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Long-run Growth Expectations and "Global Imbalances"*

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Abstract
This paper examines to what extent the build-up of "global imbalances" since the mid-1990s can be explained in a purely real open-economy DSGE model in which agents' perceptions of long-run growth are based on filtering observed changes in productivity. We show that long-run growth estimates based on filtering U.S. productivity data comove strongly with long-horizon survey expectations. By simulating the model in which agents filter data on U.S. productivity growth, we closely match the U.S. current account evolution. Moreover, with household preferences that control the wealth effect on labor supply, we can generate output movements in line with the data.

JEL Classification: E13, E32, D83, O40

Keywords: Open Economy DSGE Models, Trend Growth, Kalman Filter, Real-time Data, News and Business Cycles

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Axiom 1 *The fundamental things apply / As time goes by - Casablanca (1942)*

1 Introduction

The global economic crisis of 2008 and 2009 that began with financial market problems in the United States is often seen as related to the global imbalances building up in the preceding decade. That is, seemingly excessive borrowing by the United States in an environment of low world interest rates is seen as the pathological cause of an ever-widening and unsustainable U.S. current account deficit that was bound to be corrected sooner or later. While a correction was often believed to be triggered by a large depreciation of the dollar, the current account began to reverse itself without large exchange rate movements (yet).[1] Instead, restrictions in lending to U.S. households due to financial market problems and the ensuing increase in the U.S. savings rate appear to have initiated an end to the ever-expanding current account deficit.

In this paper, by contrast, we propose an equilibrium explanation of the U.S. current account – and thus also of global imbalances and their reversal – which abstracts from financial factors. In particular, we show that the evolution of the U.S. current account deficit from 1995 onward can to a large extent be explained by households' and firms' optimal responses to changing long-run U.S. growth expectations and to the decline of world real interest rates after 2000. The central role of growth expectations for our results is of course the implication of the intertemporal approach to the current account, according to which savings and investment decisions by forward-looking agents are based on the present value of future incomes, relative to prevailing borrowing costs determined in world capital markets.

The basis of our explanation of U.S. current account dynamics is a standard open-economy real stochastic growth model with capital accumulation and international trade in real bonds and goods. Since future long-run growth is intrinsically uncertain, we assume that the growth rate of productivity consists of persistent and transitory stochastic components. While changes in the latter have only minor implications for the present value of income, even small changes in the former can potentially cause major revisions of perceived

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[1] See Obstfeld and Rogoff (2007) and Cooper (2008), and Feldstein (2008).

wealth, and thus of the commensurate consumption choices. However, the uncertain nature of future productivity growth also requires that a signal extraction problem be solved to infer changes in trend growth. We assume that agents use the Kalman filter to generate long-run productivity growth expectations from real-time U.S. productivity data and show that these model-based productivity growth expectations are consistent with published growth expectations from surveys.

We find that simulating our calibrated model with data on U.S. productivity growth and real interest rates in the rest of the world as driving processes is sufficient to closely track the actual evolution of the U.S. current account since 1995. Given that our benchmark choice of parameter values is quite standard, this result is rather striking. Neither changing productivity growth expectations nor interest rates alone can fully explain the data. Holding growth expectations fixed, lower world interest rates since the late 1990s have played a role, but they can at best explain about a fifth of the widening U.S. current account deficit, and cannot account for the partial reversal after the crisis of 2008/2009. This instead is accounted for by the drop in perceived U.S. productivity growth since about 2006. We conclude that the main driver of the U.S. current account, and thus of global imbalances, are changing U.S. productivity growth expectations.[2]

The main implication of our results is that a large part of the evolution of the U.S. current account should be seen as the efficient response to changing but imperfectly observed fundamentals. Therefore, the buildup of the current account need not be largely the result of economic policies, such as a loose monetary stance in the U.S. along with credit market distortions, as argued by Obstfeld and Rogoff (2010). Similarly, most of the reversal of the current account since 2006 need not be the consequence of a crisis caused by financial turmoil. Instead, as U.S. growth prospects have worsened, expected income streams have fallen, which must lead to revisions of consumption and investment plans by firms, manifesting themselves in the current account.[3] From this perspective, global *im*balances need not be judged as some

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[2] We do discuss later the extent to which changing growth expectations in the rest of the world may have contributed to the fall in world interest rates.

[3] Of course, disappointed growth expectations may be at the core of the collapse of the housing market, which in turn have fed back onto the financial system. But the housing market developments are just one aspect of more fundamental factors at work.

form of pathological disequilibrium. However, as we show, even fundamentally justified changes in actual and perceived growth can have strong effects on the asset valuation of the productive capacity of the economy, and, furthermore, can also feature concomitant output movements in the direction we observed since 2008.

The second implication relates to the idea of a savings glut (Bernanke, 2005), according to which a lack of investment and high savings in the rest of the world caused an excessive supply of funds to the U.S.[4] In the work of Caballero, Fahri, and Gourinchas (2008), the superior quality and depth of the U.S. financial system have led global investors to supply funds cheaply to the U.S., while Mendoza, Quadrini, and Rios-Rull (2009) explain global imbalances as a consequence of asymmetric degree of financial development. The current account reversal in the wake of the crisis would then be explained by the interaction of financial frictions and portfolio rebalancing of international investors. While these factors certainly have played an important role, the fact that we control for the associated interest rate movements suggests that more is needed for a complete account of the global imbalances of the 2000s.

Our reasoning is closely related to the analysis of emerging market current account crises of Aguiar and Gopinath (2008), who find that shocks to trend productivity growth can be a major source of fluctuations in emerging markets. The authors use a small open economy model to identify the true growth trends from current account and consumption data, by assuming that households perfectly observe changes to the long-run growth trend. The growth trend thus inferred is highly volatile.[5] In contrast, we take into account that changes in the growth trend are only perceived with noise, and constrain ourselves to consider changes in productivity growth expectations that are consistent with measured expectations from surveys, such as the Survey of Professional Forecasters. We thus show that changes in perceived long-run productivity growth imply current account movements even for a developed economy as the U.S., and also are able to match such movements in a quantitatively more plausible manner.

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[4] Note that U.S. interest rates have not been systematically lower than in other developed economies. See Gruber and Kamin (2009), and further evidence presented below.

[5] Boz et al. (2010) employ a similar model with learning and show that it matches emerging market dynamics better than under the full information assumption of Aguiar and Gopinath (2008).

Once we acknowledge that long-run growth rates cannot be known with certainty, while at the same time being central to consumption and savings decisions, we see that revisions to growth expectations must be perpetually triggering changes in economic choices. This is akin to the notion of news-driven business cyles, as introduced by Beaudry and Portier (2004) and others.[6] In fact, the news on future productivity inherent in the updates of long-run growth generated by the Kalman Filter on current productivity amount to what Walker and Leeper (2011) label 'correlated news.' These authors show that this type of information flow produces empirically more plausible impulse responses than the 'i.i.d. news' typically analysed. The household preferences that we assume are often used in the news literature, as they allow to control the wealth effect on labor supply. Under a parameterization based on the estimate by Schmitt-Grohe and Uribe (2008), our historical simulations do indeed feature a drop in U.S. output by 2009. Note, however, that our explanation of *current account* movements also prevails for standard preferences with wealth effects, because the present value theory of the current account is one of consumption relative to income, and not of the level of income.

A large literature has explored the intertemporal approach to the current account (aka the present value model). The contrast between our ability to match the U.S. current account and the less conclusive findings in previous work lies in our treatment of interest rates and productivity. In their comprehensive survey, Nason and Rogers (2006) report difficulties in matching the data with that approach. However, all these tests assume a fixed world interest rate for the (small) countries under consideration, and a process in productivity that is trend stationary, rather than difference stationary. In other words, shocks to the trend growth rate are not considered. Neither productivity level shocks nor shocks to demography and government spending among others can explain the current account via the present value mechanism. From the perspective of our results, this is not surprising, since only changes in growth rates have sufficiently large effects on present values and therefore the current account. Other important papers studying the current account and its relation to growth

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[6] This stimulated a rapidly growing literature on news "shocks". See, for example, Jaimovich and Rebelo (2009), Schmitt-Grohé and Uribe (2008), and Fujiwara, Hirose, and Shintani (2008). Boz, Daude, and Durdu (2010) note the general link between news and information updates in their work on emerging market current accounts. We make this link explicit in section 5.

take a long-run perspective over many decades, and assume that agents have perfect foresight and/or perfect information about future growth.[7]

The paper proceeds from here as follows. First, in section 2, we motivate our analysis by showing the evolution of global long-run growth expectations and real long-term interest rates. These data suggest a close link between U.S. long-run growth expectations and the U.S. current account, but a breakdown of the close relationship between growth expectations and interest rates in the rest of the world in the early 2000s. In section 3, we develop our model – a two-country real open economy stochastic growth model – that incorporates changes in long-run trend growth. We also introduce the signal-extraction problem of inferring long-run from short-run productivity movements, and its solution by means of the Kalman filter. Calibration and simulation results are presented in section 4, where we first illustrate the economics of the model using impulse responses. Then we simulate the model using data on U.S. productivity growth and rest-of-the-world real interest rates, and on as the input to the Kalman filter. In section 5 we examine the robustness of our results with respect to a different productivity process. Furthermore, we discuss formally the nature of information shocks – or, news – in our model, and argue that shocks to long-run growth trends are a plausible and concrete example where news drive behavior. Section 6 offers conclusions and directions for future research.

