Financial Frictions and Household Debt: a New Perspective on Twin Deficits

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Abstract
This paper examines the international transmission of fiscal shocks in open economy, using a model combining heterogeneity of thrift with imperfect enforceability of contract as a motivation for the presence of financial frictions. This model generates twin deficits in response to a temporary cut in lump-sum taxes, overcoming a limitation of both standard RBC and New Keynesian models. Household debt and financial frictions amplify the effects of shocks to lump-sum taxes, but play a moderate role in the transmission of government expenditure shocks. The theoretical responses generated by this model are in line with those estimated using a VAR on U.S. data from 1973 to 2004. It is also shown that liberalization and structural changes in the asset markets — relaxing the collateral constraint in the credit market — magnifies the movement of the current account in response to fiscal shocks.

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1 Introduction
What are the effects of fiscal policy shocks on the current account? This question has occupied a prominent place both in the academic and policy debate, but there is very

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little consensus on the effects of expenditure and tax shocks and on the underlying transmission mechanism. On the one hand, central banks and public authorities, especially in Europe, seem to take almost for granted a positive correlation between public and current account deficit; on the other hand, there is very little consensus in the academic literature on the effects of these shocks, both from an empirical and theoretical point of view.

The objective of this paper is to fill this gap at least partially, by providing an empirical analysis of the effects of tax and expenditure shocks on the current account and by reconsidering the international transmission of fiscal shocks in a way consistent with the empirical evidence.

The empirical analysis shows how important is to analyze tax and expenditure shocks separately, rather than looking at generic deficit shocks, as it was the case in Kim and Roubini (2004). The evidence shows that rise in expenditure and tax cuts are usually deficit financed, with opposite effects on the trade balance: while an increase in government spending improves the trade balance (twin divergence, since the trade and fiscal budget balances move in different directions), a reduction in taxes worsens it (twin deficit). Our exercise is rather similar to the one of Monacelli and Perotti (2006): however, our results differ quite substantially, especially concerning the effects of government expenditure shocks: they conclude in favour of twin deficit even in this case. I will argue that this result is mainly due to type of deflator used in the derivation of the real series.

The empirical evidence cannot be easily reconciled with the prediction of the standard RBC model: in this paper, I show that an explicit consideration of the role of household debt in the international transmission of fiscal shocks in an economy with financial frictions can rationalize the two different responses of the trade balance to tax and government expenditure shocks.

Drawing on Iacoviello (2005) and Campbell and Hercowitz (2005, 2006) I introduce heterogeneity among households. Namely, I model two groups of agents, each identified by their rate of time preferences: Patient agents have a high discount factor, Impatient agents have a low discount factor. In equilibrium, patient agents set the steady state interest rate, and lend funds to impatient agents, whose unwillingness to save results from optimizing behavior.\(^1\); Impatient agents however, are

\(^1\)This specification is much more realistic and internally consistent than the one taking into account rule-of-thumb agents along standard optimizing consumers as in Gali, Lopez-Salido and Vallèes (2005). In this specification agents are unable nor to save or borrow, and this as a consequence of a purely exogenous specification of their consumption behavior. While the division in two groups and the relative heterogeneity in terms of time discount factor is still somehow arbitrary, our model contemplate only optimizing agents and does not restrict their optimizing horizon.
constrained in their ability to borrow by a collateral constraint. Due to its tractability, this framework is particularly attractive as it allows us to focus sharply on the mechanisms through which financial frictions shape the macroeconomic transmission of fiscal shocks in an open economy, thus providing a novel contribution to the literature on twin deficit.\(^2\)

The ‘twin deficit’ result after a tax shock is novel and most interesting in the framework of a DSGE model, as standard Neoclassical or New Keynesian models are unable to generate it.\(^3\) The intuition behind it is straightforward: a tax cut induce a positive effects on the wealth of impatient agents, who then work less and consume more — thus reducing private saving and therefore contributing to a current account deficit. The external deficit increases on impact, then goes back to zero following a hump-shaped pattern.

The ‘twin divergence’ result after a government expenditure shock is mainly given by the reduced ability to borrow of Impatient agents which compounds with the negative wealth effect arising from the increase in the present discounted value of taxes. The fall in private demand, reduces the price of collateral, reducing even further private consumption. In this way, the fall in domestic demand is bigger than the increase in government expenditure, thus leading to a trade balance surplus.

This model also permits a focused analysis of the effects of financial markets’ structural reforms: I show that the deregulation process that has taken place in the U.S. since the 1980s has raised the impact of fiscal shocks on the external stance of a country. We identify the financial liberalization with an unbinding of the borrowing constraint as in Campbell and Hercowitz (2005) and Mendicino (2005). Our results suggest that the deregulation process initiated in 1982 by the Garn-St. Germain and Monetary Policy acts may have contributed to increase the response of current account deficit to shocks, in particular by affecting the transmission mechanism of fiscal shocks.

One features of our analysis is worth stressing. Most of the recent literature\(^4\) has tackled the twin deficits by looking at the effects either of government expenditure

\(^2\)For a discussion of financial frictions in the market for household debt in closed economy see Callegari (2005).

\(^3\)Generating twin deficit by debt financed tax cuts is not trivial since standard models tend to generate twin divergence rather than twin deficit: RBC models with distortionary taxes like Baxter (1995), Baxter and Crucini (1995) and Kollmann (1998) find that tax cuts generate current account surpluses: the increase in labour supply which follows the shock increases output, and this prevails on the rise in consumption and investment expenditure. Adding sticky prices does not affect the picture considerably: the income effect would be bigger because of the higher increase in real wages, but it would not be enough to compensate the increase in output.

shocks or of generic deficit shocks (independently on its origin). Conversely, this paper analyzes twin deficits resulting from either government spending increases or tax cuts, distinguishing between the case of lump-sum and distortionary taxation. Our attention main focus is on tax cuts, given their relevance in generating the fiscal deficits of the 80s and of the 2000s.

A number of papers have recently introduced some form of consumer heterogeneity in general equilibrium model, implying a departure from Ricardian Equivalence: following Gali, Lopez-Salido and Vallès (2005) Erceg, Guerrieri and Gust (2005) introduce rule-of-thumb consumers, i.e. agents who blindly consume all their income, period by period. By simulating their model using actual data, Erceg et al. (2005) conclude that fiscal deficits play only a small role in the current account determination, since the behavior of private agents tends to offset the fall in public savings. This conclusion is in stark contrast with the widespread view, according to which tax cuts are one of the main reasons for the US current account deficit growth observed during the 1980s and the early 2000s. Kim and Roubini (2004) assess the empirical relevance of this view, surprisingly finding a negative correlation between fiscal and current account deficit (twin divergence), rather than twin deficit. Corsetti and Mueller (2006) find that twin deficit effects of spending shocks in the US are small. Cavallo (2005) studies the effects that individual components of government expenditure have on the current account, concluding that the impact of wage expenditure is considerably smaller than the one on final goods.

The remaining of the paper is structured as follows. Section 2 presents the empirical evidence and section 3 describes the theoretical model, while section 4 presents its parametrization. Section 5 analyzes the implication of the model for the Twin Deficit hypothesis. Section 6 presents the analysis of financial liberalization. Finally section 7 concludes.

