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Résumé

Nous estimons un modèle DSGE pour la zone euro en économie ouverte. Le modèle inclut des tendances structurelles pour toutes les variables, ce qui nous permet de l'estimer en utilisant des données non filtrées. Dans un premier temps, nous dérivons le sentier de croissance équilibré compatible avec des chocs permanents de productivité, des changements de cible d'inflation et des modifications de long terme de l'ouverture des économies. Nous définissons ensuite le cycle comme l'écart entre les données observées et cette trajectoire soutenable. Ainsi, notre modèle peut intégrer -sans manipulation préalable- les fluctuations de la balance commerciale. Finalement, nous trouvons un effet persistent et important de l'augmentation des imports relativement aux exports sur l'inflation de la zone euro sur les dix dernières années. Du premier trimestre 2000 au dernier trimestre 2008, nous estimons la contribution du développement déséquilibré du commerce internationale sur l'inflation à hauteur de -0.7% et de -1.4% sur le taux d'intérêt nominal à 3 mois.

Code JEL: E32, F41.

Mots-clés: Déséquilibres mondiaux, désinflation, cycle des affaires, macroéconomie en économie ouverte.

Abstract

We estimate a medium-scale DSGE model for the euro area in an open economy framework. The model includes structural trends on all variables, which allow us to estimate on gross data. We first provide a theoretical balanced growth path consistent with permanent productivity shocks, inflation target changes, and permanent shocks to the openness of the economies. We then define the cycle as the gap between this sustainable trajectory and the gross data, thus our model properly deals with deviations of the trade balance. Finally, we find persistent and strong effects from the asymmetric increase of euro area imports during the last ten years on domestic inflation. From the first quarter of 2000 to the last quarter of 2008, we estimate the contribution of the imbalanced development of international trade on euro area inflation to an average of -0.7%, and on the 3-Month interest rate to an average of -1.4%.

JEL-code: E32, F41.

Keywords: Global Imbalances, Disinflation, Business Fluctuations, Open Economy Macroeconomics.

1 Introduction

Global imbalances are considered as one of the main drivers of macroeconomic fluctuations, as emphasized by Obstfeld and Rogoff (2006), but few studies support the quantitative relevance of this widespread idea. Indeed, business cycle models are often estimated after prefiltering data ; consequently, in such models, persistent deviations of trade balance play little role in macroeconomic fluctuations. To overcome that unwelcome feature, we suggest an assessment of the importance of global imbalances through an estimation of trends and cycles in the same framework following Barthélemy et al. (2009).

To assess evidence of imported disinflation due to global imbalances, we first define a balanced growth path which corresponds to the sustainable globalization path, then we analyze the consequences of deviations from this balanced path, especially on inflation and interest rates. We estimate a two-country DSGE model for the euro area and the rest of the world from 1985Q1 to 2009Q4 including five trends: two on productivity and inflation target in both areas and one on the common movement of foreign biases which embodies the globalization process. By introducing unit roots in our model, we are able to directly estimate our model with non pre-filtered data. We find three main results.

First, we find a path consistent with the globalization process, permanent productivity shocks, and inflation target changes in both countries. To do so, we assume three hypotheses: a Cobb-Douglas aggregation of foreign and domestic goods in the utility function, the law of one price in the long run, and a zero trade balance and net foreign asset position at long horizon. In the spirit of King et al. (1988), who give restrictions on the utility functions to allow the existence of a balanced growth path, we prove that there exists a balanced growth path if the ratio between the two countries' foreign biases is expected to remain constant over time.

Second, the definition of a balanced growth path allows us to define economic-relevant cycles as the gap between gross data and this sustainable trajectory of the economy. So, we estimate a DSGE model with model-based long term fluctuations in the euro area and provide a plausible decomposition between trends and cycles for all variables. We then compare the stationary components we estimate to the standard HP-filtered variables, analyze their spectral decomposition, and confirm that, overall, our model-based cycles are both economically and statistically relevant.