2 The evolution of long-run growth expectations and world interest rates

The main explanation for the emergence of “global imbalances” that we emphasize is the evolution of perceived trend growth rates in the U.S. relative to world borrowing conditions. In this section, we aim to highlight some broad features of the data. The first step is to show how output growth expectations in the U.S. and in a group of major countries, chosen to represent the rest of the world, evolve. The appropriate source of choice here are the surveys of long-run outcome growth expectations as compiled by Consensus Economics. Note that,

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[7] These papers include Engel and Rogers (2006), Ferrero (2010), and Chen, Imrohoroglu, and Imrohoroglu (2009).

while these data are suggestive for our purposes, they are not operational in the simulations of the model, since output growth is an endogenous outcome of a variety of factors, in particular productivity growth.[8]

Since 1989, Consensus Economics conducts a monthly survey of professional economists. For the major industrialized economies, every six months this survey has included questions about participants' expectations of real GDP growth and other macroeconomic variables at horizons up to ten years. For the major economies of the Asia-Pacific region these long-horizon expectations start in 1995. We focus on real GDP growth expectations at the longest horizon (6 to 10 years ahead) for the U.S. and a set of nine countries that in 2008 jointly accounted for about 2/3 of world GDP. Moreover, the nine countries accounted in 2003 for about 2/3 of U.S. imports and slightly less of U.S. exports.[9]

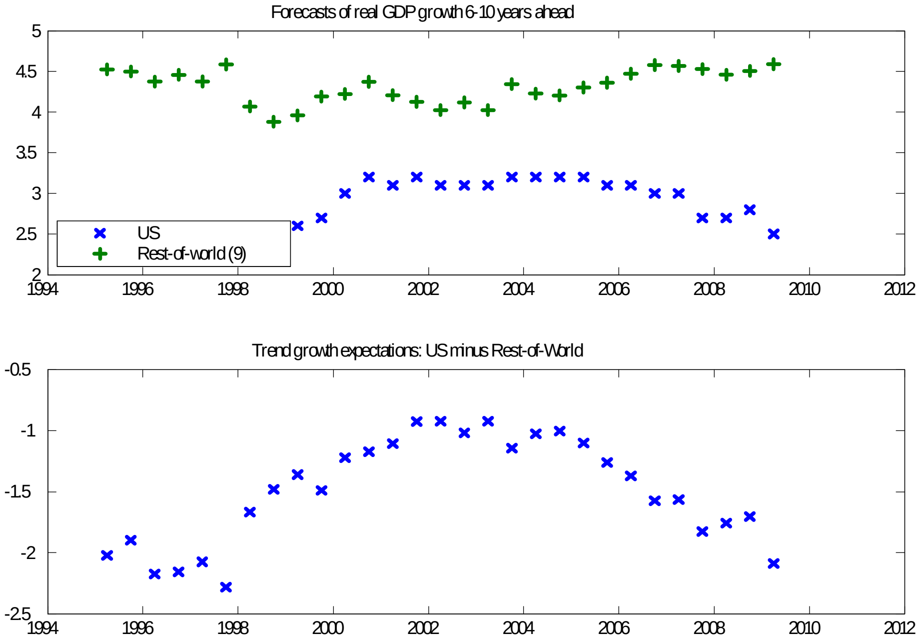

Figure 1: Consensus forecasts of real GDP growth 6-10 years ahead

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[8] In section 3.3 we compute estimates of trend *labor productivity* growth and compare these to long-horizon expectations of labor productivity growth from the Survey of Professional Forecasters (SPF). We use the consensus forecasts here to emphasize the international dimension of changes in perceive trend growth, but use the SPF below because only the latter provides long-horizon estimates of labor productivity growth.

[9] The countries included are the U.S., Japan, Germany, France, the U.K., Italy, Canada, China, Korea and Taiwan. The shares in world GDP are taken from www.ers.usda.gov, the shares in U.S. imports and exports from Loretan (2005).

The top panel of Figure 1 shows these expectations for the U.S. and the GDP-weighted average of the expectations for the other nine countries (henceforth referred to as the "rest of the world").[10] The bottom panel of Figure 1 shows the difference between the trend growth expectations for the US and the weighted average growth expectations for our "rest-of-world" aggregate. As can be seen, participants' perceptions of U.S. trend growth *relative* to the "rest of the world" rose by about 1.5 percentage points between 1998 and 2003, then remained roughly at that level until about 2005, and has since retracted about 1 percentage point. While the initial increase reflected in roughly equal measure an increase in perceived U.S. trend growth and a decline in trend growth elsewhere, the reversal in recent years is mostly due to lower U.S. trend growth expectations.

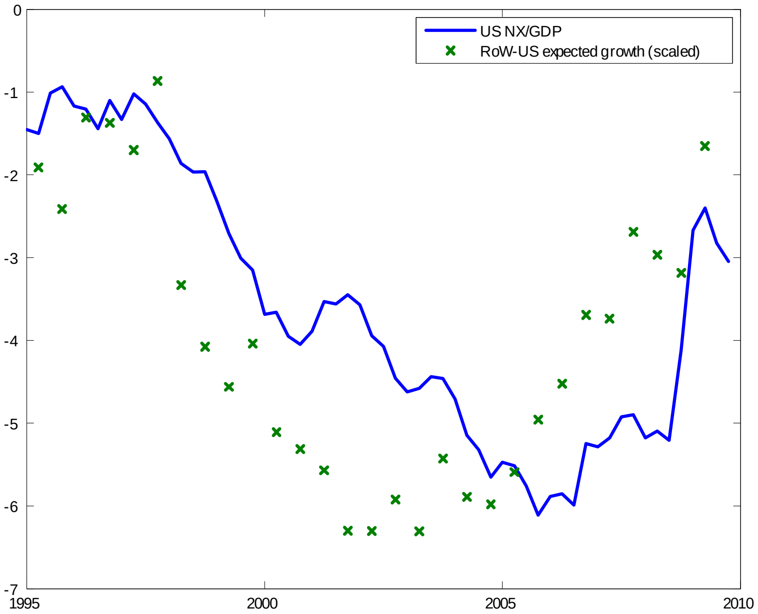

Figure 2: Consensus Forecast Growth Expectations and the Current Account

Figure 2 provides ocular evidence on the link between the current account and growth expectations, which motivates our analysis below. The points marked with x depicts the gap betwen U.S. and world growth expectations from Consensus Forecasts as shown in Figure 1. The blue line is the U.S. current account relative to GDP since 1995. It is striking to us how

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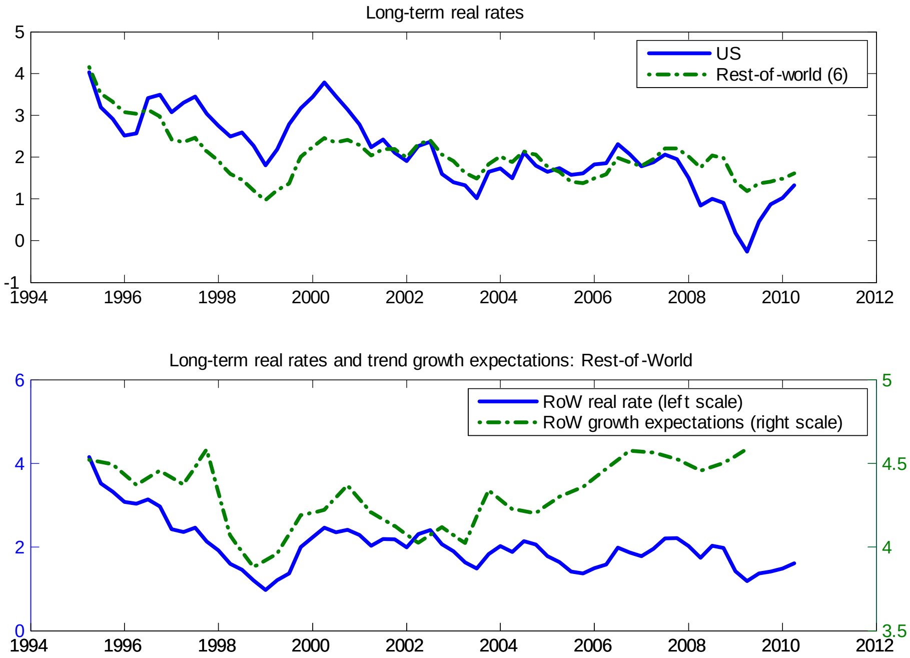
[10] The long-horizon forecasts are always published in April and October, and are shown in the figure in the first and third quarter of each year.


Long-term real rates

Long-term real rates and trend growth expectations: Rest-of-World

Figure 3: Long-term real rates and growth expectations

the growth expectations differential leads the evolution of the current account. Our model simulations based on U.S. productivity growth expectations and world interest rates below will exhibit this pattern even more strongly.

The final point of this section concerns the link between world real interest rates and growth expectations. The upper panel of Figure 3 shows estimates of the *ex-ante* long-term real government bond yields for the U.S. and a subset of six countries of our nine-country "rest-of-world" aggregate.[11] The lower panel plots the real long-term interest rate in the rest of the world (against the left axis) and the weighted growth expectations in the rest of the world. As can be seen, until about 2003 these two series moved remarkably closely together. Since then, however, there is a widening gap suggesting that other factors than perceived trend growth contributed significantly to the movement of the world real interest rate.