2 VAR Evidence

The empirical literature on fiscal policy has grown rapidly in the last years. Clarida and Prendergast (1999) use the VAR technique to estimate how the effects of a spending shocks vary with different level of pre-shocks public deficits. Kim and Roubini (2004), use a structural VAR framework to analyze fiscal deficit shocks, concluding in favor of twin divergence rather than twin deficit. Mueller (2006) use a structural VAR to study the effects of government expenditure shocks on the trade

5 Apart from nominal rigidities, which are included in the Erceg et al. model, the rule-of-thumb specification is nested in our model.
balance, and develop a model able to explain some of the observed evidences; Corsetti and Mueller (2005) perform a similar analysis concluding that whether there is twin deficit or divergence depends on the degree of home bias, the extent of investment costs and the persistence of the government expenditure shock.

The analysis is performed estimating a structural VAR on US data for the 1973-2004 period, focusing on the individual effect of expenditure and tax shocks rather than looking at generic deficit shocks (as, for instance, in Kim and Roubini, 2004) or a limitation on government expenditure shocks only (Mueller, 2006 and Corsetti and Mueller, 2006). Our analysis is comparable to Monacelli and Perotti (2006), who study the effects of government shocks and tax cuts on the US, Australia, Canada and UK: they use a different methodology to compute the real series (using the GDP deflator instead of the sectorial deflator), finding a different response of the trade balance to a government expenditure shock: however, we think that the use of a sectorial GDP is the correct choice if we want to compare our responses to those
generated by a model in which there is no explicit consideration of a public sector and wages are paid only by the private sector.

The inclusion of real GDP is crucial because allows us to control for the automatic effects of output on the fiscal variables. The measure used here to represent the external stance of the US is the trade balance, because of its higher reliability in comparison with other variables as, for instance, the current account\textsuperscript{6}. In the estimation, we also need to include some variable that can account for the international price adjustment and for variations in the opportunity cost of savings. For this reason, we set up a 6-variables VAR with real government spending, real net taxes, real GDP, trade balance, the real interest rate and the real exchange rate\textsuperscript{7}.

\textsuperscript{6}As noted in Gourinchas and Rey (2005) and Lane and Milesi-Ferretti (2001, 2006) the current account measure as it is published by the BEA does not take into account the valuation effects given by movements in asset prices and exchange rates.

\textsuperscript{7}Data on government expenditure, GDP and net taxes are taken from the NIPA database. Real
The identification scheme is as in Blanchard and Perotti (2002), in which calculated elasticities are used to net out the automatic response of taxes to change in GDP. Net taxes respond with an elasticity of 1.85 (Giorno, 2002) to changes in GDP, while government expenditure is not affected within a quarter. For what concerns the other variables a recursive scheme is imposed, with GDP first, trade balance second followed by the real interest rate and the real exchange rate.

Figure 1 shows the effects of a government expenditure shock: the shock is persistent and generates a budget deficit, since the response of net taxes is basically zero. Output jumps up on impact and then goes back to zero more rapidly than the shock itself. These responses square quite well with what generated by our model after a permanent shock to government expenditure, and thus might be interpreted as an indirect evidence in support of the random-walk hypothesis for $G_t$.

Furthermore, the specification with distortionary taxes can generate a positive trade balance impact response, though small. Thus, introducing financial frictions goes some way through in explaining the observed evidences, supporting the presence of twin divergence rather than twin deficit, also in line with the estimates of Mueller (2006) and Kim and Roubini (2004).

Figure 2 shows the impulse responses to a tax cut: the response of government spending is zero on impact and become negative after few periods, indicating that after the tax shock we have a period of budget surpluses. The response of net taxes is not at all persistent, but this does not mean that the shock is not persistent: ceteris paribus government expenditure, an increase in taxes reduce the amount of outstanding debt and so reduces the amount of interest payments, lowering the amount of resources needed by the government. The positive response of output is persistent and significative, in line with the response to a temporary shock to distortionary taxes presented in figure 11. The trade balance response is negative, though not significant: this gives support to the twin deficit hypothesis. Again, a model with financial frictions and distortionary taxes implies a smaller response than the standard model, while the specification with lump-sum taxes unambiguously predicts a trade balance deficit after a tax cut, so that both specifications are closer to the estimates than standard models.

Concerning real interest rates, matching the model impulse responses with those generated by the VAR rises an important issue. This correspondence, robust to all government expenditure is the computed by deflating the nominal series with the sectoral database, while net taxes are total revenues minus subsidies and transfers. Real GDP is obtained using the GDP deflator. The real interest rate is obtained by subtracting the the quarterly GDP deflator inflation rate from three-month treasury bill rate. The real exchange rate is taken from the IFS database.
the different specifications of government expenditure and tax shocks, underlines an important result of this paper: the role played by private debt and by the endogenous movements in collateral’s price are crucial to understand the effects of deficit shocks in the financial markets, and show how the interaction between government and households’ debt demand may explain bonds’ prices movements better than the interaction between government and firms’ demand for funds. This confirms the centrality of private debt (and of the frictions in its market) in the transmission mechanism of fiscal policy shocks in open economy.

To check for the response of collateral’s prices, we have also estimated a 7 variables VAR which also included housing prices. The first two panels of Figure 3 show how the fiscal shocks affect the relative price $q_t$, while the third describes how a shock to the relative price affect the trade balance. While the responses to the spending and tax shock are not significant, a positive shock to the housing price index generates a negative response of the trade balance: this evidence can be explained by the role of housing as a collateral in the determination of households’ behavior.

3 The Model

We study a Non-Ricardian open economy model with two symmetric countries, Home and Foreign, and durable and nondurable goods. Durables are nontradable and are

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8 In the VAR, housing prices (see the appendix for details) was introduced fourth in the order, after the gross domestic product and before the trade balance, the real interest rate and the real exchange rate.
in fixed supply; the unique nondurable good is produced using capital and labor and is traded across countries.

In each country there is a continuum of agents of mass one divided in two subgroups. The first, of measure \((1 - \lambda)\), is composed of agents owning the capital stock and renting it to firms together with their labor, buy bonds from the government and from the other group of agents and trade assets internationally. These consumers are called Patient.

The second group, of measure \(\lambda\), is composed by consumers who are relatively impatient: their discount factor is smaller than the one of Patients, and so they weigh more current than future utility; they are called Impatient. They supply labor to the firms and have access only to the internal asset market. They can move resources intertemporally by buying durable goods or by borrowing from Patients through collateralized bonds. The amount of durables they held serves two scopes: it yields utility services and can be used as a collateral.

The rational behind the introduction of the collateral constraint is based on two considerations: on one side the imperfect enforceability of contracts, so that lenders are not able to force borrowers to repay their debt, and on the other the need to avoid having Impatient agents to accumulate an infinite amount of debt. Concerning the first consideration, in case of default the lenders are able to recover only the amount of asset (real or financial) held by the borrowers, net of liquidation costs: for this reason they will not lend more than this amount to the borrowers. In relation with the second consideration, since the interest rate in steady state is set by Patient agents, the preferred path of Impatient households consumption is downward sloping, so that Impatients prefer to borrow to finance current consumption; without a borrowing constraint, the economy would converge to a limit in which Impatient agents’ consumption is zero because their amount of debt is infinite. The difference in households’ discount factors makes the borrowing constraint to be binding only for Impatient, while this is never the case for Patient agents\(^9\).

Agents maximize their utility in every period choosing the amount of nondurable and the flow of durable services they want to consume, their labor supply, the amount of bonds they want to lend/borrow and how much they want to invest in the production sector: investment is done using nondurable goods.

The production sector combines the amount of labor supplied with capital to produce the nondurable good, sold in a perfectly competitive market. The amount produced can then be consumed at home or abroad: trade entails no cost for the exporter.

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\(^9\)Note that the borrowing constraint is relative only on asset traded between households inside a country. There are no collateralized international assets.
The government imposes taxes and issue bonds to finance its spending on non-durable goods. Government expenditure and taxes are subject to exogenous shocks, while the deficit is determined by a fiscal rule.

