed by Obstfeld and Rogoff, 1996) that countries with higher population growth rates should experience higher saving rates because of the larger proportion of young savers relative to old dissavers.[5]

[3] A frictionless setup seems a reasonable benchmark to study international capital flows among industrialized countries. Goods and capital market imperfections are unlikely to drive external imbalances in the G7.

[4] See also Kollmann (1998) for a study of the US trade deficit during the period 1975–1991.

[5] This mechanism is present here too. However, higher population growth rates also lead to higher investment. In the simulations, the investment channel prevails, although the overall impact on the trade balance is quantitatively small.

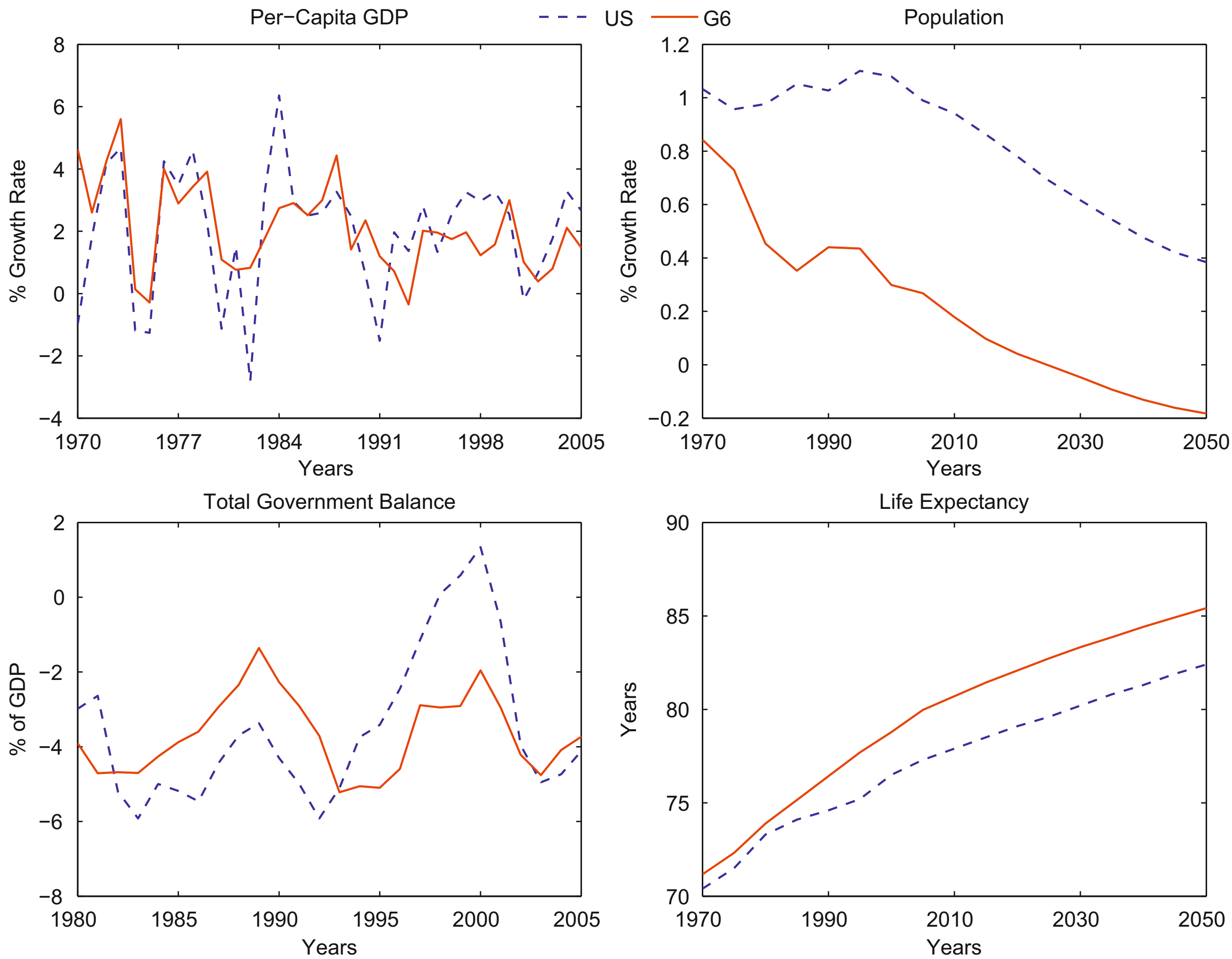

Fig. 2. GDP growth rates, demographic factors and fiscal stances in US (blue dashed line) and G6 (red continuous line). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Henriksen (2002), Feroli (2003) and Domeij and Flodén (2006) also find quantitatively significant effects of demographic variables on external imbalances.[6] This paper complements the existing literature by assessing the importance of demographic factors relative to other determinants of external imbalances, such as productivity growth and fiscal policy differentials. In addition, the demographic transition is central for explaining the decline of the world real interest rate during the last two decades. The decline of the real rate is the direct consequence of the global excess of savings associated with the demographic transition. This result carries important implications for the persistence and sustainability of fiscal and external deficits.[7] Low interest rates increase the attractiveness of debt and lower the burden of outstanding liabilities. In this respect, the model improves upon large strands of the existing literature which tend to ignore the dynamics of the real interest rate.[8]

The next section presents the model and the equilibrium for the two-country world economy. The third section discusses the quantitative results. The fourth section concludes.[9]

[6] Brooks (2003) and Attanasio et al. (2006) study the implications of demographic trends for capital flows between developed and developing countries.

[7] Gourinchas and Rey (2007b) and Bohn (2008) evaluate the sustainability of US external and fiscal imbalances respectively. Real interest rate dynamics play a crucial role in both cases.