Potential explanations for this widening gap, other than growth expectations, have fo-

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[11] For each country, long-horizon inflation expectations are proxied by a slow-moving partial-adjustment equation $\bar{\pi}_t^e = \alpha \bar{\pi}_{t-1}^e + (1-\alpha)\pi_t$ using CPI inflation. This type of equation does a good job proxying long-horizon inflation expectations in the U.S. We exclude China and Taiwan from the computation of the "rest-of-world" real interest rate for lack of government bond yield data, and Korea because of the strong effects of the Asian crisis on its yields.

cused on the relative inability of the rest of the world to create the safe assets they demand (Caballero et al., 2008), or increasing purchases of U.S. government issued paper by China, which is difficult to model. However, what matters for U.S. households and firms are borrowing conditions, not the specific factors that explain their evolution. Therefore, we directly include the realized path of the world real interest rate in our simulations rather than backing out the particular factors that generated it.

3 The Model

In this section we develop our real stochastic growth model of open economies. While most elements are standard from the open-economy real business cycle literature, there are two key modifications: learning about the rate of productivity growth, and generalized household preferences that allow for various strength of the wealth effect on labor supply in response to changes in perceived productivity growth.

3.1 Setup

The model consists of two countries, home and foreign (the rest of the world), which is denoted by an asterisk $*$. We normalize the population size of the domestic economy to 1 and the relative population size of the foreign economy, i.e., rest of the world, to $\mathcal{P}^*$, so that $1/(1+\mathcal{P}^*)$ is the fraction of home population in the world. Each country is inhabited by a large number of infinitely living households and endowed with a constant returns to scale production technology utilized by competitive firms. Firms produce a single good which can be used for consumption and investment in both countries. For ease of exposition, we fully consider only the domestic economy. The foreign country is identical in terms of preferences and technology.

Households in the home economy maximize the present value of their instantaneous utility, discounted with a factor β. Thus a representative households maximizes

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left[\left(C_t - h\bar{C}_{t-1}\right) - \chi\, L_t^{1+\nu} X_t\right]^{1-\sigma} - 1}{1-\sigma},$$

where $X_t = \left(C_t - h\bar{C}_{t-1}\right)^{\gamma} X_{t-1}^{1-\gamma} \left(\frac{Z_t}{Z_{t-1}}\right)^{1-\gamma}$. Utility depends on consumption C_t relative to a weighted external habit stock $\bar{C}_{t-1}$, given by past aggregate consumption, and a weighted disutility of labor, L_t. The weighting factor X_t governs the extent of the wealth effect on labor supply, and is inspired by Jaimovich and Rebelo (2009). The parameter γ is between zero and one. When $\gamma = 0$, these simplify to Greenwood, Hercowitz, and Huffmann (1988) preferences, often used in the open economy literature, allowing plausible labor responses to positive wealth innovations. When $\gamma = 1$, the preferences are the growth consistent preferences from King, Plosser, and Rebelo (1988). In contrast to Jaimovich and Rebelo, we extend the model by including the scale factor $\left(\frac{Z_t}{Z_{t-1}}\right)^{1-\gamma}$, to ensure that the model is consistent with steady state growth in aggregate labor-augmenting technology Z_t, defined below.[12] Note that the expectations operator denotes here the expectation conditional on information available in the current period, which may be imperfect.

The household faces two constraints, the budget constraint and the capital accumulation equation. The former is given by

$$W_t L_t + r_t^k K_{t-1} + r_{t-1} B_{t-1} = C_t + I_t + B_t - B_{t-1}.$$

Income consists of real labor income $W_t L_t$, as well as return on capital determined in the previous period, $r_t^k K_{t-1}$, and the net return on a single non-contingent real bonds, $r_{t-1} B_{t-1}$, respectively. The income is used to finance consumption C_t, investment I_t, and to accumulate net foreign assets, B_t. When agents borrow from the rest of the world it follows that $B_t < 0$. Financial markets are incomplete in that households cannot insure against all possible contingencies. The capital accumulation constraint equals

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

Investment is subject to quadratic adjustment costs, with $\phi(1) = 0$, $\phi'(1) = 0$, and $\phi''(1) > 0$ at the stationary steady state and g the long-run net growth rate. When agents take net positions in international bond markets, a financial intermediation premium must be paid, which relates the domestic interest rate r_t and the rest of the world's real interest rate r_t^* by the following function:

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[12] Jaimovich and Rebelo (1998) impose that $\gamma > 0$, so that preferences are growth consistent, by the weight on the King-Plosser-Rebelo part of preference. Very low values of γ imply however in the limit highly persistent deviations from the steady state growth part.

$$r_t = r_t^* - \varphi \left[\exp\left(\frac{B_t}{Y_t} - \frac{B}{Y} \right) - 1 \right], \tag{1}$$

where B/Y reflects the steady-state ratio of the country's net foreign assets to GDP.[13] Thus, both the actual net foreign asset position relative to GDP, B_t/Y_t, and movements of the real interest rate r_t^* in the rest of the world will affect the borrowing conditions of the domestic economy.

A competitive representative firm in the domestic economy produces a single good according to the technology

$$Y_t = \widetilde{K}_t^{\alpha} \left(Z_t L_t \right)^{1-\alpha},$$

where $0 < \alpha < 1$, and $\widetilde{K}_t$ is the capital stock used by the firm. In equilibrium it will have to equal the capital K_{t-1} supplied by households. Aggregate technology evolves according to

$$\ln Z_t - \ln Z_{t-1} = g_t + \omega_t, \tag{2}$$

with

$$g_t = \left(1 - \rho_g\right) g + \rho_g g_{t-1} + \nu_t. \tag{3}$$

Both ω_t and v_t are i.i.d. distributed as $\nu_t \sim N\left(0, \sigma_v^2\right)$ and $\omega_t \sim N\left(0, \sigma_\omega^2\right)$. The growth in technology thus has two components. An innovation ω_t leads to a permanent shift in the *level* of technology Z_t, but has no persistent effects on the *growth rate* of technology, $\ln\left(Z_t/Z_{t-1}\right)$. An innovation v_t, by contrast, leads to a sequence of changes in Z_t in the same direction because it raises its growth rate temporarily above its steady-state growth rate.[14]

The foreign economy (i.e., the rest of the world) is identically specified. In particular, we assume that it faces the same steady-state growth rate. Nonetheless, both regions can grow at different rates for a substantial amount of time, depending on the realizations of the domestic and foreign technology shocks. Since the model is expressed in per capita terms, the global goods market clearing condition takes account of the relative sizes of the two

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[13] The financial intermediation premium ensures that the net foreign asset position becomes stationary in the linearized version of the model (see Schmitt-Grohe and Uribe, 2003).

[14] An alternative formulation of the technology process involving regime switching has been explored in Kahn and Rich (2007).

regions:

$$\frac{C_t^*\mathcal{P}^*}{1+\mathcal{P}^*}+\frac{C_t}{1+\mathcal{P}^*}+\frac{I_t^*\mathcal{P}^*}{1+\mathcal{P}^*}+\frac{I_t}{1+\mathcal{P}^*}=\frac{Y_t^*\mathcal{P}^*}{1+\mathcal{P}^*}+\frac{Y_t}{1+\mathcal{P}^*}. \tag{4}$$

For later expositional purposes, the world real interest rate can also be written as the average of the foreign and domestic interest rates.

$$r_t^w=r_t^*\frac{\mathcal{P}^*}{1+\mathcal{P}^*}+r_t\frac{1}{1+\mathcal{P}^*}. \tag{5}$$

Finally, bond market clearing requires that

$$\frac{B_t^*\mathcal{P}^*}{1+\mathcal{P}^*}+\frac{B_t}{1+\mathcal{P}^*}=0, \tag{6}$$

since bonds are in zero net supply in the world economy.

3.2 Stationary equilibrium conditions

Households in both regions solve optimization problems of choosing capital, investment, consumption, labor input, and international bonds, taking the choices of agents as given. Furthermore, while habits are external (in the sense that households take $\bar{C}_t$ to be exogenous), the scale factor X_t of labor disutility is taken as internal. This means that households take into account the effect of consumption choices on the future evolution of X_t and thus the effect this has on the future disutility of labor. Firms have the sole task of hiring capital and labor in a competitive market, and produce output using the available technology. Optimization of agents and aggregate constraints result in optimality conditions for all relevant variables, depending on expectations about the future.

The economy of the model is growing at a stochastic growth rate. Therefore, to find the solution for the equilibrium dynamics, the system must be made stationary for standard solution methods to be applicable. Thus we divide all variables that grow in steady state with the same growth rate as technology by Z_t, denoting the rescaled variables by lower case letters: $k_{t-1}=K_{t-1}/Z_{t-1,}$ $c_t=C_t/Z_t$, $\lambda_t=\Lambda_t Z_t^{\sigma}$, $dz_{t+1}=Z_{t+1}/Z_t$ and similarly for the other non stationary variables. After the rational expectations solution has been found, the levels of the variables can be found by appropriate rescaling.

The households' optimal choice of consumption is given by the equality of the marginal utilities of wealth and of consumption, and by the Euler equation. In stationary form, the first condition is

$$\lambda_t = \left(c_t - \frac{h}{dz_t}c_{t-1} - \chi L_t^{1+\nu} x_t\right)^{-\sigma} + \mu_t \gamma \left(c_t - \frac{h}{dz_t}c_{t-1}\right)^{-(1-\gamma)}. \tag{7}$$

The marginal utility of wealth is given by the Lagrange multiplier on the budget constraint. It equals the marginal utility of consumption which here depends on the term arising for non-separable utility plus a term due to the interaction between consumption and the marginal disutility of labor, which follows from the presence of $x_{t.}$ The latter in turn evolves as

$$x_t = \left(c_t - \frac{h}{dz_t}c_{t-1}\right)^{\gamma} x_{t-1}^{1-\gamma}. \tag{8}$$

and is associated with a multiplier μ_t. This evolves somewhat involved according to

$$\mu_t = \beta E_t dz_{t+1}^{1-\sigma} (1-\gamma) \frac{x_{t+1}}{x_t} \mu_{t+1} - \chi L_t^{1+\nu} \left(c_t - \frac{h}{dz_t}c_{t-1} - \chi L_t^{1+\nu} x_t\right)^{-\sigma}. \tag{9}$$

For the special case of $\gamma = 1$ and $h = 0$ the condition reduces to the more familiar equation

$$\lambda_t = c_t^{-\sigma} \left(1 - \chi L_t^{1+v}\right)^{1-\sigma},$$

as the multiplier μ_t drop out. Equation (7) has the same intuition, except that it adds the effect of habits in consumption ($h > 0$) and the strength of the wealth effect, as given by $\gamma < 1$. The intertemporal Euler equation derived from the holdings of real bonds is

$$\lambda_t = \beta (1 + r_t) E_t \lambda_{t+1} (dz_{t+1})^{-\sigma}, \tag{10}$$

which balances current and future marginal utilities. The only difference with a standard Euler equation is the presence of the scale factor resulting from the presence of time varying growth rates in the stationary condition.