The subscript denotes the period in which a variable is set: \( K_{t-1} \), for instance, represents the amount of capital set in period \( t-1 \), even if it enters into the production function at time \( t \). The superscript "I" identifies the variables of the group of borrowers, whereas the superscript "P" denotes the Patient agents’ variables: a star "*" will be used for foreign variables.

### 3.1 Household Sector

#### 3.1.1 Patient Consumers

Households in this group maximize the following intertemporal utility function

\[
V_P = \mathbb{E}_t \sum_{s=0}^{\infty} \beta^s \left\{ \theta \ln H^P_t + (1 - \theta) \ln C^P_t + \chi^P \frac{(1 - N^P_t)^{1-\varphi^P}}{1 - \varphi^P} \right\}
\]

subject to the budget constraint

\[
C^P_t + I^P_t + q_t \Delta H^P_t + B_t + B^H_t + B^G_t + \psi \frac{(B_t - B^{SS})^2}{2} = W_t N^P_t + R^K_t K^P_{t-1} + R_t B_{t-1} + R^H_t B^H_t + R^H_t B^G_t - T_t
\]

where \( C^P_t \) and \( I^P_t \) are nondurable consumption and investment of Patient agents. \( H^P_t \) is the stock of durables held by patient agents at time \( t \) and \( q_t \) is the durable/nondurable relative price; these agents can invest their income also on additional bonds holding, where \( B_t \) is the bond traded across countries, \( B^I_t \) is the amount of resources lent to the group of Impatiens and \( B^G_t \) are the government bonds purchased. The last term on the left-hand side measures the adjustment costs of international bonds, given by the difference between the current and the steady state value, whose relevance is measured by \( \psi \). These costs make the domestic interest rate \( R^H_t \) to be different from the international one, \( R^I_t \).

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\( ^{10} \)The reason why there are adjustment costs only for international bonds may be justified on the ground that to change the stock of any kind of bonds households must get a whole set of informations: while getting them at the domestic level is actually cost-free because of the continue stream of information that a household receives about her own country, getting information on the other country is costly since it requires the intermediation of specialized firms operating in perfect competition. Indeed, the introduction of these costs are neutral to the final result, and instrumental to achieve the stationarity of the final system, see Schmitt-Grohe and Uribe (2003).
Labor income is the product between real wage, \( W_t \) and labor, \( N_t^P \). \( R_{t-1} \) is the interest rate set in period \( t - 1 \) on bonds purchased in period \( t - 1 \). \( R_t^K \) is the rental price paid by firms on the amount of capital \( K_{t-1} \). \( T_t \) are the lump-sum taxes paid to the government; the government also collects a distortionary tax on output, which translates into a tax on labour and capital income.

Capital evolves as follows

\[
K_t = (1 - \delta_K) K_{t-1} + \phi \left( \frac{I_t}{K_{t-1}} \right) K_{t-1}
\]

since only Patient agents hold capital, this relation holds both at the group and aggregate level.

The evolution of capital is subject to investment costs identified by the function \( \phi \left( \frac{I_t}{K_t} \right) \); this convex costs are modelled so to guarantee a constant level of capital in steady state such that

\[
\begin{align*}
\phi (\delta_K) &= \delta_K \\
\phi_t (\delta_K) &= 1 \\
\phi_t (\cdot) &> 0 \\
\phi_t (\cdot) &\leq 0
\end{align*}
\]

Combining the FOCs for bonds and nondurable consumption we obtain the Euler condition for international bonds

\[
1 = \beta R_t E_t \left\{ \frac{C_t^P}{C_{t+1}^P} \right\} - \psi (B_t - B^{SS})
\]

where the last term on the right-hand side is due to the presence of international bonds adjustment costs. The condition for the domestic bond is the standard one

\[
1 = \beta R_t^H E_t \left\{ \frac{C_t^P}{C_{t+1}^P} \right\}
\]

The durable/nondurable flow condition is given by

\[
\frac{\theta}{1 - \theta} \frac{C_t^P}{H_t^P} = q_t - \beta E_t \left\{ \frac{C_t^P}{C_{t+1}^P} \right\}
\]

This condition states that the marginal rate of substitution between durable and nondurables is given by the relative price \( q_t \) and by the discounted value of the expected returns from selling durables next period.
The investment dynamics are given by the interaction of the following two conditions

\[ Q_t = \frac{1}{\phi' \left( \frac{K_t}{K_{t-1}} \right)} \]  \hspace{1cm} (4)

\[ Q_t = E_t \left\{ \beta \frac{C_{t+1}^P}{C_{t+1}^P} \left[ R_{t+1}^{K} + Q_{t+1} \left( 1 - \delta_K + \phi_{t+1} - \phi_{t+1} \frac{I_{t+1}}{K_t} \right) \right] \right\} \]  \hspace{1cm} (5)

These conditions jointly determine investment and the value of \( Q_t \), the present discounted value of the expected stream of utility that may come from an additional unit of capital.

The first order intratemporal condition is

\[ \chi^P (1 - N_t^P)^{-\varphi^P} = W_t \frac{1 - \theta}{C_t^P} \]  \hspace{1cm} (6)

### 3.1.2 Impatient Agents

This type of households maximize the following intertemporal utility function

\[ U = E_0 \sum_{t=0}^{\infty} \gamma^t \left[ \theta \ln H_t^I + (1 - \theta) \ln C_t^I + \chi^I \frac{(1 - N_t^I)^{1-\varphi^I}}{1 - \varphi^I} \right] \]

subject to

\[ C_t^I + q_t \Delta H_t^I + R_{t-1}^H B_{t-1}^H = W_t N_t^I + B_t^H - T_t \]  \hspace{1cm} (7)

where \( C_t^I \) denotes Impatient agents’ consumption, \( H_t^I \) is the time \( t \) stock of durables, \( N_t^I \) is the amount of labor supplied and \( T_t \) are lump-sum taxes paid to the government and \( \tau_t \) is the distortionary tax rate imposed on output.

Since the interest rate is set by Patient agents and \( \gamma < \beta \), the preferred consumption path of Impatient agents will be downward sloping: these households will prefer to borrow to finance today’s consumption, reducing that of the future. With time additive preferences even a small difference between \( \gamma \) and \( \beta \) causes the consumption of Impatient to converge to zero and their debt holding to infinite, as already pointed out in Lucas and Stokey (1984). Following the recent literature started by Iacoviello (2005a, 2005b) and Campbell and Hercowitz (2005) we impose that in case of default of the borrower the lender can liquidate the stock of durables held by the Impatient household and keep the revenues. This implies the following constraint on the amount of resources that can be borrowed by Impatient agents

\[ B_t^H \leq m E_t \left\{ q_{t+1} H_{t+1}^I / R_t^H \right\} \]  \hspace{1cm} (8)
This says that the maximum amount that can be borrowed is equal to the expected value at time $t+1$ of the stock of durables, discounted back at period $t$. This amount is further reduced by assuming the presence of liquidation costs, which make the multiplicative $m$ term to be less than 1. Of course, when $m = 0$ Impatient household cannot borrow, and behave as rule-of-thumb agents. This borrowing constraint can be thought as the device that lenders use to guarantee themselves against default in an environment characterized by imperfect enforceability. The imperfect enforceability problem becomes extreme in case of international debt, since for foreign lenders it may be particularly costly to get informations on the amount of collateral held by the borrower and to seize the liquidated value in case of default. Given that, foreign patient agents are not willing to engage in asset trading with home Impatients (and vice-versa)\textsuperscript{11}.