Third, turning to the data, we find a strong deflationary effect of asymmetric globalization since 2000 for the euro area. From the first quarter of 2000 to the last quarter of 2008, we estimate the contribution of the imbalanced development of international trade on euro area inflation to an average of -0.7%. Without these persistent shocks affecting the euro area current account, we find the Euribor-3M would have been 1.4 percentage points higher on average than it was during this period.

Global imbalances are one of the main topical issues in open macroeconomics. Obstfeld and Rogoff (2009) emphasize their role in the build up of the subprime crisis, but they remain a crucial issue even after the crisis and the considerable narrowing of the imbalances, as stressed by Blanchard and Milesi-Ferretti (2010). However, these concerns find few echoes in the DSGE literature. Indeed, assessing the quantitative effects of global imbalances requires a careful use of data.

Hence, as in the previous essay, we define model-based long term fluctuations by adding first order integrated shocks inside our DSGE model. Then we estimate at the same time the cyclical fluctuations and the trends generating process as suggested by Ferroni (2009). As in Barthélemy et al. (2009), we include unit roots inside the model to reproduce long term fluctuations of the data and estimate them simultaneously with the model's deep parameters. The integration of non stationary shocks allows for a more economic definition of cycles than statistical filtering. Besides, it leads to the possible assessment of permanent shocks on the cycle fluctuations. Finally, the assessment of global imbalances consequences crucially depends on how we define deviations from the sustainable path of globalization and thus needs a precise assessment of globalization. In fact, previous open economy DSGE models such as Adolfson et al. (2007) or Christoffel et al. (2008) detrend data so that trade balance fluctuations remain very small and weakly persistent, while our approach tends to be as close as possible to the gross data. As an illustration, Figure 1 displays trade balance using HP-filtered data for exports and imports. This graph clearly exemplifies the need of a careful use of data as independent HP-filtering leads to errors in the sign, the size, and the persistence of the trade balance.

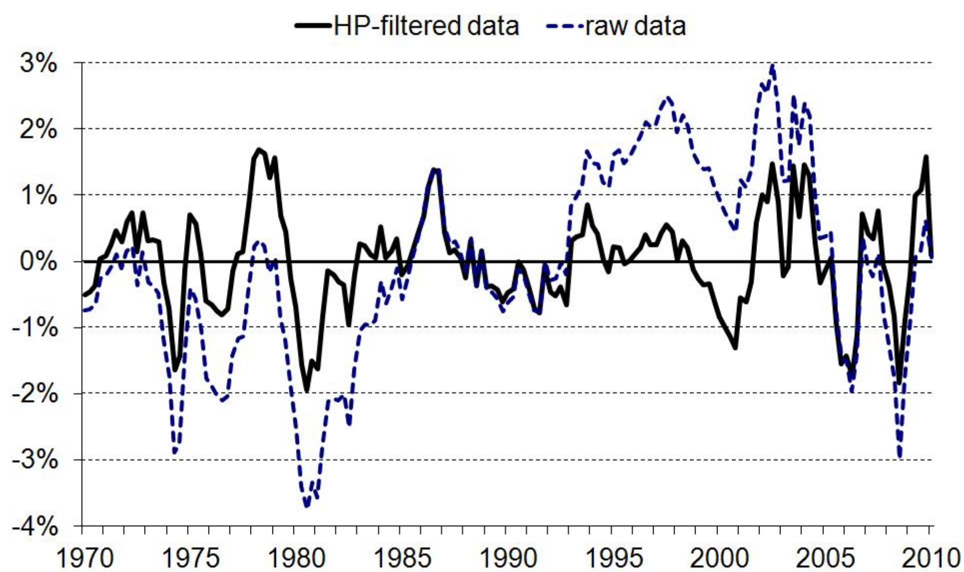

Figure 1: EA Trade Balance over GDP ratio

One of the main features of globalization is the sharp increase of openness and we choose to describe it as a shift in the demand for foreign goods. To determine the associated balanced growth path, we mainly make three assumptions: the aggregation of foreign and domestic goods is a Cobb-Douglas function with a time-varying foreign bias, the law of one price holds at long horizon to avoid long term deviations between domestic and export prices, and finally the trade balance and net foreign asset position are stationary with zero mean. Under these three assumptions we find that there exists a balanced growth path if the current foreign biases ratio is equal to its expected value. We consider both permanent sustainable globalization shocks and transitory shocks to the foreign biases. So, openness changes result from the demand side, however it would have been strictly equivalent to include shifts in transport or barrier costs.