Factor supplies are determined by an intra-temporal condition for labor supply and intertemporal conditions for investment and capital. Labor supply is chosen to meet

$$\lambda_t w_t = (1+\nu) \chi x_t L_t^{\nu} \left(c_t - \frac{h}{dz_t}c_{t-1} - \chi L_t^{1+\nu} x_t\right)^{-\sigma}, \tag{11}$$

which equalizes the utility value of the real wage with the disutility of labor. Capital is chosen such that the marginal value of a unit of installed capital is equal to its discounted expected value, which is the sum of the marginal product of capital and the expected value of capital, net of depreciation. Thus capital adjusts to meet the Euler equation

$$Q_t = E_t \beta_{t+1} \left[r^k_{t+1} + Q_{t+1} (1 - \delta) \right], \tag{12}$$

where $\beta_{t+1} = (dz_{t+1})^{-\sigma} \lambda_{t+1}/\lambda_t$ is the appropriately defined stochastic discount factor, and r^k_t is the rental rate of capital and Q_t the marginal value of a unit of installed capital. In the presence of adjustment costs investments follows

$$\begin{aligned} 1 &= Q_t \left(1 - \frac{\phi}{2} \left(\frac{i_t}{i_{t-1}} dz_t - e^g \right)^2 - \frac{i_t}{i_{t-1}} dz_t \phi \left(\frac{i_t}{i_{t-1}} dz_t - e^g \right) \right) \\ & + \phi E_t \beta_{t+1} Q_{t+1} \left(\frac{i_{t+1}}{i_t} dz_{t+1} - e^g \right) \left(dz_{t+1} \frac{i_{t+1}}{i_t} \right)^2, \end{aligned} \tag{13}$$

and the stationary capital stock evolves according to

$$k_t = (1 - \delta) \frac{k_{t-1}}{dz_t} + i_t \left[1 - \frac{\phi}{2} \left(\frac{i_t}{i_{t-1}} dz_t - e^g \right)^2 \right]. \tag{14}$$

Aggregate output of firms in the domestic economy equals

$$y_t = \left(\frac{k_{t-1}}{dz_t} \right)^{\alpha} L_t^{1-\alpha}. \tag{15}$$

The optimal choices of k_{t-1} and L_t are governed by the equality of marginal products to factor prices:

$$w_t = (1 - \alpha) \left(\frac{k_{t-1}}{dz_t} \right)^{\alpha} L_t^{-\alpha}, \tag{16}$$

$$r^k_t = \alpha \left(\frac{k_{t-1}}{dz_t} \right)^{-(1-\alpha)} L_t^{1-\alpha}. \tag{17}$$

Finally, from the budget constraint it follows that output equals spending plus net foreign asset accumulation:

$$y_t = c_t + i_t + b_t - b_{t-1} + \frac{dz_t - (1 + r_{t-1})}{dz_t} b_{t-1}. \tag{18}$$

These stationary conditions together with (1)-(6) and their foreign counterparts determine the equilibrium of the system, along with the corresponding transversality conditions.

A rational expectations equilibrium of the model is a set of sequences $\{c_t,\, c_t^*,\, y_t,\, y_t^*,\, L_t,\, L_t^*,\, i_t,\, i_t^*,\, \lambda_t,\, \lambda_t^*,\, \mu_t,\, \mu_t^*,\, Q_t,\, Q_t^*\ b_t,\, k_t,\, k_t^*,\, r_t,\, r_t^*,\, r_t^k,\, r_t^{k^*},\, w_t,\, w_t^*,\, x_t,\, x_t^*,\, dz_t,\, dz_t^*,\, g_t,\, g_t^*\}$ for $t \geq 0$ given the sequences of shocks $\{\varepsilon_t,\, \nu_t,\, \varepsilon_t^*,\, \nu_t^*\}_{t=0}^{\infty}$. The model is solved by log-linearizing the stationary equilibrium equations around the stationary steady state, and applying familiar methods for the solution of rational expectations models (e.g., Sims, 2002).

3.3 Extracting the perceived trend growth rate

As in Edge, Laubach, and Williams (2007) and Gilchrist and Saito (2008), agents only observe the current level of technology Z_t, but are unable to disentangle changes in $\ln Z_t$ from $\ln Z_{t-1}$ into one-off level shifts ω_t and persistent growth rate changes due to innovations ν_t, in the notation introduced above. They therefore form at each point in time a best estimate $g_{t|t}$ of the current level of trend growth. Given the linearity of our setup, this best estimate is obtained by the Kalman filter according to the recursion

$$g_{t|t} = (1-\kappa)\rho_g g_{t-1|t-1} + \kappa \ln dz_t,$$

where $dz_t = Z_t / Z_{t-1}$. The Kalman gain κ is given by

$$\kappa = \frac{\eta - (1-\rho_g^2) + \eta\sqrt{((1-\rho_g^2)/\eta)^2 + 1 + 2(1+\rho_g^2)/\eta}}{2 + \eta - (1-\rho_g^2) + \eta\sqrt{((1-\rho_g^2)/\eta)^2 + 1 + 2(1+\rho_g^2)/\eta}},$$

where the signal-to-noise ratio $\eta \equiv \sigma_\nu^2/\sigma_\omega^2$ measures the importance of innovations to trend growth relative to permanent one-off changes to the level of technology. All agents, domestic and foreign, share the same signal extraction problem for the productivity process.

The results of our analysis rely critically on the gain parameter κ, which gives the degree to which agents update their estimate of trend growth based on actual productivity growth. To calibrate the gain, we use the median unbiased estimator of the signal-to-noise ratio of Stock and Watson (1998). Applying this method to quarterly labor productivity data for the U.S. nonfarm business sector from 1948Q1 to 2008Q4 leads to an estimated signal-to-noise ratio, η of 0.025. Because the Stock-Watson estimator is based on the assumption of a unit root growth rate process, this implies a quarterly gain of 0.025 as well. In our model calibration, for the sake of stationarity of the model, we assume that ρ_g is close to, but

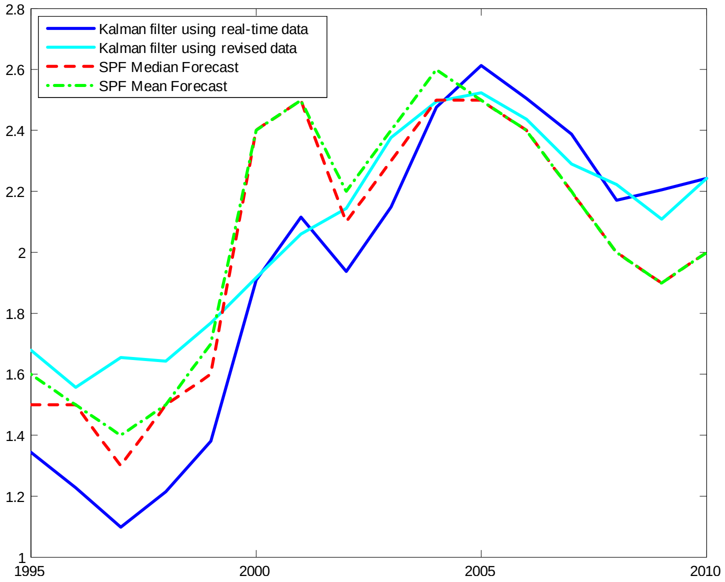

Figure 4: Evolution of estimates of trend productivity growth

strictly less than one. We maintain the gain implied by the Stock-Watson procedure, but combine it with a value ρ_g of 0.99, to obtain the corresponding signal-to-noise ratio.

One method of evaluating the plausibility of this assumed gain is to compute trend growth estimates and contrast them with survey expectations of long-run productivity growth. The red and green dashed lines in Figure 4 present respectively the median and mean forecast of average labor productivity growth in the nonfarm business sector over the next 10 years from the Survey of Professional Forecasters (SPF).

These forecasts are published once a year around mid-February. Following Edge et al. (2007), we compute Kalman filter estimates based on real-time data for annual labor productivity growth (the dark blue line) as well as the estimate based on the currently available data (the light blue line).[15] The Kalman filter estimates based on real-time data approximate the SPF estimates very well. Strikingly, over the period from 1995 to 2010 the five turning points in the Kalman filter estimates coincide almost exactly with the turning points in the SPF estimates. As shown in the figure, the use of real-time data is critical to obtain

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[15] The real-time estimate combines the latest Kalman filter estimate for each vintage of annual labor productivity data. We use the labor productivity data as published towards the beginning of the year so as to correspond to the data that was available to respondents of the SPF when they reported their long-run forecasts of labor productivity growth.