As a consequence of the introduction of this constraint, durable goods play a double role in this economy, providing utility to consumers and serving as a pledgeable asset\textsuperscript{12}.

The associated FOCs of Impatients are

1. \[ 1 = \gamma R^I_t E_t \left\{ \frac{C^I_t}{C^I_{t+1}} \right\} + \Xi_t \] (9)
2. \[ \frac{\theta}{1 - \theta} \frac{C^I_t}{H^I_t} = q_t - E_t \left\{ \gamma \frac{C^I_t}{C^I_{t+1}} q_{t+1} + \Xi_t m \left( \frac{q_{t+1}}{R^H_t} \right) \right\} \] (10)
3. \[ \chi^I (1 - N^I) - \phi^I = W_t \frac{1 - \theta}{C^I_t} \] (11)

$\Xi_t$ is the Lagrange multiplier on the borrowing constraint and measures the value of relaxing the borrowing constraint, expressed in terms of durable or nondurable good.

\textsuperscript{11}Here we push to an extreme one of the basic assumptions Iacoviello and Minetti (2003), which implies quadratic costs of liquidation in case of international Patient/Impatient asset trading and linear cost with internal asset trading. This implies that the expected loss in case of default when lending internationally increases with the value of the credit much quicker than when lending internally. In this model foreign patient lenders face transaction costs so high that they are willing to lend internationally only to other patient agents.

\textsuperscript{12}As shown by Carroll(1997), impatient agents with borrowing constraints, when facing shocks to labor income tends to save a portion of their income when the shock is positive: this amount of precautionary wealth is then used as a buffer in case of bad events, to avoid the event of zero consumption.

A series of positive events may make the agents to hold an amount of wealth such that the constraint (8) is not binding anymore. However, as shown in Iacoviello(2005)by simulation, if we assume small enough shocks to labor income, agents behave as if the constraint was always binding. This then permits to assume equality in (8) and to log-linearize the system.
Equation (9) is the standard Euler equation with an additional term that measures the importance of the borrowing constraint: as $\Xi_t$ rises the growth rate of consumption rises and consumption depends more and more on current rather than on intertemporal income.

Equation (10) determines the marginal rate of substitution between durable and nondurable goods: with respect to equation (3) here the user cost for Impatient agents is lowered by the additional flow of bonds obtained by increasing the stock of durables, whose weight is given by the borrowing constraint multiplier. Finally the supply of labor is regulated by eq. (11).

The same equation holds for the foreign country, where variables are indicated with a star and where the internal interest rate is $R^F_t$ and the internal asset $B^F_t$.

### 3.2 Production Sector

While durable goods are assumed to be in fixed supply, nondurable goods are produced by firms combining capital and labor and sold in a competitive market.

The production function is

$$Y_t = A_t K^\alpha_t N^{1-\alpha}_t$$

where $N_t \equiv \lambda N^I_t + (1 - \lambda) N^P_t$ is aggregate labor.

The conditions regulating the demand for labor and capital are

$$W_t = (1 - \alpha) \frac{Y_t}{N_t}$$

$$R^K_t = \alpha \frac{Y_t}{K^\alpha_{t-1}}$$

### 3.3 Government Sector

The government imposes taxes $T_t$ and sell bonds $B^G_t$ to finance government spending $G_t$. The flow budget constraint is

$$G_t + R^H_{t-1} (1 - \lambda) B^G_{t-1} = T_t + (1 - \lambda) B^G_t$$  \hspace{1cm} (12)

where $T_t \equiv \lambda T^I_t + (1 - \lambda) T^P_t$ are aggregate taxes.

The government spending process is exogenous to the system and given by an AR(1) data generation process

$$G_t = \rho_g G_{t-1} + (1 - \rho_g) G^{ss} + \varepsilon^g_t$$

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where $\varepsilon^g$ is an i.i.d. white noise shock.

The budget deficit can be defined as

$$d_t \equiv g_t - t_t$$

where small-caps letters denote variables in log-linear terms, $\tau$ is the steady state distortionary tax rate and letters without superscript denotes aggregate variables.

The path of the government deficit depends on the outstanding amount of government bonds and on government expenditure: we assume the following deficit rule

$$d_t = (1 - \phi_y) g_t - \phi_b b_t + \varepsilon^T_t$$

where $\varepsilon^T_t$ is an exogenous shock to taxes. This shock is assumed to be given by an autoregressive process

$$\varepsilon^T_t = \rho \varepsilon^T_{t-1} + u_t$$

During the analysis I will consider both kinds of financing scheme, either based on distortionary taxation or on lump-sum taxes. In the case of permanent shock to distortionary taxes lump-sum transfers are assumed to adjust as to guarantee the intertemporal solvability of the government.

### 3.4 Equilibrium Conditions

Equilibrium is achieved when all the FOCs of the two groups are met and markets clear.

The nondurable and durable goods market clearing conditions are

$$G_t + G_t^* + C_t + C_t^* + I_t + I_t^* = Y_t + Y_t^*$$

$$\lambda H_t^I + (1 - \lambda) H_t^P = H$$

$$\lambda H_t^{I*} + (1 - \lambda) H_t^{P*} = H^*$$

Note that assuming a logarithmic utility specification together with a Cobb-Douglas aggregation between durables and nondurables guarantees that the quantity of durable goods circulating in the system does not affect the dynamics of the system. This is because the intertemporal elasticity of substitution is equal to the intratemporal elasticity between durable and nondurable so that any steady-state change in demand due to a variation in the aggregate stock of durables is matched by an opposite change in the relative price, keeping $qH$ constant.

Equilibrium in the factor market is achieved when

$$N_t = \lambda N_t^I + (1 - \lambda) N_t^P$$

$$K_t = (1 - \lambda) K_t^P$$
The government sector is in equilibrium when the flow budget constraint (12) holds with equality and the interest rate adjusts so that the demand for bonds is equal to its offer. The evolution of the external sector is analyzed by looking at the trade balance\textsuperscript{13} from the point of view of the home country, which is defined as

\[ TB_t = Y_t - C_t - G_t - I_t \]

The system is log-linearized and then solved using Uhlig (1999)’s toolkit.

### 3.5 Inspecting the Mechanism

The introduction of household debt and financial frictions changes the internal propagation mechanism of the model with respect to the standard RBC model. To see how, we focus on the determinants of Impatient agents’ consumption behavior by analyzing the equation for nondurable consumption, obtained by combining the log-linearized form of equations (7), (8), (10) and (9)\textsuperscript{14}

\[ c_t^I = \kappa_1 \left\{ \frac{qH^I Y}{Y} \left[ q_t + \kappa_2 o c_t + \kappa_3 \bar{\zeta}_t \right] \right\} + dw_t \quad (14) \]

where

\[ o c_t \equiv r_t - E_t \Delta q_{t+1} \]

is the opportunity cost of holding durables and

\[ dw_t = (1 - \alpha)(1 - \tau) \left( w_t + n_t^I - \frac{1}{1 - \tau} \bar{\tau}_t \right) - t_t^I - \frac{1}{\beta} h_{t-1}^H + \frac{qH^I Y}{Y} h_{t-1}^I \quad (15) \]

is the amount of cash-on-hand available to Impatient agents\textsuperscript{15}. The coefficient \( \kappa_1 \), the elasticity of nondurable consumption with respect to cash-on-hand changes,

\textsuperscript{13}As pointed out in Kollmann(1998), measuring the trade balance is relatively easy and less arbitrary than the current account: the value of the latter depends heavily on the criteria followed to evaluate each different kind of asset. For this reason, we use the trade balance as an index of the external stance of a country.