[8] One exception is Caballero et al. (2008), who also emphasize the connection between global imbalances and low real interest rates.

[9] A separate appendix with details on the derivations, a description of the data and additional results is available as supplementary content in Science Direct and at http://nyfedeconomists.org/ferrero/.

2. A life-cycle model of the US and the G6

The world consists of two countries, Home (US) and Foreign (G6), initially identical. Individuals in each country consume a single good (the numeraire), which can be traded internationally at no shipping cost. There is no aggregate uncertainty. Agents have perfect foresight but can be surprised by unexpected exogenous shocks. This section describes the structure of the Home economy in detail. If necessary, an asterisk denotes Foreign variables.

Life-cycle structure: At time t, workers (w) and retirees (r) have mass N_t^w and N_t^r, respectively. Between period t and $t+1$, a worker remains in the labor force with probability $\omega_{t,t+1}$ and retires with the complementary probability. If retired, an individual survives from period t to period $t+1$ with probability $\gamma_{t,t+1}$.[10] In period $t+1$, $(1-\omega_{t,t+1}+n_{t,t+1})N_t^w$ new workers are born. Consequently, the law of motion for the aggregate labor force is

$$N_{t+1}^w = (1-\omega_{t,t+1}+n_{t,t+1})N_t^w + \omega_{t,t+1}N_t^w = (1+n_{t,t+1})N_t^w, \tag{1}$$

so that $n_{t,t+1}$ represents the growth rate of the labor force between period t and $t+1$. The number of retirees evolves over time according to

$$N_{t+1}^r = (1-\omega_{t,t+1})N_t^w + \gamma_{t,t+1}N_t^r. \tag{2}$$

From (1) and (2), the dependency ratio ($\psi_t \equiv N_t^r/N_t^w$), which summarizes the heterogeneity in the population, evolves according to

$$(1+n_{t,t+1})\psi_{t+1} = (1-\omega_{t,t+1}) + \gamma_{t,t+1}\psi_t. \tag{3}$$

Workers inelastically supply one unit of labor while retirees do not work.[11] Preferences for an individual of cohort $z=\{w,r\}$ are a restricted version of the recursive non-expected utility family (Kreps and Porteus, 1978; Epstein and Zin, 1989)

$$V_t^z = \{(C_t^z)^\rho + \beta_{t,t+1}^z[E_t(V_{t+1}|z)]^\rho\}^{1/\rho}, \tag{4}$$

where C_t^z denotes consumption and V_t^z stands for the value of utility in period t. Retirees and workers have different discount factors to account for the probability of death

$$\beta_{t,t+1}^z = \begin{cases} \beta\gamma_{t,t+1} & \text{if } z=r, \\ \beta & \text{if } z=w. \end{cases}$$

The expected continuation value in (4) differs across cohorts because the future value of utility depends on the current employment status

$$E_t\{V_{t+1}|z\} = \begin{cases} V_{t+1}^r & \text{if } z=r, \\ \omega_{t,t+1}V_{t+1}^w + (1-\omega_{t,t+1})V_{t+1}^r & \text{if } z=w. \end{cases}$$

This life-cycle model is analytically tractable because the transition probabilities ω and γ are independent of age and the retirement period. With standard preferences, however, this assumption would imply a strong precautionary saving motive for young agents, which is at odds with the data. Risk–neutral preferences with respect to income fluctuations prevent counterfactual excess of savings by young workers (Farmer, 1990; Gertler, 1999). The separation of the coefficient of intertemporal substitution ($\sigma \equiv (1-\rho)^{-1}$) from risk aversion implied by (4) helps to produce a reasonable response of consumption and savings to interest rate variations.

Retirees: An individual retired in period i chooses consumption $C_t^r(i)$ and assets $A_{t+1}^r(i)$ for $t \geq i$ to solve

$$V_t^r(i) = \max\{(C_t^r(i))^\rho + \beta\gamma_{t,t+1}[V_{t+1}^r(i)]^\rho\}^{1/\rho}, \tag{5}$$

subject to

$$A_{t+1}^r(i) = \frac{R_{W,t}A_t^r(i)}{\gamma_{t-1,t}} - C_t^r(i). \tag{6}$$

For a retiree who survives between period $t-1$ and t, the return on a dollar investment is $R_{W,t}/\gamma_{t-1,t}$, where $R_{W,t}$ is the world interest rate that clears the international capital market. In essence, retirees turn their wealth over to a perfectly competitive mutual fund industry which invests the proceeds and pays back a premium over the market return to compensate for the probability of death (Yaari, 1965; Blanchard, 1985).[12]

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[10] Because retirement is an absorbing state in this model, the probability of retiring is more realistically related to mental and physical disability risks.

[11] Gertler (1999) shows how to introduce variable labor supply in this framework without sacrificing its analytical tractability. The assumption of inelastic labor supply, however, constitutes a natural benchmark. Current demographic trends should induce individuals to supply more hours. This conjecture stands in sharp contrast with the data (see Fig. 1 in the Appendix).

[12] The mutual fund only operates within national borders. This assumption prevents equalization of returns in the insurance market, which would dampen the effect of life expectancy differentials across countries.

Workers: Individuals are born workers and start their life with zero assets. A worker born in period j chooses consumption $C_t^w(j)$ and assets $A_{t+1}^w(j)$ for $t \geq j$ to solve

$$V_t^w(j) = \max\{(C_t^w(j))^\rho + \beta[\omega_{t,t+1} V_{t+1}^w(j) + (1-\omega_{t,t+1}) V_{t+1}^r(j)]^\rho\}^{1/\rho}, \quad (7)$$

subject to

$$A_{t+1}^w(j) = R_{W,t} A_t^w(j) + W_t - T_t^w - C_t^w(j) \quad (8)$$

and $A_t^w(j)=0$ for $t=j$, where W_t represents the market wage and T_t^w is the total amount of lump-sum taxes paid by each worker. The value function $V_{t+1}^r(j)$ is the solution of the problem (5)–(6) above and enters the continuation value of a worker to discount the possibility that retirement occurs between time t and $t+1$.