An outcome of our model-based trends and our estimated model is a strong and persistent effect of asymmetric openness on output, inflation, and interest rates. This result stems from a rather simple intuition that a country with an increasing propensity to consume foreign goods rather than domestic ones undergoes deflationary pressures due to lower demand for its domestic goods. The imbalanced development of international trade contributed to an average of -0.7% on euro area inflation and of -1.4% on the 3-month interest rate, from 2000 to 2008. Even if our propagation mechanism is quite intuitive, other papers emphasize opposite effects from the imbalanced development of the international environment during the last decade. Some economists highlight the positive link between a foreign productivity shock and domestic inflation. Our model embodies this mechanism, but the direct effect of supply shocks in the rest of the world remains quite negligible, and the response of domestic inflation depends mostly on the resulting consumption profile. During the last decade, the extraordinary development of emerging economies, especially China, led to increasing distortions between their national savings and their national investment. As a result, the disequilibrium caused by surplus countries generated disinflation and persistently low interest rates, as related by Macfarlane in a 2005 speech. Finally, Melitz (2003) shows that a demand for a new variety coming from outward leads to more competitiveness, a fall in mark-ups and finally a decrease in relative prices. Our model is unable to replicate Melitz's result as we assume Dixit-Stiglitz aggregation hence, constant mark-ups. Nevertheless, we believe that the main impact of an increase in foreign production is a rise in inflation due to demand pressures on the capital and labor markets whereas Melitz assumes inelastic labor supply.

The remainder of this paper is organized as follows: section 2 brings some out-of-model evidences of imported inflation due to global imbalances; section 3 details the main features of the model and the derivation of the balanced growth path consistent with both permanent openness changes; section 4 briefly describes the estimation procedure and the implied decomposition; section 5 presents a quantitative assessment of the role of global imbalances for inflation in the Euro Area, while section 5 concludes.

2 Inflation and global imbalances: Some stylized facts

Trade balance disequilibrium is one of the key determinant of the so-called global imbalances as they result in unbalanced net foreign asset position. Unbalanced trade may stem from multiple reasons. One of the possible explanation that we are going to focus on is a transitory disequilibrium between foreign demand of domestic goods and domestic demand of foreign goods. This kind of disequilibrium may result from either an asymmetric change in tariffs or a change in the willingness to consume foreign goods. In both cases, this disequilibrium reflects a change in protectionism.

A transitory disequilibrium in external demands should have an impact on output-gap and therefore on inflation. Indeed, this disequilibrium should imply a lower demand for goods produced in the country with a deteriorating trade balance, and hence a fall in output-gap. In general equilibrium - i. e. if we assume that supply of production function inputs are not fixed - this decrease should trigger off a fall in wages and in the rate of return of capital and eventually a fall in GDP deflator inflation. Obviously, this mechanical presentation does not reflect the multiple other adjustments which can alter the link between distortions in external demands and inflation. Among others, monetary authority may raise its interest rate to limit the magnitude of inflation change, exchange rate can adjust as the demand for each currency change and so on.

Turning to international trade data, we find a positive link between inflation changes and