\textsuperscript{14}The log-linear equations are described in Appendix B.

\textsuperscript{15}The values of the coefficients are

\[
\begin{align*}
\kappa_1 &= \frac{1}{\frac{c_t}{Y} + \frac{qH^I Y}{Y} (1 - \beta m)} \\
\kappa_2 &= \frac{(1 - \beta m) (\beta - \gamma) (1 - m)}{1 - \gamma - m (\beta - \gamma)} \\
\kappa_3 &= \frac{\gamma (1 - m)}{1 - \gamma - m (\beta - \gamma)}
\end{align*}
\]

Details of the derivations are available under request.
is less than one since a share of cash-on-hand is used to buy new durable goods, limiting the fluctuations of nondurable consumption and labor supply.

The terms in the square brackets describe how Impatient agents value nondurable goods relative to durable goods. The Lagrange multiplier measures how binding the borrowing constraint is: a fall in current income relative to the future one makes Impatient agents more willing to borrow from future income to finance current consumption and the borrowing constraint becomes more binding. A similar effect is generated by a current or future increase of the marginal rate of substitution between durable and nondurable goods.

The opportunity cost $o_c_t$ measures the cost of holding durable goods expressed in terms of bonds’ return $r_t$. The variations in $\Delta_t$ and of $dw_t$ prevail over the variations in the opportunity costs so that Impatient agents consumption and labor supply vary sensibly with current and future income changes\textsuperscript{16}.

Appendix D shows the behavior of the model after temporary and permanent productivity shocks and the results of its simulation.

4 Parametrization

The discount factor of patient agent is set to 0.99, so to compare the results with quarterly data; the discount factor of impatient consumers is set to 0.98. This value is slightly higher than what implied by Campbell and Hercowitz (2005), but well in line with microeconomic evidences as in Lawrence (1991), Carroll and Samwick (1997) and Cagetti (1999).

The importance of durables in the utility function is measured by $\theta$ which is set to 0.1 so that the ratio of private debt to output is equal to 0.6, the average value for the period 1970-2000. $\lambda$, the share of impatient agents is set to 0.5, consistently with the estimate of Campbell and Mankiw (1989) and with the values considered by Gali, Lopez-Salido and Vallés (2005) for the rule-of-thumb behavior\textsuperscript{17}. Campbell and Hercowitz (2005) and Mendicino (2005) use the same share of borrowers in their models with financial frictions.

$\varphi^I$ and $\varphi^P$ are assumed to be equal, and $\chi^I$ and $\chi^P$ are calibrated such that the

\textsuperscript{16}In a previous extended version of this paper we studied the business cycle properties of the model analyzing the economy’s response to productivity shocks, and simulating to model.

The economy responses are well in line with the empirical evidence on productivity shocks related to the RBC literature. The second moments of the model, while well in line with the previous literature, cannot solve the quantity puzzle as emphasized by Backus, Kehoe and Kydland (1994).

\textsuperscript{17}Note that the Rule-of-Thumb specification is nested in this model and can be recovered by setting $\theta$ and $m = 0$. 

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labour supply is equal across groups and set to $1/3$. The wage elasticity of labour supply (inverse Frisch elasticity) $\sigma$ is equal for both kinds of agents and is set to 0.3: this value is consistent with the values obtained through calibration in macro studies (Rotemberg and Woodford (1997,1999)) when $\alpha = 1/3$.

Setting $\alpha = 1/3$ is roughly consistent with the observed income shares. The depreciation rate of capital $\delta_K$ is set to 0.025. According to King and Watson (1996) we calibrate $\eta$, the elasticity of investment with respect to $Q$, to 1. The coefficient of the international bonds adjustment costs $\psi$ is set to 0.01.

I analyze the effects of tax and government expenditure shock to the home country, where $\rho_g$ and $\rho_r$ are both equal to 0.9. Both values are in line with the estimates of Blanchard and Perotti (2002) for the tax cuts and with Gali, Lopez-Salido and Valles (2005) for the government expenditure process. The test used to generate these estimates are not very powerful when confronted with the null hypothesis of a unit-root: Kollmann (1998), for instance, conclude that total factor productivity, government expenditure and public revenues are non-stationary processes. For these reasons, an analysis of permanent shocks to government expenditure will also be included.

The policy parameters of the fiscal rules in the baseline model are equal across groups and countries, with $\phi_b = 0.3$ and $\phi_g = 0.12$, in accordance with the calibrated values of Gali, Lopez-Salido and Valles (2005) and the observed hump-shaped response of government debt to a spending shock. The steady state value ratio of government expenditure to GDP is 0.2, corresponding to the average level of expenditure in the last 30 years.

Another variable of interest is the share of durable that can be used as a collateral $m$, set it to 0.89, in line with the values estimated by Campbell and Hercowitz (2004) and Iacoviello (2005) for the post-1982 period.

Finally, we assume that in steady state the outstanding amounts of international bond $B_t$ and government bonds $B^g_t$ and $B^{g*}_t$ are zero.

5 Fiscal Policy and the Trade Balance

Tax cuts are often used as a fiscal policy instrument for their direct and quick effects on households’ income. Indeed, the Reagan administration in the 80s and the Bush government in the last years have focused their fiscal policy on tax reduction as a

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18 For the exact definition of this value look to appendix A.
19 This value however, is not consistent with the values estimated in micro studies, even if these values have to applied carefully in macroeconomic analysis like this one (see Browning, Hansen and Heckman (1999)).

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stimulus for the economy. A detailed assessment of twin deficits in the US cannot abstract from a deep and complete analysis of the transmission mechanism of tax cuts in a general equilibrium setting.

After a temporary shock to lump-sum taxes, all the dynamics are driven by the responses of Impatient agents, since in the $\lambda = 0$ case Ricardian Equivalence would hold.

After the shock (figure 4), Impatient agents benefit of a rise in available cash-on-hand $dw_t$, which is used to increase borrowing and buy more durable goods. On impact then, and for few periods thereafter, the marginal utility of income falls so that they work less and consume more. These variations, however, are quite short-lived because the amount of debt that has to be repaid each period reduces quickly the amount of cash-on-hand available.

The higher level of consumption, together with the fall in labour supply both contribute to widen the gap between internal demand and supply, so that the home

Figure 4: Temporary shock to lump-sum taxes.
country register a deficit in the trade balance. The negative response of the trade balance is due to the presence of the borrowing constraint: we would obtain the same qualitative pattern setting \( m \) to zero. Allowing Impatient agents to borrow introduce an amplification mechanism that makes the quantitative response perfectly in line with the empirical evidences shown in the next section 5.4.

In synthesis, the model with lump-sum taxes generates nice twin deficit responses, whose pattern is quantitatively and qualitatively in line with the existing evidences.

![Graphs showing impulse responses of selected variables to a tax cut shock when the elasticity of labour supply \( \phi \) is varied between 0 and 3.]

Figure 5: Impulse responses of selected variables to a tax cut shock when the elasticity of labour supply \( \phi \) is varied between 0 and 3.

This result is particularly remarkable because it displays a positive correlation between fiscal and trade balance deficit (twin deficit) after a tax cut, a feature that standard optimizing model are not able to replicate. It is also important because it shows that tax cuts might be at the heart of the twin deficits episodes of the 1980s and 2000s, once the dynamics of private debt are explicitly taken into account. Such
a result seems then to reconcile economic analysis with the common sense, which supports the view that fiscal deficit are a major determinants of external deficits. This result however, is not in contradiction with Ferguson (2005) which conclude that the increase in private savings offset the fall in public savings, thus reducing the impact of fiscal deficit increases on the external stance of a country. This paper shows the validity of this mechanism for the non-constrained agents, displaying that, at the same time, the presence of constrained agents generates a new channel of transmission which sets again fiscal deficits at the centre of the stage for trade balance determination.