Firms: Goods markets are perfectly competitive. Firms produce goods according to a constant returns to scale Cobb–Douglas production function

$$Y_t = (X_t N_t^w)^\alpha K_t^{1-\alpha}, \quad (9)$$

where $\alpha \in (0,1)$ is the labor share and X_t is the level of exogenous labor-augmenting productivity at time t. Productivity grows over time according to

$$X_{t+1} = (1 + x_{t,t+1}) X_t.$$

Investment adjustment costs augment the standard law of motion of capital

$$K_{t+1} = (1-\delta) K_t + \left[1 - \frac{\phi}{2}\left(\frac{I_t}{I_{t-1}} - \mu_t\right)^2\right] I_t, \quad (10)$$

where $\delta \in (0,1)$ is the depreciation rate (constant and equal across countries), $\phi \geq 0$ is the adjustment cost parameter and the term μ_t is such that adjustment costs are zero along the balanced growth path.

Government: The government levies lump-sum taxes and issues one-period debt B_{t+1} to finance a given amount of wasteful spending G_t according to the flow budget constraint

$$B_{t+1} = R_{W,t} B_t + G_t - T_t, \quad (11)$$

where $T_t = N_t^w T_t^w$ represents the total tax revenue. In the simulations below, the government directly controls the debt-to-GDP ratio (calibrated from the data) taking public spending as exogenous. Taxes endogenously adjust to satisfy the government intertemporal budget constraint.

2.1. Equilibrium in the world economy

All markets are competitive and all agents take prices as given. Formally, a competitive equilibrium for the world economy is a sequence of quantities and prices such that in each country (i) households maximize utility subject to their budget constraints, (ii) firms maximize profits subject to their technology constraints, (iii) the government chooses a path for taxes and debt, compatible with intertemporal solvency, to finance an exogenous level of total spending, (iv) all markets clear.

The Appendix shows that the simple demographic structure of this model makes aggregation independent of the birth date and retirement period of each individual. Compared to a standard growth model, the ratio of retirees' asset holdings to total assets in the economy is the only extra state variable that summarizes life-cycle heterogeneity.

Total assets for the domestic economy are the sum of the capital stock, government bonds and the net foreign asset position F_t

$$A_t = K_t + B_t + F_t. \quad (12)$$

The evolution of net foreign assets links the goods and the asset markets. Net foreign assets represent the payment received from the rest of the world in exchange for exporting goods[13]

$$F_{t+1} = R_{W,t} F_t + NX_t, \quad (13)$$

where the trade balance NX_t is the difference between domestic production and absorption

$$NX_t = Y_t - (C_t + I_t + G_t). \quad (14)$$

International capital flows equalize the return $R_{W,t}$ across countries. In equilibrium, Home and Foreign holdings of net foreign assets must add up to zero

$$F_t + F_t^* = 0.$$

[13] As in Obstfeld and Rogoff (1996), the current account balance is the one-period variation in the net foreign asset position

$$CA_t \equiv F_{t+1} - F_t = (R_{W,t} - 1) F_t + NX_t.$$

For the US, the current account and trade balance almost coincide, which translates into a very small net interest rate payment on the outstanding stock of net foreign liabilities. See Tille (2008) and the references therein for a discussion of the valuation effects associated with the maturity and denomination of the US stock of foreign assets and liabilities.

Given the presence of exogenous growth in population and technology, the model admits a steady state only for variables expressed in efficiency units (i.e., $z_t \equiv Z_t/(X_t N_t^w)$ for any generic variable Z_t). The Appendix characterizes a symmetric steady state of the model for stationary variables in which the exogenous forcing processes are constant and equal across countries. In this equilibrium, non-scaled quantities grow along the balanced growth path at the constant rate $(1+x)(1+n) \cong 1+x+n$. The computations of the steady state and the transitional dynamics employ standard non-linear Newton methods (for details, see Juillard, 1996).[14]

The next section discusses the calibration and the results of the quantitative experiments. To build some intuition in advance, it is useful to consider the limiting case of the model without adjustment costs ($\phi = 0$). Given the assumption of perfectly integrated international financial markets, no arbitrage implies that, in each period, capital in efficiency units must be equal across countries

$$R_{W,t} - 1 + \delta = (1-\alpha)(k_t)^{-\alpha} = (1-\alpha)(k_t^*)^{-\alpha} \Rightarrow k_t = k_t^*, \quad \forall t. \tag{15}$$

Since both countries have access to the same technology, also output per efficiency unit is equalized across borders (y_t=y_t^*). Under the assumption that g_t=g_t^*, the national account identity (14) gives an expression for the trade balance as a function of consumption and investment differentials

$$nx_t = -\frac{1}{(1+\Phi_{R,t})}[(c_t - c_t^*) + (i_t - i_t^*)], \tag{16}$$

where $\Phi_{R,t} \equiv X_t N_t^w/(X_t^* N_t^{w*})$ is an adjustment factor due to different detrending across countries which captures the different economic size of the two regions over time.

3. A quantitative investigation of the US trade deficit

This section evaluates the quantitative importance of differentials in productivity, demographics and fiscal policy to account for the bilateral trade balance between the US and the G6 during the period 1970–2005.

Two main results stand out. First, productivity differentials are the main driving force for the dynamics of the US trade balance vis-a-vis the G6. Second, demographic differentials generate a non-negligible and nearly permanent US trade deficit. Importantly, the demographic transition is crucial for explaining the decline of the world real interest rate over the sample period. Fiscal policy differentials only play a minor role.