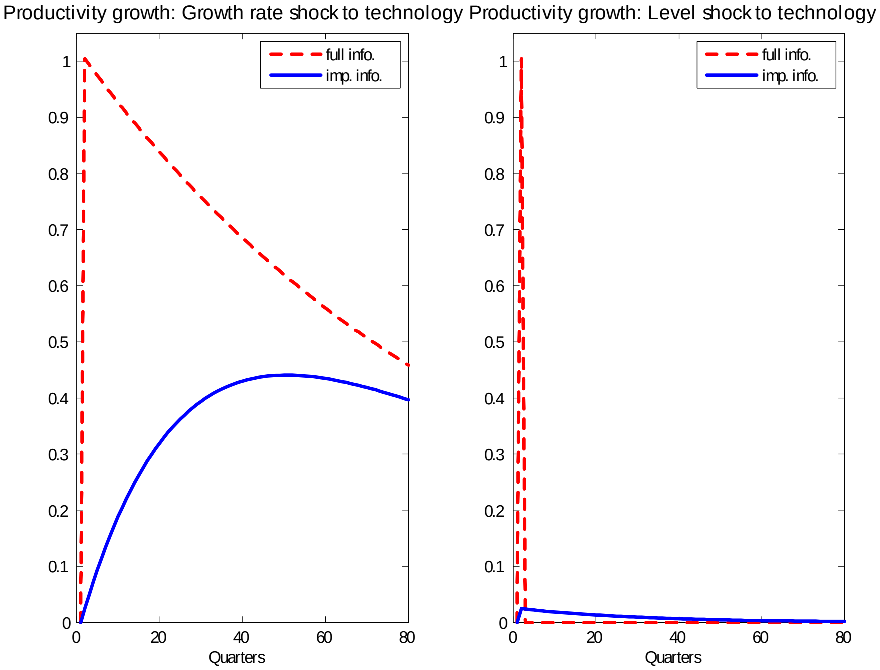

Figure 5: Growth expectations relative to fundamentals

this result: The Kalman filter estimate based on the revised data is not nearly as successful in reproducing the patterns of the SPF estimates. The conclusion that we draw from this figure is that our simple learning model, with the gain calibrated from the Stock-Watson median unbiased estimator, provides a plausible model for the formation of trend growth expectations.

How growth expectations evolve relative to fundamentals is illustrated in Figure 5, where we simulate a one standard deviation shock to the growth rate in the upper panel of the figure. This results in the blue line, which also depicts the case of full information. The growth rate of technology jumps up and with persistence ρ_g slowly returns to the long-run steady state growth rate. Under imperfect information, and the estimated Kalman gain, agents assign only 2.5 percent of a productivity innovation to the permanent change in the growth rate rather than merely the level. Subsequently, as technology growth is persistently higher than expected, the Kalman filter updates the perceived growth rate. Note that the gap between the blue and red-dashed line is equal to the perceived transitory shock, whose role diminishes over time.

In the lower panel of Figure 5, we see the corresponding evolution of the growth rate of productivity after a one time shock to the level. Again, the Kalman filter assigns 2.5 percent of the change to the growth rate shock, and the remainder to the transitory shock. However, even though there are no further changes to technology, the long-term growth expectations continue to be above steady state, since they are revised only slowly downwards.

3.4 Calibrating the remainder of the model

In our calibration, we assign values to the deep parameters using guidance from the literature and a priori reasoning. Their values are displayed in Table 1.

International capital mobility is high, in that we set the international risk premium parameter to a value of $\varphi = 0.0002$, since we consider a long-run horizon, and a period where financial market appear highly integrated. For simplicity we assume that in the steady state $B = B^* = 0$. The size of the domestic economy in the world economy is assumed to be 25% so that $\mathcal{P}^*$ equals 3.

Household preferences are calibrated based on values from Schmitt-Grohe and Uribe (2008), who estimate the Jaimovich-Rebelo (2008) model of news shocks. They find a value for the coefficient of relative risk aversion close to $\sigma = 2$ and a labor supply parameter of about $\nu = 1$, which implies a Frisch labor supply elasticity of 1. In line with Schmitt-Grohe and Uribe we set the steady state hours worked $L = 0.2$. Most crucially, the parameter determining the response of labor supply to changes in consumption, is set based on the estimation of Schmitt-Grohe and Uribe, at $\gamma = 0.0075$. This is somewhat higher than the value of Jaimovich and Rebelo, who set $\gamma = 0.0001$. Both values imply that the positive effect of increased consumption on labor supply only slowly fades away. For $\gamma < 1$, the marginal disutility of labor will rise as much with consumption, since X_t will grow slower than the stock of consumption, $C_t - h\mathcal{C}_{t-1}$, so that $X_t/ (C_t - h\mathcal{C}_{t-1})$ initially falls. The implication of this is that current labor supply may rise after increased perceived wealth. Thus, as γ falls the wealth elasticity of labor supply declines. We also follow Schmitt-Grohe and Uribe estimates and set the habit formation in consumption $h = 0.85$. This value is in line with other estimates of habit formation in the literature, e.g. Smets and Wouters (2007). The discount factor β is set at a quarterly value of 0.9975.

Table 1: Parameters of the model

Parameters		Values
φ	International risk premium	0.0002
σ	Coefficient of relative risk aversion	2
ν	Labor supply parameter	1
L	Steady state hours worked	0.2
γ	Wealth elasticity of labor supply	0.0075
h	Habit formation in consumption	0.85
β	Discount factor	0.9975
α	Capital share	0.3
δ	Depreciation rate	0.025
ϕ	Investment adjustment costs	5
$\mathcal{P}^*$	Size of the foreign economy	3

In terms of technology, the parameter of the production function is set at $\alpha = 1/3$. Capital depreciates at quarterly rate $\delta = 0.025$. The investment adjustment costs are calibrated at $\phi = 5$, which is in line with the literature (e.g., Smets and Wouters, 2003). The foreign country has identical preferences and technologies. All these parameter values determine the steady state of the stationary version of the model. For the simulations, we rescale the endogenous variables either to actual levels or to growth rates, to match them with actual data.

4 Simulating trend growth expectations and the U.S. current account

In this section we use the calibrated model to quantitatively explore the link between growth expectations and the U.S. current account. We focus on four variables, the current account, the present value of income as generated by the model, output, and the rest-of-the-world real interest rate. First, we show the impulse responses of these variables to one-time one percent shocks to the growth rate of productivity, where we use the properties of the productivity process and the associated Kalman gain. Second, we conduct a full historical simulation of the U.S. current account by feeding the data for U.S. labor productivity and the rest-of-the-world real interest rate into the solution of the model.

4.1 Impulse responses to a growth rate shock

Figure 6 shows the impulse responses of the current account (relative to GDP), the present value of income, GDP, and the rest-of-the-world real interest rate to an innovation ν_t that raises productivity growth upon impact by one percentage point and then decays slowly. The current account is shown relative to GDP, and the next two in growth rates, while the real interest rate is shown in levels. We also depict for comparison the evolution of the variables under full information about the growth rate of future technology (the dashed lines).

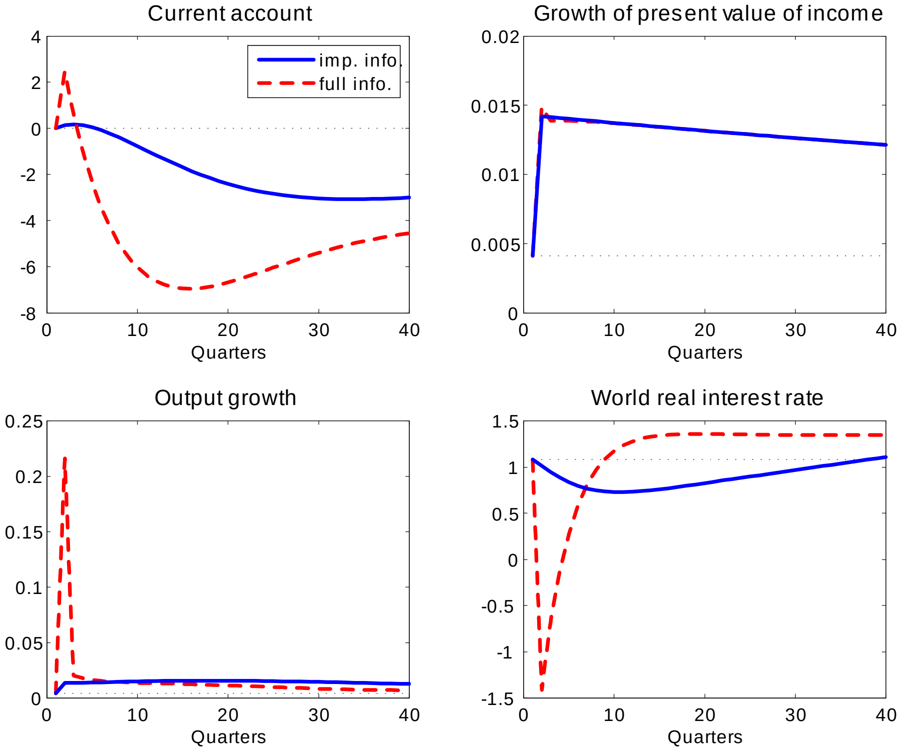

Figure 6: Impulse responses of the domestic variables to a domestic growth rate shock

After the increase in technology growth the current account gradually declines, since the higher perceived wealth increases consumption more than output, leading households to borrow in world markets. This is also reflected in the increase in the present value of U.S. income, discounted with the appropriate stochastic discount factor. The rest-of-the-world real interest rate first drops, but later rises, as domestic demand for funds for consumption and investment surpasses the supply of funds by foreigners. Output rises because of rising labor supply.