Figure 6: Impulse responses of selected variables to a tax cut shock when $\theta$ is raised from 0 to .3.

Is this result robust to changes in the parameters’ values? Given the centrality of labor dynamics in, we check how the trade balance response changes varying the elasticity of labour supply $\varphi$ (which is equal among group). The first panel of
figure 5 shows that the trade balance response is virtually unchanged as $\varphi$ varies from 0 (labour enters linearly in the utility function) to 3 passing through 0.5 (the value assumed here) and 1 (logarithmic disutility of labour). As $\varphi$ grows, the higher output response given by the increased labour supply is matched by an increase in consumption, which then maintains the trade balance constant.

The trade balance response changes its magnitude, but not its sign, when the relative preference for $H^j_t$ as a durable good, $\theta$ is risen from 0 (Impatient agents become rule-of-thumb consumers) to 0.3. The trade balance deficit shrinks because as $\theta$ rises the share of expenditure devoted to consumption is smaller; the higher amount of collateral available mitigates the shift of resources towards durable goods, so that these changes does not manage to generate an external surplus.

As figure 4 shows, however, the negative response of output to a tax cut is not in line with the VAR evidence underlined in section 1: as suggested by Perotti (2004), the response of output to a tax cut might actually change if the sample is reduced by
shifting the starting date to the first quarter of 1982. As figure 7 shows, the response of output is now almost flat, with the point estimate negative on impact and then rising during the following quarters. This kind of response, much more in line with the theoretical impulse responses generated by our model, is never significantly different from zero. Also the response of the real interest rate is in line with the VAR evidence, showing a small but positive change, mainly due to the increase in the demand for domestic bonds from Impatient agents.

Summarizing, the trade deficit result to a temporary lump-sum tax shock is a robust result which casts a new light on the way fiscal policy affects the external stance of a country. In section 6 we will analyze how an unbinding of the collateral constraint (a fall in \( m \)) affects the trade balance response.

5.1 Government Spending Shock

The responses to a government expenditure shock generate twin deficit in the case of temporary shocks and twin divergence after a permanent shock. The presence of Impatient agents, however, rises the trade balance response in the temporary shock scenarios to values very close to zero.

The driving force in all the different schemes illustrated here is the negative wealth effect generated by the increase in the present discounted value of taxes, necessary to finance the shock.

After a permanent shock, the increase in private savings generated by the wealth effect is enough to offset the increase in public demand, at least on impact (see fig. 8): the trade balance rises but falls quickly to negative values. The main mechanism behind the positive impact response of the trade balance is that the wealth effect hits Impatient agents harder, since it generates a downward shift in the durable/nondurable relative price, which reduces the value of the collateral and tightens their borrowing constraint.

Since the collateral constraint becomes more binding, private consumption of Impatient agents falls, thus contributing to a reduction in domestic demand. The smaller amount of resources borrowed increases the marginal utility of income, and labour supply rises: the increase in domestic production is crucial to offset the increase in public demand. This indirect negative effect due to the fall in the relative price of durables is described in more detail in Callegari (2006) analyzing fiscal policy in closed economy in presence of financial frictions.

However, the positive response of the trade balance to a government shock is not robust to change in the persistency of the process: reducing \( \rho_g \) to 0.9 (figure 9) makes the response is negative and the impact response is smaller in absolute value.
Figure 8: Permanent shock to government expenditure. Specification with lump-sum taxes.
Figure 9: Temporary shock to government expenditure
than that of the standard RBC model (from 0.2 to 0.15). The reduction in the price of collateral is now smaller than after a permanent shock, thus reducing the impact of the indirect wealth effect described above, due to the tightening of the collateral constraint.

The response of the interest rate is qualitatively in line with the VAR evidence, which point to a negative but not significant change: the response generated by the model is negative after a permanent shock and slightly positive after a temporary shock.

In synthesis, introducing financial frictions makes the behavior of the economy much more in line with the VAR evidence described in section 2: the response of the trade balance is always bigger than in the standard RBC model, and becomes positive when the $G_t$ process follows a random walk.

The qualitative features of the impulse responses cannot be generated by a standard RBC model: by looking at the previous figures, the trade balance response is always negative after an expenditure shock and, because of Ricardian equivalence, null after a tax cut.

6 The Effects of Financial Liberalization

The $m$ term in the borrowing constraint can be interpreted in several ways: as the value of collateral that is lost when the borrower defaults, or as the down-payment occurring in a leveraged purchase of durable goods. As Campbell and Hercowitz (2005) and Mendicino (2005) do, this coefficient can also be interpreted as a proxy for the degree of financial liberalization of the system, which can be viewed as an exogenous reduction in the equity requirement on households. Alternatively, the liberalization may be interpreted also as an increased reliance on market mechanism to evaluate households’ ability to repay back the loans, leading eventually to smaller liquidation costs.

Consistently with this view, the effect of financial liberalization reforms undertaken by the U.S. after 1982 may be evaluated by analyzing the economy’s responses when $m$ is varied. In line with Campbell and Hercowitz (2006) and Iacoviello (2005) we can think of $m = 0.5$ as the parameter relative to the pre-liberalization economy, and to $m = 0.89$ as that relative to the post-liberalization economy.

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20 Adding distortionary taxes to the model, a temporary tax cut leads to positive response of the trade balance, in stark contrast with the VAR evidence.

21 See Campbell and Hercowitz (2005) for comprehensive summary of the evolution of U.S. credit markets since the beginning of the 20th century.
Figure 10 shows the responses generated by a lump-sum tax cut shock when $m$ varies from 0 to 0.89: we are particularly interested in this shock since it generates evidence-consistent twin deficit results and since tax cuts are at the core of the fiscal deficit episodes of the 80s and 2000s. The first panel of the figures shows that increasing $m$ from 0 to 0.5 lowers the trade balance impact response of about 50%, from $-0.04$ to $-0.06$. However, increasing $m$ from 0.5 to 0.9, (a variation in line with the effect of the liberalization process) reduces the trade balance response by a much bigger factor, taking the trade balance impact response to $-0.14$. This means that in a pre-liberalization economy ($m = 0.5$) 6% of the tax cut is transmitted to the trade balance deficit on impact, which represents less than half of what we observe after the same tax cut when $m = 0.89$. 

![Figure 10: Responses to a lump-sum tax cut with different values of $m_H$ in the collateral constraint](image-url)
The behavior of Impatient agents in the labour market is once again the major factor behind this result: increasing \( m \) works as an amplifier of the positive wealth effect enjoyed by Impatients, which eventually lead them to work less and consume more. The amplification effect can be seen in the last panel of figure 10: the response of domestic assets when \( m = 0.9 \) is almost three times higher than with \( m = 0.5 \). This leads to lower level of output which, together with the increase in aggregate consumption, leads to an increase in the trade deficit response.

This effect of financial reforms have important policy implications. The analysis shows that the effects on the current account of a tax cut have bigger effects now than it was 20 years ago: the improved ability of Impatient agents to borrow (which leads to a higher steady state level of debt) entails bigger negative effects of tax cuts (which, in non-stationary economies, may lead to growth in the international net debt position). This argument provide a rational for the parallel growth of private and international debt observed from the beginning of the 80s, and call for a more cautious use of tax cuts in a context, like the one currently experienced by the U.S., characterized by a high level of private debt.

\[ \text{7 Conclusions} \]

This paper shows how the introduction of Impatient agents and household debt modifies the response of a standard one-good, open economy model to tax cuts and other business cycle shocks.