3.1. Calibration and description of the experiment

Table 1 reports the values of the parameters and steady state exogenous variables. The time period is one year. Individuals are born workers at age 20, stay on average $(1-\omega)^{-1}$ years in the labor force and live on average $(1-\gamma)^{-1}$ years after retirement. The value for the probability of retiring ($\omega = 0.9778$) matches an average retirement age of 65, as in Auerbach and Kotlikoff (1987).

The remaining fixed parameters are fairly standard in the real business cycle literature (e.g. Cooley, 1995). The only exception is a relatively low value for the elasticity of intertemporal substitution ($\sigma = 0.5$), which reflects a compromise choice among micro-estimates.[15] The choice of the discount factor ($\beta = 0.98$) targets a 5.0% real interest rate in 1970. The labor share α equals 2/3 and the depreciation rate δ equals 10%. The choice of the adjustment cost parameter ($\phi = 0.2$) generates a volatility of investment rates roughly in line with the data. The ratio of government spending to GDP is 20% for both countries, a value consistent with the average across members of the G7 for the period 1970–2005. With the exception of Japan, all G7 countries exhibit fairly constant ratios of government spending to GDP, close to the overall mean.

Productivity growth rates, demographic variables and fiscal stances change unexpectedly in 1970 (the initial symmetric steady state). After the initial period, agents perfectly anticipate the evolution of the exogenous variables, which become constant in 2030.[16] The economy reaches its final steady state at a later date, due to the endogenous dynamics of capital and net foreign assets.[17] The paths of productivity growth, labor force growth, surviving probability and debt-to-GDP ratio drive the transition from the initial to the final steady state.

[14] Standard open economy models with incomplete markets feature steady state indeterminacy and non-stationary dynamics of net foreign assets. Here, the life-cycle structure helps to pin down endogenously the steady state value of net foreign assets. Ghironi (2006) shows a similar result in a framework with overlapping families of infinitely lived agents (as in Weil, 1989). Schmitt-Grohé and Uribe (2003) discuss a number of alternative mechanisms to circumvent this problem.

[15] Low values for the elasticity of intertemporal substitution are typical in the public finance literature. For example, Auerbach and Kotlikoff (1987) use a value of 0.25.

[16] As in large scale overlapping generation models, abstracting from aggregate uncertainty preserves the tractability of the model and simplifies the computations. Chen et al. (2009) explicitly consider uncertainty in productivity growth, which leads to a smoother process for the saving rate. The effect is qualitatively similar to an increase in investment adjustment costs.

[17] The choice of 1970 as the initial year for the simulation makes the model assumption of perfectly integrated international capital markets broadly consistent with the progressive elimination of restrictions to international capital flows after the collapse of the Bretton Woods system of fixed exchange rates. The choice of 2030 as the final year averages out some of the uncertainty in the demographic projections.

Table 1
Parameter values and steady state exogenous variables.

Initial symmetric steady state			
n		1%	Population growth rate
$(1-\omega)^{-1}$		45	Average working period (years)
$(1-\gamma)^{-1}$		5	Average retirement period (years)
β		0.98	Discount factor
σ		0.5	Elasticity of intertemporal substitution
α		2/3	Labor share
δ		10%	Depreciation rate
x		1.5%	Growth rate of technology
g		20%	Government spending (% of GDP)
b		26%	Government debt (% of GDP)
Final steady state			
	US	G6	
n	0.2%	0.2%	Population growth rate
$(1-\gamma)^{-1}$	15	18	Average retirement period (years)
b	60%	60%	Government debt (% of GDP)

Productivity is the Solow residual of the production function (9). The initial steady state productivity growth is 1.5%, which corresponds to the average in the data between 1970 and 2005. Productivity growth slowly reverts back to steady state from its actual value in 2005 for both countries.

Consistent with the evidence on population growth rates, the labor force grows at 1% in 1970 for both regions. The final steady state value of 0.2% corresponds to the average projected population growth rate between the US and the G6 in 2030. During the transition, population growth rates proxy for the growth rate of the labor force. Convergence of productivity and population growth rates prevents the faster growing country from eventually representing the entire world economy in the model.

The average expected lifetime horizon is the target to calibrate the probability of surviving. In 1970, the expected lifetime horizon was 70 years for both US and G6 ($\gamma=\gamma^*=0.8$). The projections for 2030 indicate a life expectancy of 80 years for the US ($\gamma=0.93$) and 83 years for the G6 ($\gamma^*=0.94$). The probabilities of surviving during the transition result from linear interpolation of the values for life expectancy in the initial and final steady states, holding constant the average employment duration to 45 years.[18]

The 26% debt-to-GDP ratio in the initial steady state matches the average between the US and the G6 in 1980. For the US, this value also represents a reasonable approximation for the 1970s, a decade during which the ratio of net debt to GDP was roughly constant. The experiment also assumes a constant ratio of debt-to-GDP equal to 26% in the G6 throughout the 1970s. Debt-to-GDP ratios are assumed to slowly converge to 60% in 2030 from the actual levels in 2006 (approximately 50% in the US and 70% in the G6).

The Appendix presents additional details on the data used in the quantitative experiment.

3.2. Quantitative results

Fig. 3 compares the time series of the US trade balance (as a percentage of GDP) vis-a-vis the G6 with the correspondent variable generated by the model for the period 1970–2005.

Overall, the model fits the data quite well.[19] The simulated series for the US trade balance predicts slightly excessive surpluses in the second half of the 1970s and early 1980s but the model still captures the rapid deterioration of the US trade balance in the midst of the 1980s. The downward blip in 1989 mostly depends on the negative productivity shock associated with the German reunification.