The impulse response show clearly the difference between the imperfect and full information case. Without the slow dissemination of knowledge about the growth trend, all variables react more pronounced and partly less persistent. The current account deficit builds up faster because the higher perception of long-run growth, and thus of wealth leads households to increase consumption faster. Also, investment demand is higher because agents aim at building up the capital stock faster to exploit the higher marginal product of capital. The reason that output rises is again the increase in labor supply, due to the mitigated wealth effect discussed later. Under our parameterization, $\gamma = 0.0075$, based on Schmitt-Grohé and Uribe (2008), the effect of higher expected future wealth on labor supply is enormous.

We now turn to the historical simulation of these variables. In a later section, we dig deeper into the reasons for the behavior of labor supply and the role of preferences.

4.2 Historical simulation of the U.S. current account

For the historical simulation of the model we use only two real time data inputs: the productivity data from which agents infer the long-run growth trend of labor productivity, and the proxy of the rest-of-the-world real interest rate, described in section 2, and show the implied evolution of the U.S. current account and the other variables. This section reports the results obtained with BLS labor productivity growth data; in the next section, we alternatively use an estimate an estimate of TFP. Note that the historical simulation starts in 1991, a period when the U.S. current account was virtually balanced.

As pointed out earlier, the reason for using the rest-of-the-world real interest rate rather than a measure of rest-of-the-world growth expectations (or even rest-of-the-world productivity growth) is that the former provides a better measure of the external financing conditions relevant for U.S. households' decisions. As discussed in section 2, the latter is not well explained by rest-of-the-world income growth expectations alone.[16] Rather than trying to model a host of factors that fully explain the rest-of-the-world real interest rate, we use it as a direct input to the simulation. The simulation thus identifies the particular evolution of

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[16] There is also the more technical issue that measures of productivity comparable to the U.S. data are in fact not readily available for several of the countries in our rest-of-the-world aggregate.

the U.S. current account that is consistent both with U.S. productivity growth expectations and the rest-of-the-world real interest rate.[17]

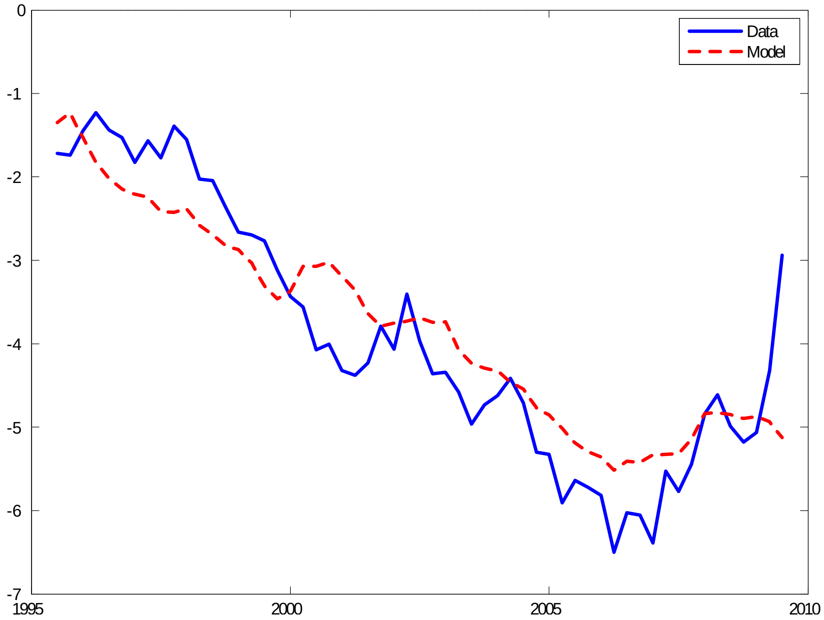

Figure 7: Actual and simulated evolution of the U.S. current account

Figure 7 presents the main result of this paper: the U.S. current account is to a large extent explained by U.S. productivity growth expectations along with world borrowing conditions as reflected in the world real interest rates. The match of the two lines is quite striking, given the rather simple structure of our basic real open-economy model. Notably, the buildup of the current account deficit comes to an end at about 2006, and the deficit closes somewhat. As will be seen below, this is solely due to smaller increases in productivity growth, which leads agents to revise income growth expectations downward. The sharp reduction in the deficit at the very sample end, owes presumably to the collapse of trade finance in the immediate aftermath of the Lehman bankruptcy, something that our model is of course not designed to replicate.

What is the economics behind the behavior of the current account? Taking the present value model literally, we compute the present discounted value of income as perceived by

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[17] To present agents with a stochastic process for the world interest rate, we fit an AR(1) process to it. The estimated persistence parameter over the time period 1991:1 to 2009:4 equals 0.94.

agents in the model. That is, at each point in time, we use households' stochastic discount factor to value the expected income streams, thus getting a measure of perceived wealth. This perception of wealth is what households base their consumption (smoothing) decisions on, and leads them to borrow if the prevailing rest-of-the-world real interest rate is below the one that would obtain under autarky. Obviously, the buildup of the current account reflects the fact that rest-of-the-world real interest rates are lower than what market forces in a closed economy would force the interest rate to be, namely the one that equalized current consumption and investment with current output.

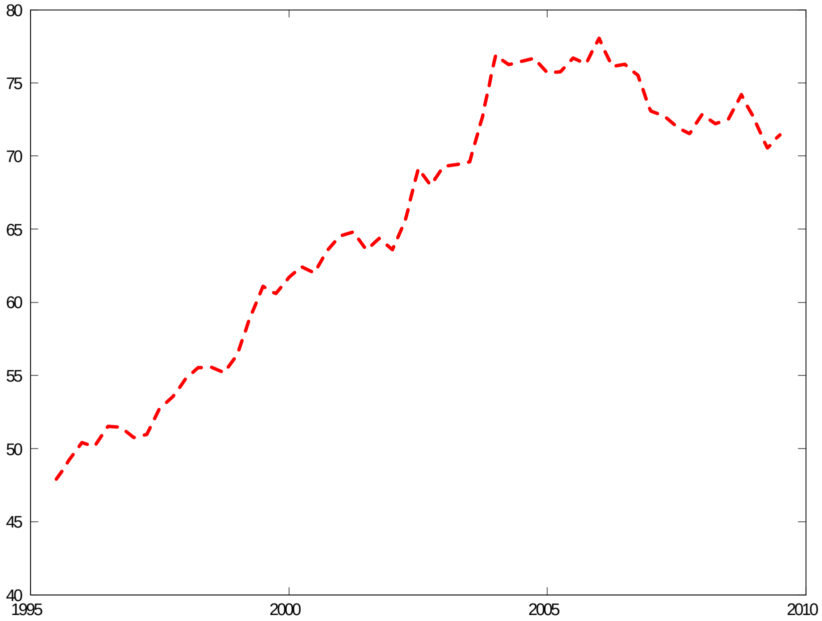

Figure 8: Simulated present value of income

Figure 8 shows clearly the large changes in the level of wealth that go along with changes in perceived income growth. Interestingly, we observe only a slight downward revision of wealth after 2000, the bursting of the dotcom bubble, followed, however, by an acceleration in 2003 and 2004. From 2004 up until 2006 wealth perceptions stagnated at a high level, until falling to a lower level in 2007. Most striking is the large drop in wealth towards around 2007/2008. The revision in wealth must, by the logic of our model, lead to adjustments in agents consumption and investment plans and should manifest itself also in output movements.

The evolution of output growth as generated by the model is shown in Figure 9. The correlation between model and data growth rates is quite striking, especially from 2000 onward. We also do see a downturn at the end of the sample. The dynamics of output are governed by three forces. First, there is the direct impact of aggregate productivity on output. Second, there is the direct impact of labor supply, and third, the more long-run adjustment arising from investment that raises the capital stock in response to rising productivity (actual and projected). Most important is the behavior of labor supply. As mentioned earlier, household preferences allow labor supply to respond positively to favorable growth expectations. Under standard preferences, labor supply would decline in times of faster consumption growth, and thereby mitigating the output response to perceived higher income growth.

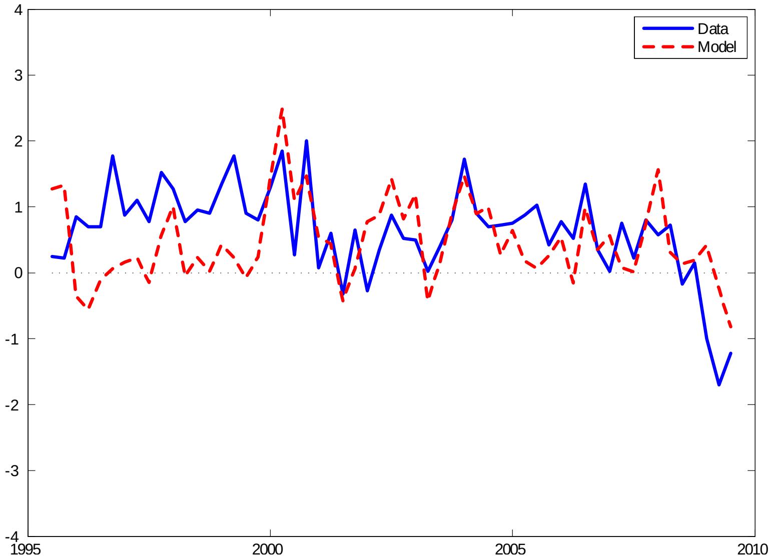

Figure 9: Actual and simulated U.S. output growth

In the model, the adjustment to changing growth trends is efficient ex ante, since agents react in the best possible manner to the available information. However, ex-post, growth expectations will often turn out to be wrong, and behavior will appear suboptimal. Assuming that an optimal filtering process gives the best possible estimate of the long-run growth trend, outcomes cannot be improved upon. We stress that even in the absence of deviations from fundamentals, such as bubbles, the adjustment to fundamental changes can induce substantial strain on an economy. In spite of the absence of financial or nominal frictions, the model is able to generate behavior of output growth that in some respects matches actual data. For example, the model generates a downturn in output – an actual recession in terms of negative growth rates – solely as the result of a downward revision in wealth arising from slowing down productivity growth.