I find that tax-cut shocks tend to generate a positive income effect on Impatients, which reduces their labour supply and increase consumption: these two effects works towards a reduction of the trade balance response. This response is unambiguously negative and well in line with both the common sense and the observed evidences. The model adds realism without foregoing simplicity and effectiveness in explaining the transmission mechanism.

The role of household debt and financial frictions in the case of government expenditure shock is also important, since the negative wealth effect (in both its direct and indirect form) hits patient and impatient agents in the same way. For Impatient agents, the fall in the collateral’s price tightens the borrowing constraint, reducing the stock of debt: the consequent fall in cash-on-hand results in an increase in labour supply which rises the trade balance response, almost overturning the sign of the response after a permanent shock to \( G_t \). Allowing for Impatient agents in the economy tends to generate responses more in line with trade divergence rather than twin deficits, as the VAR estimate show.

In synthesis, the responses generated by the model with household debt are in line
with the structural VAR estimate on US data, which support the presence of twin
deficit after a tax cut and twin divergence after a government expenditure increase.
This model constitutes a significant step forwards in matching these responses, com-
pared with the standard RBC model.

A possible and desirable extension is a more detailed estimation of the model’s
parameters so to assess the actual importance of financial frictions in the economy,
as Coenen and Straub (2004) do with the model with rule-of-thumb agents. Another
interesting frontier of research may be the analysis of optimal fiscal policy in this
framework, with an explicit consideration of its effects on the current account.

Furthermore, this model seems to have promising implications concerning the
movements in prices: introducing home and foreign tradable goods and looking at
the variations in real exchange rate and terms of trade might thus represent a further
step in understanding the role of private debt in the transmission mechanism of fiscal
shocks.

References

   Theory and Evidence" in Cooley, T. (Ed.) Frontiers of Business Cycle Research,
   331-356

   Paper n.5025

   Foreign Trade" International Economic Review, 36, 821-854

   Dynamic Effects of Changes in Government Spending and Taxes on Output",

   eral Equilibrium Models" in J. B. Taylor and M. Woodford (eds.) Handbook of
   Macroeconomics, North-Holland

   ary Savings", mimeo, University of Chicago

   Thumb behavior", mimeo, European University Institute


The log-linearized budget constraint of Patient agents is

\[
\frac{C^P}{Y} c^P_t + \frac{qH^P}{Y} h^P_t + \frac{\delta K}{1 - \lambda} k_t + b_t + b_t^H + b^g_t = \\
(1 - \alpha)(1 - \tau) \left( w_t + n^P_t - \frac{1}{1 - \tau} \hat{\tau}_t \right) + \left( \frac{B}{\beta (1 - \lambda) Y} + \frac{B^g}{\beta (1 - \lambda) Y} + \frac{\lambda}{1 - \lambda} \frac{B^H}{Y} \right) r_{t-1} + \\
+ \frac{1}{\beta (1 - \lambda)} b_{t-1} + \left( \frac{\alpha}{1 - \lambda} \right) (1 - \tau) \left( r^K_t + k_t - \frac{1}{1 - \tau} \hat{\tau}_t \right) \\
+ \frac{\lambda}{\beta (1 - \lambda)} b^H_{t-1} + \frac{1}{\beta (1 - \lambda)} b^g_{t-1} - t_t
\]
where $b_t, b_t^H, b_t^q$ and $t_t^P$ are ratio between the variable’s differential and steady state output. The log-linearization of the FOCs are

$$q_t = \beta E_t q_{t+1} + [1 - \beta (1 - \delta_K)] E_t \left\{ r_{t+1}^K - \frac{1}{1 - \tau} \hat{r}_t \right\} - r_t^H$$

$$i_t - k_{t-1} = \eta q_t$$

$$k_t = \delta_K i_t + (1 - \delta_K) k_{t-1}$$

$$\sigma n_t^P = w_t - c_t^P - \frac{1}{1 - \tau} \hat{r}_t$$

$$[1 - \beta (1 - \delta_H)] \left( c_t^P - \hat{q}_t - h_t^P \right) + \beta (1 - \delta_H) (E_t \Delta \hat{q}_{t+1} - E_t \Delta c_t^{P}) = 0$$

$$E_t \Delta c_t^{P} = r_t - \psi b_t$$

$$E_t \Delta c_t^{P} = r_t^H$$

where $\sigma = \varphi^j \chi_{1 - N_j}^N$, $\chi$ and $\varphi^j$ are adjusted such that the two elasticities are equal across agents and the labour supply in steady state is equal to 1/3 for both groups.

The equations relative to the impatient consumers are

$$\frac{C^I}{Y} c_t^I + \frac{q^H}{Y} \Delta h_t^I + \frac{1}{\beta} \frac{B^H}{Y} r_{t-1}^H + \frac{1}{\beta} b_t^H =$$

$$(1 - \alpha) (1 - \tau) \left( w_t + n_t^I - \frac{1}{1 - \tau} \hat{r}_t \right) + b_t^H - t_t$$

$$\gamma E_t \Delta c_t^{I} = \gamma r_t^H + (\beta - \gamma) \hat{\xi}_t$$

$$\sigma n_t^I = w_t - c_t^I - \frac{1}{1 - \tau} \hat{r}_t$$

$$b_t^H = \frac{\beta m q^H}{Y} E_t (q_{t+1} + h_t^I - r_t^H)$$

and the durable/nondurable flow condition is given by the following equation

$$\gamma \left( E_t \Delta \hat{q}_{t+1} - E_t \Delta c_t^{I} \right) + m (\beta - \gamma) \left( E_t \Delta \hat{q}_{t+1} + \hat{\xi} - r_t^H \right) =$$

$$= [1 - \gamma - m (\beta - \gamma)] (\hat{q}_t + h_t^I - c_t^I)$$

where $\hat{\xi}_t$ is the log-deviation of the multiplier on the borrowing constraint, $\hat{q}_t$ is the log-deviation of the relative price.

The only differences between these conditions and the ones relative to the foreign is the sign of the adjustment costs in the Patient agent Euler equation.
The production function is
\[ y_t = \alpha k_{t-1} + (1 - \alpha) n_t \]

The cost minimization process of the firms lead to the following first-order conditions
\[ w_t = y_t - n_t \]
\[ r^K_t = y_t - k_t \]

The conditions relative to the government sector
\[ g_t + \frac{1}{\beta} B^g H r^K_t \frac{1}{\beta} b^g_{t-1} = t_t + b^g_t \]

where \( t_t \) = \( \lambda t_t^I + (1 - \lambda) t_t^P \). The flow budget constraint defines the government policy together with the tax rules (??) and (??). Similar equations hold for the foreign country. Equilibrium is guaranteed by the following conditions
\[ y_t + y^*_t = \gamma_c c_t + \gamma^*_c c^*_t + \gamma_i i_t + \gamma^*_i i^*_t + g_t + g^*_t \]
\[ \lambda H^I h^I_t + (1 - \lambda) H^P h^P_t = 0 \]
\[ \lambda H^I s^I h^I_t (1 - \lambda) H^P s^P h^P_t = 0 \]
\[ n_t = \lambda n^I_t + (1 - \lambda) n^P_t \]
\[ n^*_t = \lambda n^I_t + (1 - \lambda) n^P_t \]

where \( \gamma_i \) is the steady state output ratio of variable \( i \): the star denotes a foreign variable.