Fig. 4 displays the patterns of net saving and investment rates behind the evolution of the US external imbalances. In the data, the US external deficits mostly correspond to a reduction in the net saving rate. Net investment, although volatile, has hovered around 8% of GDP for the entire sample period. Conversely, net saving as a fraction of GDP has declined from about 8% in 1970 to 3% in 2005. The model broadly replicates these empirical patterns. The decline of the simulated net saving rate (from 8% to 6%) is less striking than in the data. The difference depends on the absence from the model of

[18] Linear interpolation partly compensates for using data on life expectancy at birth (rather than at 20) by understating the surviving probabilities during the entire transition relative to the data. Data on life expectancy at 20 are available for only a few survey years. This partial evidence indicates that the differentials in life expectancy at birth between the US and the G6 are generally preserved at 20 (see Table A1 in the Appendix).

[19] The correlation coefficient between simulated and actual data is 0.90. A regression of the data on the simulated series returns an intercept of -0.44 and a slope coefficient of 0.68, both statistically significant at the 5% level. The R-squared of such a regression is 80%.

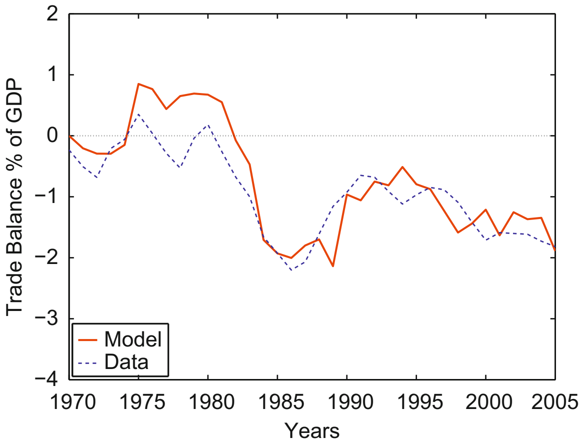

Fig. 3. US trade balance in the data (blue dashed line) and in the model (continuous red line). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

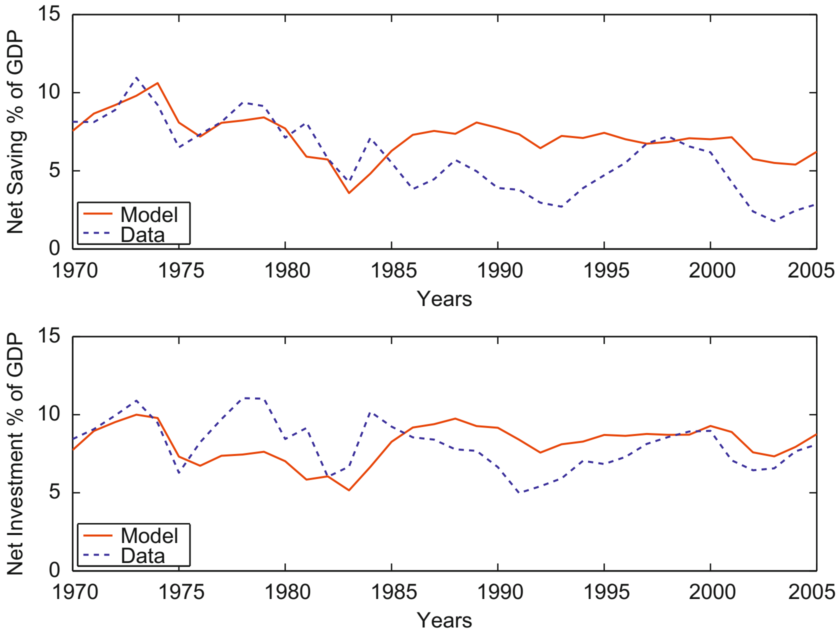

Fig. 4. US saving (top panel) and investment (bottom panel) rates. Data (blue dashed line) against model (continuous red line). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

countries, such as China, oil producers, and other emerging economies, which have financed an increasingly larger share of the US external imbalances in recent years. The simulated net saving rate is very close to the data early in the sample, when the role of emerging economies in financing the US trade deficit was less relevant.

Table 2 summarizes the relative importance of productivity, demographics and fiscal policy for the simulated trade balance as a percentage of GDP. The decomposition consists of two steps. The first step isolates a deterministic component, identified as the sum of the simulations when either demographic factors or fiscal stances alone differ across countries. The top part of the table reports the percentage of the deterministic component explained by each factor in isolation. The second step removes from the baseline simulation the deterministic component just calculated and identifies the stochastic component as the simulation when only productivity growth differs across countries plus a residual term. The bottom part of the table reports a standard variance decomposition of the stochastic component.[20]

[20] The residual in the stochastic component is not orthogonal to the productivity term. Hence, the covariance generally differs from zero.

Table 2
Decomposition of simulated trade balance.

	Deterministic component		
	Demographics	**Fiscal policy**	
Entire sample	64.81	35.19	
1971–1980	76.32	23.68	
1981–1990	74.17	25.83	
1991–2005	50.89	49.11	
	Stochastic component		
	Productivity	**Residual**	**2*Covariance**
Entire Sample	73.25	6.16	20.59
1971–1980	100.48	0.21	−0.69
1981–1990	89.74	2.42	7.84
1991–2005	51.40	14.21	34.39

Note: The deterministic component is the sum of the simulated trade balance as percentage of GDP when either demographic factors or fiscal stances alone differ across countries. The stochastic component is the difference between the baseline simulation and the deterministic component. The numbers in the table represent the percentage of the total explained by each term.