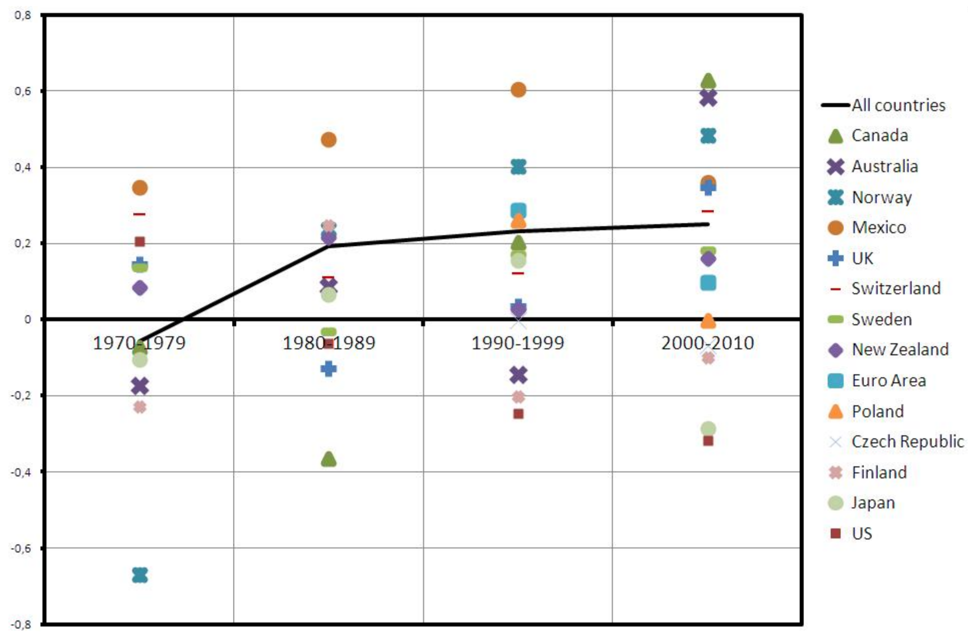

Figure 2: Correlations between inflation changes and trade balance over GDP changes.

the trade balance changes for a set of 14 countries. We compute correlations between changes in inflation and the trade balance (in value and divided by GDP) for the last four decades on a quarterly basis. Figure 2 displays these correlations; each marker corresponds to a specific country whereas the black line stands for the overall correlation for all countries. The overall correlation rises from -0.06 for the seventies to 0.25 for the first decade of the century. This positive correlation (from 1980 and onwards) tends to support the idea that trade deficit leads to disinflation risk. In appendix, we check that this result remains when considering HP-filtered data (see figure 8).

The positive correlation between inflation and the trade balance does not necessarily reflect a causal relation, thus this positive correlation does not indicate the "role" of global imbalances for inflation. However, this stylized fact suggests that the mechanism we emphasize in this paper - i.e. a deteriorating trade balance due to a shift in demands for domestic goods contributes negatively to the output-gap and the inflation - may be of first order magnitude. The remainder of this paper develops and estimates a two-country DSGE model to test the quantitative relevance of trade disequilibrium for inflation and monetary policy taking into account key macroeconomic features relevant for this analysis.

3 The model

The model contains most of the standard key features of the recent literature in DSGE models in open economics. As in Christoffel et al. (2008), it includes monopolistic competition *à la* Dixit-Stiglitz, with nominal rigidities on wages and prices *à la* Calvo, deep habits on domestic and foreign goods consumption, real rigidities on investment and a smoothed Taylor rule for the interest rates. We build a model with a balanced growth path consistent with long term changes in productivity, inflation target and openness by assuming three hypothesis: the consumer preferences over domestic and foreign goods are modeled as a Cobb-Douglas function; in the long run, producer pricing insures that the law of one price holds for both domestic and foreign goods; and the trade balance and net foreign asset position are stationary with zero mean.

This section begins with a general overview of the model, then describes the long term equilibrium path and finally discusses the sources of fluctuations.

3.1 General setup

We consider a two-country model in which households consume domestically produced goods or imported goods, invest in domestically produced goods, rent their capital, adjust the capital utilization rate and choose their wages as they propose a differentiated type of labor. A fraction of intermediary firms produce differentiated goods that they sell to final goods producers aimed at local market, while the rest of intermediary firms produce differentiated goods sold to exporters. In top of that, monetary policy adjust its nominal interest rate to limit unwelcome fluctuations and government authority decides their expenditures (in domestically produced goods).