9 Steady State

Recall that \( B, B^g, T, T^* \) are defined in the calibration section. \( B = B^g = 0 \).
The other relevant coefficients for the steady state are

\[ R = R^H = R^F = \frac{1}{\beta} \]

\[ \frac{qH^I}{Y} = \frac{\theta [(1 - \alpha)(1 - \tau) - T^I/Y]}{(1 - \theta) [1 - \gamma - m(\beta - \gamma)] + \theta (1 - \beta) m} \]

\[ B^H \frac{Y}{Y} = \frac{\beta m qH^I}{Y} \]

\[ C^I \frac{Y}{Y} = \frac{1 - \theta qH^I}{\theta} [1 - \gamma - m(\beta - \gamma)] \]

\[ R^K = \frac{1}{\beta} - 1 + \delta_K \]

\[ \frac{I^P}{Y} = \frac{\delta_K \beta \alpha}{(1 - \beta + \delta_K)(1 - \lambda)} \]

\[ C^P \frac{Y}{Y} = \frac{1 - \lambda(1 - \alpha)}{1 - \lambda} (1 - \tau) + \frac{\lambda (1 - \beta) B^H Y}{\beta (1 - \lambda)} Y - \frac{I^P Y}{Y} - \frac{T^P Y}{Y} \]

\[ \frac{qH^P}{Y} = \frac{\theta C^P}{1 - \theta Y} / (1 - \beta) \]

10 Nondurable goods consumption condition

In this section, all the equations are relative to Impatient agents.

Let Impatient agents' cash-on-hand be defined as

\[ dw_t \equiv (1 - \alpha)(1 - \tau) \left( w_t + n^I_t - \frac{1}{1 - \tau} \tau_t \right) - n^I_t - \frac{1}{\beta} b^H_{t-1} + \gamma qH h^I_{t-1} \]

By substituting the borrowing constraint in the budget constraint of Impatient agents is obtained the following condition

The following condition for the demand of durable goods is obtained by rearranging the durable/nondurable flow condition and substituting in it the Euler equation

\[ h^I_t = (c^I_t - q_t) + oc_t \frac{\gamma + m(\beta - \gamma)}{1 - \gamma - m(\beta - \gamma)} - \hat{\xi}_t \left[ 1 - \frac{1 - \beta}{1 - \gamma - m(\beta - \gamma)} \right] \]

where

\[ oc_t \equiv r^H_t - E_t \Delta q_{t+1} \]

is the "shadow" opportunity cost of Impatient agents, i.e. the user cost of holding durables in terms of nondurable goods that would hold if \( \lambda = 1 \).
Plugging this condition in the budget constraint (??) and arranging in a proper way we get

\[ c_t^I = \kappa_1 \left\{ \frac{qH_t}{Y} \left[ q_t + \kappa_2 \omega c_t + \kappa_3 \hat{\omega}_t \right] + dw_t \right\} \]

where

\[ \kappa_1 = \frac{1}{c_t^I + \frac{qH_t}{Y} (1 - \beta m)} \]

\[ \kappa_2 = \frac{(1 - \beta m)(\beta - \gamma)(1 - m)}{1 - \gamma - m(\beta - \gamma)} \]

\[ \kappa_3 = \frac{\gamma (1 - m)}{1 - \gamma - m(\beta - \gamma)} \]

## 11 Business Cycle Properties of the Model

### 11.A Productivity Shock

We study the effects of temporary and permanent productivity shocks in both the specifications with distortionary taxes and lump-sum taxes, comparing the impulse responses with those generated by a standard RBC model, obtained by setting \( \lambda = 0 \).

Figure 11 shows the responses generated by a temporary shock in a model with distortionary taxes. The rise in real wage increases cash-on-hand \( dw_t \) allowing Impatient agents to buy more durable and nondurable goods; this expenditure effect is amplified by the fall in distortionary taxes due to the positive output response and by the higher amount of borrowing of Impatient agents allowed by increased stock of durable goods. The rise in debt demand translates into an increase in the interest rate and in the (shadow) opportunity cost \( oc_t \). All these elements, as expressed in (14), contribute to increase consumption \( c_t^I \).

\(^{22}\)The model obtained by setting \( \lambda = 0 \) is equal to the RBC model as in Baxter (1995) modified to allow for durable goods.

Rather than on the presence of \( H_t \), the differences with Baxter (1995) are mainly due to the elasticity of the Tobin’s \( q \) with respect to investment, \( \eta_t \), which is here set to one, according to King and Watson (1996). Baxter (1995) set it to 15, which implies a much bigger variations of investment.

Kollmann (1998), differently to our specification, assumed quadratic costs of adjusting capital and distortionary taxes only on labour.
The output impact response is smaller when $\lambda = 0.5$ for two reasons: first, the fall in Impatient agents labour supply, and second, the investment response is now smaller because of the increase in the interest rate. Both the higher increase in consumption and the smaller rise of output leads to a smaller trade surplus, which is now almost half that observed in the $\lambda = 0$ case.

Figure 12 shows the same shock in the model with lump-sum taxes. The basic mechanism, leading to a rise in the interest rate and a fall in labour supply, is the same, but the magnitude of the responses is smaller, both in the $\lambda = 0$ and $\lambda = 0.5$ case.

11.A.1 Permanent Shock

After a permanent shock (figure 13 and 14) the wealth effect is so big that it prevails on the income effect (due to the rise in real wage) also for Patient agents, so that the labour supply falls also in the $\lambda = 0$ case. Introducing Impatients leads to a
bigger variability of the economy responses: labour and output drop more (so that investment rises less on impact), and consumption jumps up of a bigger amount. As a consequence the trade balance deficit is in the order of 1% of GDP, much higher than the 0.2 level generated by the standard RBC model.

In the specification with lump-sum taxes (figures 12 and 14) the effects of a positive productivity shock are not dissimilar: aggregate labour and output shift down, triggering a trade balance deficit.

Table 1 shows the cross-country correlations implied by this model in presence of temporary shocks to productivity, government expenditure and to the tax rate: the AR(1) coefficient is set to 0.9 for all the processes, roughly consistently with the evidences in Kehoe and Perri (2002) and Kollmann (1998). This model cannot solve the quantity anomaly presented in Backus, Kehoe and Kydland (1995), since the cross-country correlation of output is still negative and lower than that of consumption, while in the data it is positive and higher than that of consumption; moreover,
the cross-correlation of labor is negative while it is positive in the data\textsuperscript{23}. However, our model does not perform worst than the standard RBC model, and actually the second moment are closer the actual ones than in the $\lambda = 0$ case.

\textsuperscript{23}Another problem described in Backus, Kehoe and Kydland (1995) is the negative correlation of investment, which does not show up here because of the kind of adjustment cost process assumed.
Table 1 - Second Moments of the Model

<table>
<thead>
<tr>
<th></th>
<th>$\text{Corr}(y, y^*)$</th>
<th>$\text{Corr}(c, c^*)$</th>
<th>$\text{Corr}(i, i^*)$</th>
<th>$\text{Corr}(n, n^*)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Data</td>
<td>0.58</td>
<td>0.36</td>
<td>0.3</td>
<td>0.42</td>
</tr>
<tr>
<td>Our Model</td>
<td>-0.28</td>
<td>0.45</td>
<td>0.71</td>
<td>-0.11</td>
</tr>
<tr>
<td>RBC model</td>
<td>-0.35</td>
<td>0.52</td>
<td>0.76</td>
<td>-0.28</td>
</tr>
</tbody>
</table>

The US Data are the one reported in Kehoe and Perri (2002)
The specifications used for the simulation of our model is the one with distortionary taxes