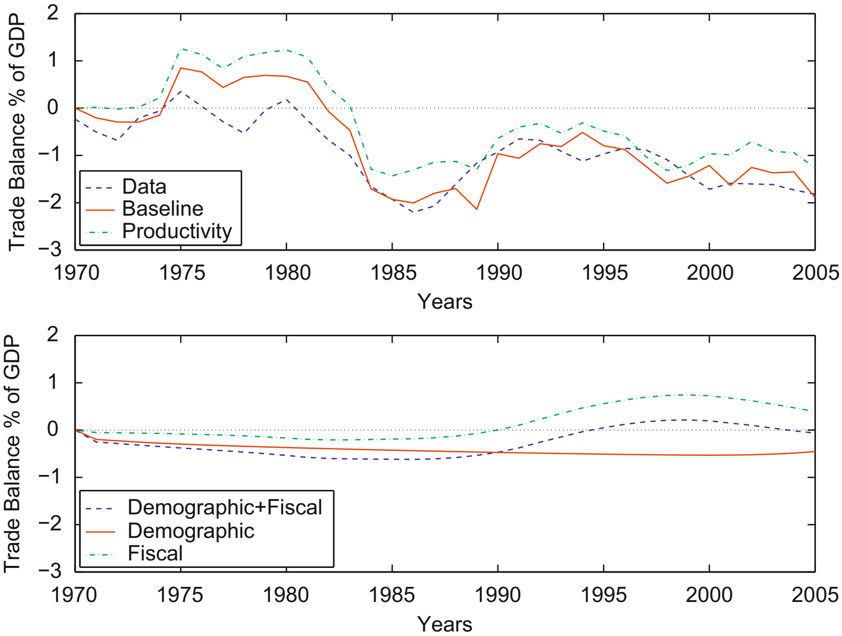

Fig. 5. Determinants of the US trade balance. Top panel: data (blue dashed line), baseline simulation (red continuous line) and simulation when only productivity growth differs across countries (green dash-dot line). Bottom panel: simulation when either demographic factors (red continuous line) or fiscal stances (green dash-dot line) alone differ across countries, and sum of the two (blue dashed line). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

The table quantifies the two main results for the trade balance. Demographic factors account for about 65% of the deterministic component. Productivity explains more than 70% of the variance of the stochastic component. The remainder of this section discusses the main intuition behind these numbers.

Productivity growth: The first quantitative result is that productivity growth differentials are mainly responsible for the dynamics of the US trade balance. Relative to the baseline experiment, the correlation of the simulated trade balance with the data barely decreases (0.87 instead of 0.90) when only productivity growth differs across countries (see top panel of Fig. 5).

Productivity growth affects both investment and consumption like in the standard neoclassical growth model. In the absence of adjustment costs and with the same growth rate of the labor force across countries, productivity growth differentials fully determine relative investment

$$i_t - i_t^* = (x_{t,t+1} - x_{t,t+1}^*)k_t. \tag{17}$$

Higher productivity growth in the US attracts foreign resources because agents in the world economy want to hold claims against capital in the country that employs it more efficiently. In addition, the wealth effect leads to temporarily higher US consumption relative to the G6 ($c_t - c_t^* > 0$). Expression (16) then implies that the trade balance turns negative. As productivity growth differentials subside, US households repay the outstanding foreign liabilities by decreasing consumption and increasing savings. As in the data, periods of positive US productivity growth differentials (basically the second part of the 1980s and again since the late 1990s) corresponds to widening external imbalances.

Demographic factors: One limitation of the model with productivity growth differentials only is that it systematically underpredicts the US external imbalances. The crucial implication is that demographic factors and fiscal policy differentials account for a non-negligible and very persistent component of the US external imbalances with the G6. In particular, the bottom panel of Fig. 5 shows that demographic factors alone make up for almost the entire difference.

Differentials in life expectancy represent about one-half of the total effect of demographic variables on the trade balance. Holding everything else equal, a higher surviving probability γ reduces the marginal propensity to consume of both retirees and workers. Therefore, a longer lifetime horizon in the G6 implies a smaller marginal propensity to consume of retirees in that region (mpc_r^*) relative to the US (mpc_r)

$$mpc_r^* - mpc_r = -\beta^\sigma R_W^{\sigma-1}(\gamma^* - \gamma).$$

A similar channel also affects the marginal propensity to consume for workers, due to the expectation of a longer retirement period. In the aggregate, the increase in the expected lifetime horizon increases the saving rate. Workers save more in order to finance a longer retirement period while retirees spread their consumption over a longer retirement period. The crucial implication for the trade balance is that, ceteris paribus, the level of savings is higher in the country with higher life expectancy.[21] The relative excess of savings generates a trade surplus associated with the accumulation of a positive stock of net foreign assets. The life-cycle structure of the model is the core of this mechanism.

Population growth rate differentials explain about one-quarter of the total effect of demographic variables on the trade balance. Earlier work on the open economy relevance of demographic factors mostly focused on the role of population growth rates (see the survey in Obstfeld and Rogoff, 1996), which can influence the trade balance along two conflicting margins. On the one hand, different population growth rates across countries affect relative investments very much like productivity differentials

$$i_t - i_t^* = (n_{t,t+1} - n_{t,t+1}^*)k_t, \tag{18}$$

where expression (18) abstracts from investment adjustment costs and productivity differentials. As for productivity, a higher US population growth rate relative to the G6 leads to capital inflows to maintain an equal rate of return across countries. On the other hand, the evolution of population growth rates influences the overall age profile of each country. Given two countries initially identical in all respects, a reduction of the population growth rate in the Foreign country increases the dependency ratio relative to the Home country

$$\frac{\psi_{t+1}}{\psi_{t+1}^*} = \frac{1+n_{t,t+1}^*}{1+n_{t,t+1}}.$$

Since retirees consume relatively more than workers, this channel generates an increase of aggregate consumption in the country with the higher dependency ratio. The simulation suggests a mild predominance of the investment channel, although the overall effect appears to be rather small.[22]

The interaction between differentials in life expectancy and population growth rates accounts for the remaining quarter of the overall effect of demographic factors on the trade balance. The combination of these two forces exerts a more than proportional pressure on the dependency ratio. The number of retirees grows relative to the number of workers because (i) the average lifetime horizon is longer (aging) and (ii) fewer people are born in each period (growth). The pool of retirees is larger in the G6 than in the US. But retirees in the G6 live on average longer and, thus, need to save relatively more than their US counterparts.