4.3 The role of trend growth and the savings glut hypothesis

In this section we assess the importance of trend growth expectations and the world real interest rate for the US current account. It has been argued that an excessive supply of funds to world financial markets, a savings glut, has resulted in a flow of savings into the U.S., and thus generating the large current account deficit of the 2000s. One way to shed light on this issue is to ask how the current account would have evolved had U.S. productivity growth not picked up since the late 1990s. We operationalize this by keeping productivity growth expectations constant at its long run steady-state rate over the sample, but still feeding in the measure of rest-of-the-world real interest rates. In this way, present value revisions from changing productivity growth are at a minimum. Of course, actual productivity does change over time, but we rule out that agents draw any conclusions about the long-run from such changes. The complementary picture is one where the rest-of-the-world real interest rate is held fixed at its steady state rate, but instead growth expectations are allowed to evolve as mandated by the inference from the Kalman filter.

Figure 10 shows the resulting evolution of the current account had only interest rates changed, but not growth expectations. Thus, holding growth expectations fixed, lower rest-of-the-world real interest rates since the late 1990s can be seen to have played a role, but they can at best explain a fifth of the widening U.S. current account deficit. Furthermore, since these interest rates have stayed low during and after the economic crisis of 2008/2009, they cannot explain the narrowing of the current account by the end of this decade.[18]

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[18] To give a full picture, the world interest rate ought to be regarded an endogenous variable for a counterfactual analysis for a large open economy such as the U.S. Then, knowing the driving forces of the interest rate in general, i.e. global equilibrium, it would be even more instructive to allow the interest rate to move when holding growth expectations fixed. The resulting lack of demand for funds by U.S. households would then let the world interest rate fall by even more than was observed in equilibrium, thus possibly have a stronger impact on the U.S. current account than seen above.

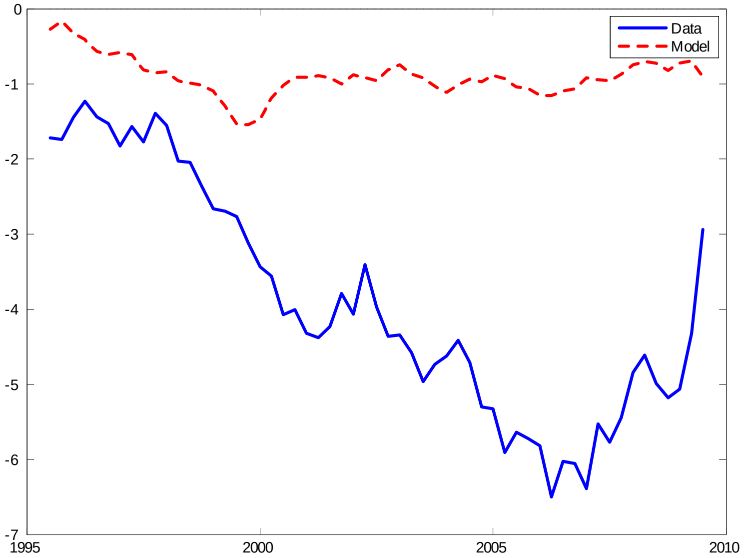

Figure 10: Actual and simulated U.S. current account (world real interest rate only)

Instead, the narrowing of the current account by the end of this decade is largely accounted for by the slowdown in perceived U.S. productivity growth since about 2006 alone. It is evident from Figure 11 that, even holding rest-of-the-world real interest rates fixed, the current account would have widened incessantly from the 1990s onward, only to slow down by the end of the sample. Thus, changing growth expectations are an important driver of the U.S. current account and consequently of global imbalances.

5 Extensions

In this section we examine the robustness of our results with respect to a different, possibly cleaner, measure of productivity. We also highlight the relationship between learning about the persistence of a technology shock and the rapidly evolving literature on the role of news about future technology as source of business fluctuations.

5.1 A different measure of productivity

Our use of labor productivity in the U.S. nonfarm business sector allowed us to directly confront the trend growth estimates generated by the Kalman filter with published surveys

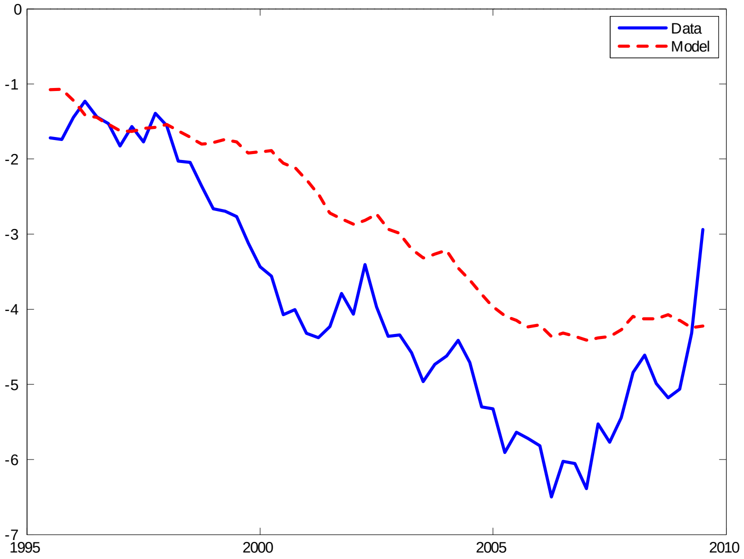

Figure 11: Actual and simulated U.S. current account (Growth expectations only)

of long-horizon expectations of productivity growth. However, the BLS measure of labor productivity is certainly imperfect as a measure of exogenous technology. In the following we therefore replace the historical process of BLS labor productivity by the (appropriately scaled) total factor productivity (TFP) estimates of Basu, Fernald and Kimball (2006) that are corrected for cyclical variation in factor utilization and other endogenous influences. We again use the Kalman Filter specified above to obtain the perceived trend growth rate on which agents base their current but foward looking decisions, which affect the current account and output movements of the economy.

Figure 12 shows how the perceived future growth rate, based on the U.S. TFP process, determines the model's implied U.S. current account. Again, the solid blue line represents the data, the dashed red line the model-implied evolution. It follows from the figure that, for the TFP estimates of Basu et al. as well, the simulated series matches the data quite closely. Thus, we conclude that the evolution of the U.S. current account seems to be explained to a large extent simply by changes in perceptions of trend growth, whether agents base their estimates of trend growth on observations of labor productivity or of TFP.

We conclude from this that what matters are the perceived long-run trend growth rates to explain the U.S. current account and output growth and not the specifics of the productivity

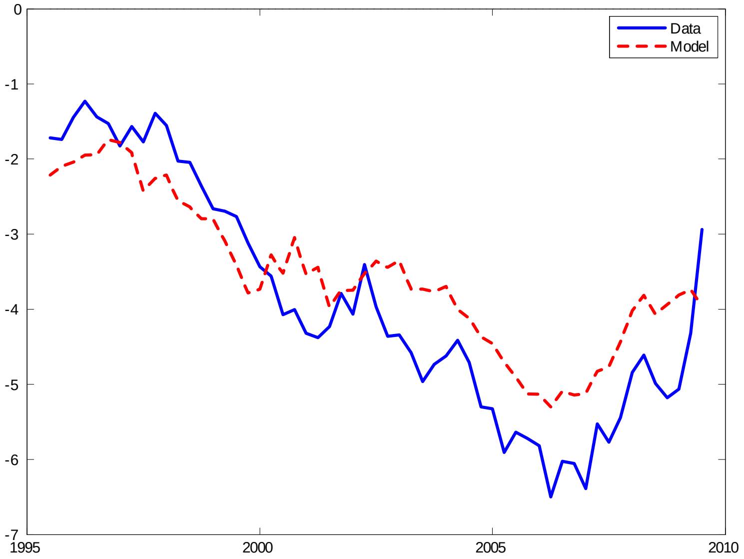

Figure 12: Actual and simulated evolution of the US current account (U.S. TFP)

data based on which agents form their expectations about trend growth.

5.2 News and trend growth expectations

In this section we aim to clarify the relation between the central role in our analysis of learning about the persistence of a technology shock and the rapidly developing literature on the role of news about future technology as source of business fluctuations. In so doing, we also examine the role of our use of GHH preferences for the dynamic responses of the key variables in our economy. An important role of these preferences is suggested by the seminal paper of Jaimovich and Rebelo (2009), who explore the importance of preferences for the comovement of output, hours and consumption in response to news about future technology shocks.

The experiment considered in much of the news literature – information arriving at date t about a technology improvement at date $t+k$ that is found at that time to be either happening or not – looks at first quite distinct from our signal extraction problem. However, a technology shock occurring in our model sets in motion not only a change in the level of technology today, but also revisions to expectations about future technology levels. Moreover, in *every* period after a shock occurring, there will be further revisions to expectations of technology in *all* future periods (although vanishing asymptotically). These revisions are illustrated in Figures 13 and 14.