Discussion: The quantitative predominance of productivity growth differentials in accounting for the US external imbalances vis-a-vis the G6 is consistent with other recent studies. Engel and Rogers (2006) explain the evolution of the US current account since the mid 1990s with the increase in the US share of output among advanced economies. Survey evidence from the Consensus Forecasts supports their results. This paper identifies in productivity growth and demographic factors the two key variables that drive the US share of world output and quantifies their relative importance.[23]

Chen et al. (2009) also stress the central role of productivity growth differentials in explaining the dynamics of the US external imbalances. However, their model also underpredicts the US current account by about 0.5% of GDP when only

[21] A higher survival probability also increases the dependency ratio. For a given marginal propensity to consume, a larger pool of retirees drives up aggregate consumption. However, the reduction in the retirees' marginal propensity to consume due to the longer lifetime horizon quantitatively dominates the effect of the change in the composition of the population.

[22] Higgins (1998) finds empirical support for both channels associated with population growth.

[23] The increase in the US share of world output in the model between 2005 and 2030 roughly coincides with the projections from Consensus Forecasts.

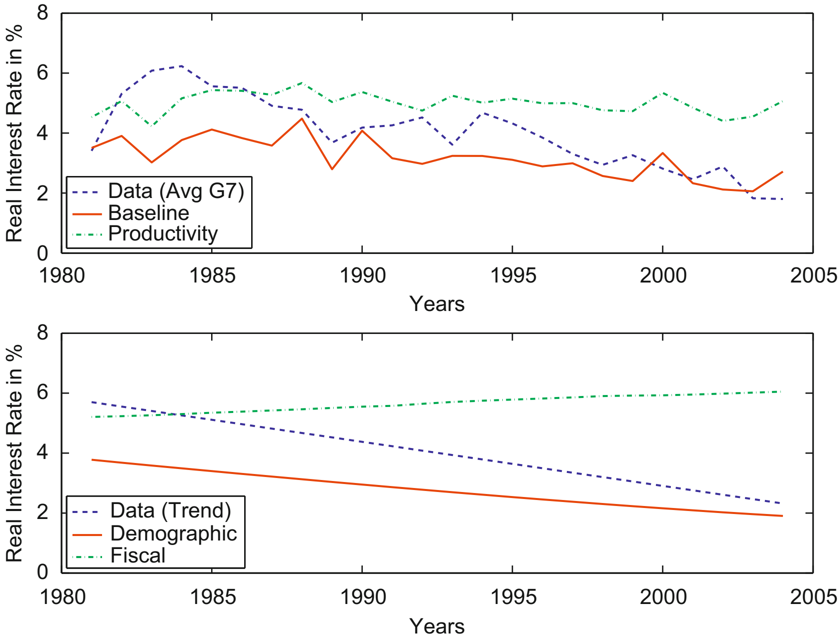

Fig. 6. World real interest rate. Top panel: data (blue dashed line), baseline simulation (red continuous line) and simulation when only productivity growth differs across countries (green dash-dot line). Bottom panel: linear trend in the data (blue dashed line) and simulation when either demographic factors (red continuous line) or fiscal stances (green dash-dot line) alone differ across countries. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

productivity differs across countries. In their analysis, differences in tax rates and depreciation fill the gap. Here, the gap is filled by demographic factors, especially differentials in life expectancy.

Recently, Henriksen (2002), Feroli (2003) and Domeij and Flodén (2006) also find a persistent component of US external imbalances against other industrialized countries due to demographic factors. Differently from these studies, the simple model presented in the previous section combines demographic factors with other potential explanations of external imbalances in a unified and tractable framework. More importantly, the quantitative analysis disentangles the role of population growth rates and life expectancy differentials along the demographic transition. The main finding is that life expectancy is the key demographic indicator responsible for external imbalances.

Fiscal policy: The quantitative contribution of fiscal policy differentials to the US external imbalances vis-a-vis the G6 is modest. Importantly, this result is not built into the model. To the contrary, the life-cycle structure in the model breaks Ricardian equivalence and allows for potentially large effects of fiscal deficits on the net foreign asset position.[24]

Fiscal policy differentials affect the trade balance only through relative consumption, although the general equilibrium effect on the world real interest rate partly mitigates the benefits of fiscal expansions on aggregate demand. Conditional on a fiscal expansion in the US relative to the G6, the model predicts that fiscal and trade deficits are “twins”. Unconditionally, however, the data push against the twin-deficit hypothesis. The US fiscal stance has been only marginally expansionary relative to the G6 for the first 20 years of the sample and relatively contractionary ever since. Therefore, the model with only fiscal differentials predicts a small trade deficit (on average, 0.13% of GDP) for the period 1970–1990 and a counterfactual trade surplus (0.5% of GDP) for the rest of the sample.[25]

3.3. The world real interest rate

The increase in international financial integration since the early 1980s has corresponded to a period of declining world real interest rates (the dashed line in Fig. 6). The “saving glut” hypothesis (Bernanke, 2005) interprets the evolution of real interest rates and the US external imbalances as two aspects of the same phenomenon, both driven by a significant increase in the world supply of savings. Recently, Caballero et al. (2008) and Mendoza et al. (2009) have formalized this

[24] The effects of fiscal deficits on external imbalances are about three times as large as the estimates of Erceg et al. (2005). Under the baseline calibration, a permanent increase in the US fiscal deficit of 1% of GDP generates a deterioration of the US trade balance at the trough of roughly 0.6% of GDP.