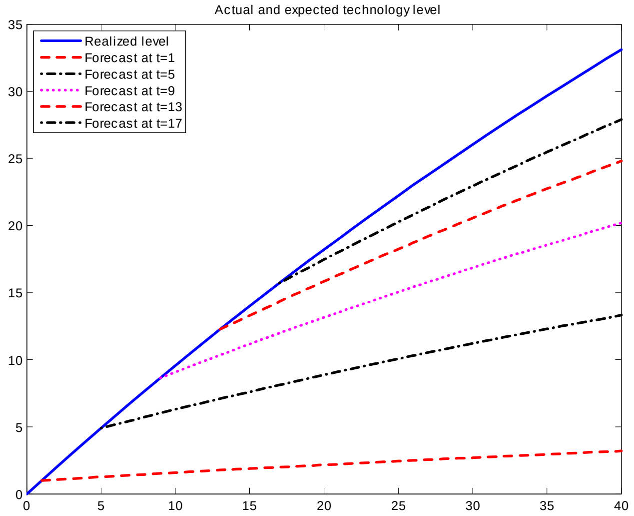

Figure 13: Revisions to expected log technology (Growth rate shock)

Figure 13 considers the case of a shock ν to the growth rate of technology occurring at date 1. At date 1, the log level of technology rises by 1. Because the signal-to-noise ratio in our calibration is small, this shock is mostly seen as a permanent shift in the level to technology, with very little consequences for future growth. As time goes by and agents update their beliefs $g_{t|t}$, not only are expectations of future levels of technology being revised upwards, the slope of the expected trajectory of technology becomes more closely aligned to the actual slope (the solid blue line) of the evolution of technology.Thus, in the spirit of the news literature, in each period there are expectations of future, as yet unrealized, technology increases that are being revised up from the previously held beliefs, and in each period agents are surprised by the actual increase in the level of technology.

As shown in Figure 14, apart from the increase in the level of technology in the impact period, the logic of revisions of beliefs works in reverse when the source of the technology improvement is a one-off increase ω in the level of technology.The initial small revision in the estimate of $g_{t|t}$ caused by the shock leads to expectations of (albeit small) future technology improvements that fail to materialize. The news process in our model is thus a case of

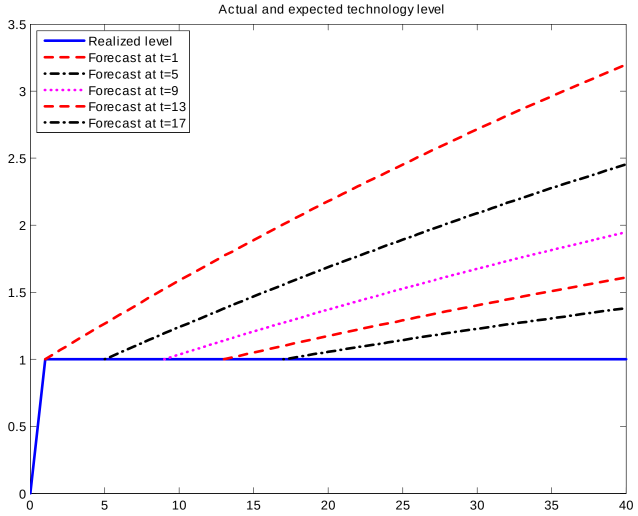

Figure 14: Revisions to expected log technology (Level shock)

what Walker and Leeper (2011) call "correlated news," except that each shock in our model triggers an infinite *sequence* of such correlated news shocks, a new one in each period due to the revision of $g_{t|t}$. The impulse responses presented in Figure 6 can thus be viewed as the sum of IRFs to a traditional technology shock and IRFs to a sequence of subsequent news arrivals.

Given the close relation between technology shocks, be they level or growth rate shocks, and perceived news about future technology, in Figure 15 we explore the role of information and of our preference specification for the response of hours to technology shocks.As highlighted by Jaimovich and Rebelo (2009), the class of preferences considered by King et al. (1988) induces in response to expected future technology increases a decline in hours today due to the wealth effect on labor. This effect is not present with the preferences considered by Greenwood et al. (1988). In the class of preferences proposed by Jaimovich and Rebelo that we use here, the parameter γ measures the strength of this wealth effect, with $\gamma = 1$ corresponding to the King et al. preferences and $\gamma = 0$ to the preferences of Greenwood et al. The responses shown in the left panels of Figure 15 are derived using $\gamma = 1$, those in the left panels using a value of γ very close to 0.

Consider first the solid blue lines, which are the impulse responses derived under perfect information about the nature of the shock. The upper two panels show that qualitatively the hours responses to a one-off permanent increase in the level of technology are quite similar under the two preference specifications: Because consumption is permanently higher, temporarily labor input falls, with this effect being larger in the case of γ close to 0. The lower two panels, by contrast, illustrate the effect of the "news component" in a growth rate shock on hours: With $\gamma = 1$ hours sharply decline due to the wealth effect of expected future productivity gains whereas with $\gamma = 0$ the opposite is the case.

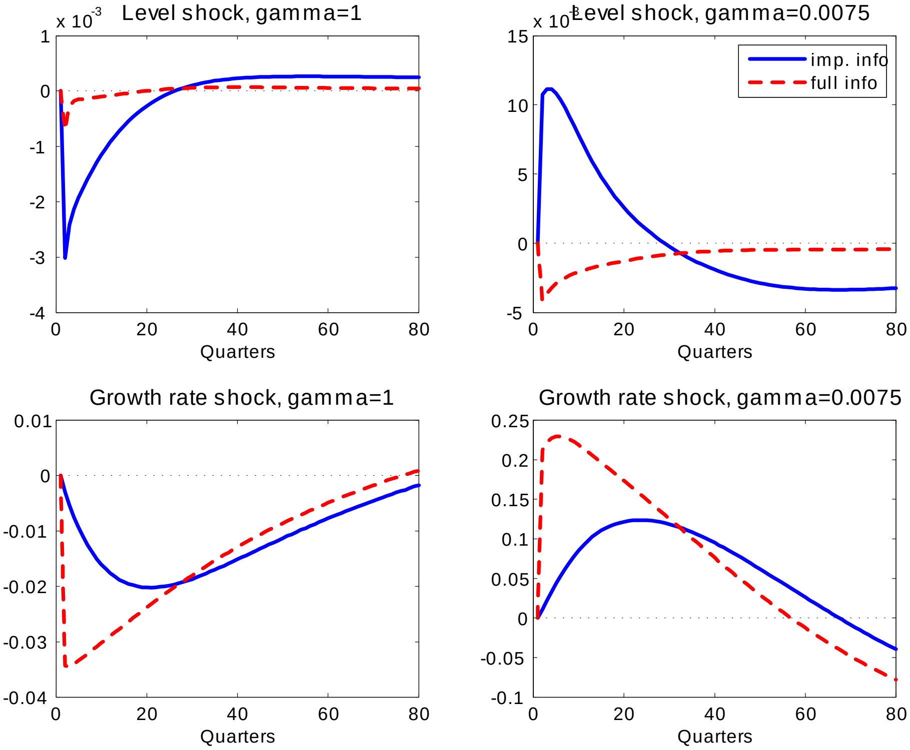

Figure 15: IRFs of hours worked (Preferences and learning)

In the case of learning – the dashed red lines – the responses to a growth rate shock (the lower two panels) are qualitatively similar to those under perfect information, due to the constant arrival of positive news about future technology implied by the updating of beliefs $g_{t|t}$. The interesting case is that of a level shock. In the case of $\gamma = 1$ (the upper left panel) the initial expectation of future technology increases (as shown by the forecast of technology in the impact period, the first red dashed line in Figure 14) reinforces the negative impact response under perfect information. By contrast, under GHH preferences (the upper right panel) the expectation of future technology increases leads to an increase in hours that more than offsets the negative effect of the increase in technology upon impact. Over time, as the expected technology increases fail to materialize, the response of hours turns negative.

6 Conclusions

In this paper we have argued that the evolution of the U.S. current account, and thus of one side of what has been labelled "global imbalances," can be largely explained within a standard neoclassical growth model once changes in perceived trend growth rates in the domestic and foreign economies are properly taken into account. Our sole departures from a standard two-country real business cycle model are the assumption of a technology process composed of two components of different persistence and the associated filtering problem that agents need to solve, and the use of preferences in the spirit of Jaimovich and Rebelo (2009). As we have shown, the second assumption is relevant for improving our model's fit of output movements, whereas only the first assumption is necessary for explaining the current account evolution.

It may seem odd, in the aftermath of the greatest financial crisis at least since the Great Depression, to focus on an explanation that abstracts completely from financial factors. First, we emphasize that we provide an explanation for the evolution of the current account, *not* for the financial crisis. Second, we do not claim that financial innovation had no role to play in facilitating the capital flows from the rest of the world to the U.S. Rather, we argue that it is important to first explore how far a simple, standard economic framework together with careful modeling of agents' growth expectations can take us in understanding these capital flows.

Moreover, our conclusions seem particularly relevant in the current situation, in which the economic policy debate is focused on regulatory reform so as to prevent a repeat of a financial crisis of the dimension just seen. In the context of this debate, limits to current account imbalances have been proposed as an essential element. Our analysis on the contrary has shown that large current account deficits can be the optimal response to relatively small changes in trend growth rates. That said, for as long as agents need to take decisions under imperfect knowledge of trend growth rates at home and abroad, it is inevitable that current account movements will at times turn out to have been excessive, with all the concomitant painful adjustment this entails.

Despite our emphasis on a frictionless framework, a natural next step would be to expand our model by integrating a role for financial intermediation within and between countries to better understand how changes in trend growth perceptions might interact with financial structure. We leave this for future work.

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