[25] An important implication of the quantitative analysis is that the existence of fiscal surpluses and trade deficits in the US during the 1990s is not necessarily evidence in favor of Ricardian equivalence. The US fiscal stance relative to the rest of the world, not its absolute magnitude, determines the equilibrium effects of fiscal deficits on external imbalances.

idea by linking the global saving glut to capital markets imperfections in emerging economies. This thesis is appealing because of the prominent role of emerging market economies in accounting for the growing US external imbalances after the Asian crises of the late 1990s. One limitation, however, is that real rates started falling in the mid 1980s across industrialized countries, well before the emergence of the global saving glut.

This section discusses the relation between global imbalances and decreasing real interest rates in light of the driving forces discussed so far. The demographic transition is the key factor to quantitatively account for the dynamics of the world real interest rate. In particular, the increase in life expectancy plays a crucial role in generating a reduction of the real return. As agents expect to live longer, the saving rate of both workers and retirees increases. Even though lower population growth rates would tend to reduce the long run world saving rate by increasing the dependency ratio, the interaction with longer life expectancy more than compensates for this effect. The larger pool of retirees experiences on average a longer lifetime relative to the initial steady state. The model with only differentials in demographic factors quantitatively accounts quite well for the decline of the world interest rate observed in the data (bottom panel of Fig. 6).

Conversely, neither measured productivity growth nor actual fiscal policies alone can explain the decrease of real returns in international financial markets. On the one hand, productivity growth moves consumption and investment in the same direction. These two dimensions, however, exert opposite pressures on the real interest rate. Quantitatively, the model with only differentials in productivity growth produces a fairly flat pattern of the world real interest rate (top panel of Fig. 6). On the other hand, in the model, the effects of fiscal policy on the world real interest rate depend on the global fiscal stance. Fiscal policy has been mildly expansionary among G7 countries during the last three decades. Therefore, the model with only fiscal policy differentials predicts an increase in the world real interest rate which is clearly at odds with the data (bottom panel of Fig. 6).[26]

The consistency of simulated and observed data for the real interest rate is an important reality check for the model. Low (and decreasing) real interest rates generally favor deficits by reducing the cost of borrowing and maintaining a low burden of outstanding debt. This mechanism constitutes an intertemporal valuation effect which increases the persistence of net foreign debt. Consider, for example, a gradual increase in Foreign life expectancy. In the model, such a shock generates a trade deficit in the Home country and puts downward pressure on the world real interest rate. Simulation results suggest that the real interest rate absorbs approximately half of the impact adjustment in the trade balance. If the Foreign country were small enough not to affect the world interest rate, the trade deficit in the Home country would be twice as big. Moreover, the decreasing interest rate along the transition implies a more persistent trade deficit and a more gradual rebalancing toward the new steady state, given the reduced burden of foreign debt.

4. Conclusions

Differentials in productivity growth and demographic factors account for the evolution of the US external imbalances vis-a-vis the G6 during the last three decades. Productivity growth differentials explain a large fraction of the level of the US trade balance and essentially all of its dynamics. Demographic differentials imply a non-negligible and nearly permanent US external deficit. In addition, the demographic transition plays a critical role in generating a decline in the world real interest rate consistent with the data. On the contrary, fiscal policy differentials are of minor importance.

One important finding is that differentials in life expectancy, rather than population growth rates, are the main demographic indicators responsible for differences in saving patterns across countries.[27] One interesting avenue for future research could be developing an extended model with detailed life-cycle decisions, productivity and distortionary effects of various tax policies to study to which extent the margins highlighted here and in other recent papers are in fact complements or substitutes.

Considerations about social security systems in different regions may influence the conclusions. This aspect currently represents an important difference between the US and the G6, as well as several other countries. The sustainability of welfare states and the agents' expectations of potential reforms are the crucial dimensions of this problem, particularly in light of the current demographic trends. For example, one possible response to a longer expected lifetime horizon would be an increase, either voluntary or mandatory, of the retirement age. This topic is clearly at the forefront of the economic and political debate, although most countries have yet to take explicit measures in this direction.

The main implication of the results is that capital generally flows toward relatively young and rapidly growing economies. Countries with these characteristics often experience large and possibly persistent external imbalances.[28] Unfortunately, this conclusion is not robust outside the circle of industrialized countries. China is the obvious counter-example. The Appendix presents a three-country version of the model in which the third region is (like China) a relatively

[26] The results shed some new light on the empirical (lack of) relationship between fiscal deficits and interest rates. Evans (1987) interprets the absence of high interest rates in periods of substantial fiscal deficits (both for the US and internationally) as evidence in support of Ricardian equivalence. However, the failure to control for demographic trends may bias the results against the hypothesis that fiscal deficits trigger a positive response of the real interest rate.

[27] Chen et al. (2009) also find a negligible role for population growth differentials.

[28] Australia, for example, has averaged a 4.3% current account deficit relative to GDP over the last decade. During the same period, average GDP growth exceeded 3%. Australia's population growth rate is currently comparable to the US (around 1%) while life expectancy is only slightly higher. Backus et al. (2009) survey external imbalances for a large cross-section of industrialized and developing countries.

young, although fast-aging, country with strong growth performance. Perhaps not surprisingly, the quantitative results predict the opposite pattern of external imbalances relative to the data. This counterfactual result is one way to frame the paradox of why capital does not flow from rich to poor countries (Lucas, 1990). The introduction of financial market imperfections, as in Caballero et al. (2008) or Mendoza et al. (2009), seems a promising approach to solve this puzzle.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.monec.2010.04.004.

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