Households

We assume a large number of identical households $j \in [0, 1]$ maximizing their additive time-separable logarithmic utility function described by the following equation:

$$u_j(t) = \mathbb{E}_t \left[\sum_{T=t}^{+\infty} \beta^{(T-t)} e^{\varepsilon_T^B} \left(\ln C_{j,T} - \frac{L_{j,T}^{1+\sigma_l}}{1+\sigma_l} \right) \right] \tag{1}$$

where $\mathbb{E}_t$ stands for the conditional expectation given information at time t, β denotes the discount factor and σ_l is the inverse of the Frish elasticity of labor supply. $C_{j,T}$ (resp. $L_{j,T}$) is the overall utility-relevant consumption index (resp. hours worked) of household j at time T. Households face a trade-off between consuming domestic or foreign goods described by a Cobb-Douglas aggregation function:

$$C_{j,t} = \frac{(C_{j,t}^D - hC_{t-1}^D)^{1-\Omega_t} (M_{j,t} - hM_{t-1})^{\Omega_t}}{\left[(1-\bar{\Omega}_t)\left(1 - he^{-\bar{g}_{C^D}}\right)\right]^{1-\bar{\Omega}_t} \left[\bar{\Omega}_t\left(1 - he^{-\bar{g}_M}\right)\right]^{\bar{\Omega}_t}} \tag{2}$$

where C_D (resp. M) corresponds to consumption in domestic (resp. foreign) goods, Ω is the foreign bias ($1 - \Omega$ is the home bias), h is the deep external habit formation parameter and $\bar{g}_X$ (resp. $\bar{X}$) is the growth rate of the deterministic drift (resp. the balanced growth path) of X. The assumption of Cobb-Douglas preferences over domestic and foreign goods forces the price elasticity of imports to 1. However, recent studies, such as Imbs and Mejean (2009), argue that this elasticity might be much larger than 1. In the literature, the standard assumption on preferences is a CES function, which allows a greater price elasticity, as in Obstfeld and Rogoff (2006). Nevertheless, dealing with trends and keeping our model tractable force us to choose this more specific form of utility. This simplification allows for an elegant solution to the balanced globalization path and facilitates the log-linearization of our model around this equilibrium path. We assume deep habit formations on domestic goods and imported goods to reduce the instantaneous response of imports and consumption to a change of relative imports prices. Finally, the denominator of equation (2) corresponds to a normalization terms aimed at simplifying the log-linearization of such expression.

Households maximize their inter-temporal utility, equation (1), under the following budget constraint :

$$P_t^C C_{j,t} + P_t I_{j,t} + T_t + \Psi(z_{j,t}) K_{j,t-1} + B_{j,t} + \frac{B_{j,t}^F}{S_t} \tag{3}$$
$$= W_{j,t} L_{j,t} + r_t^k z_{j,t} K_{j,t-1} + D_t + \aleph_{j,t} + R_{t-1} B_{j,t-1} + \frac{R_{t-1}^B B_{t-1}^F}{S_t}$$

where T_t denotes lump-sum taxes paid to the fiscal authority, $z_{j,t}$ the variable capital utilization rate, $\Psi(z)$ is the cost of the capital utilization ($\Psi(1) = 0$), $K_{j,t-1}$ the stock of capital, $B_{j,t}$ domestic bonds, $B_{j,t}^F$ foreign bonds, costing one unit of foreign currency today for R_t^B units of currency tomorrow, r_t^k the return on capital, D_t dividends and $\aleph_{j,t}$ state-contigent securities providing insurance against household-specific wage-income risk.

Moreover, households own the capital $K_{j,t-1}$, rent a fraction $z_{j,t}$ to the firms, and invest $I_{j,t}$ for the following periods, under the capital accumulation constraint, as in Christiano et al. (2005):

$$K_{j,t} = (1-\tau) K_{j,t-1} + (1+\varepsilon_t^I) \left(1 - S\left(\frac{I_{j,t}}{I_{j,t-1}}\right)\right) I_{j,t} \tag{4}$$

where $S(e^a) = S'(e^a) = 0$ and $S''(e^a) = \phi_i^{-1}$ is the real rigidities on investment parameter, τ is the rate of depreciation of installed capital and ε_t^I is an investment specific technology shock affecting the efficiency of the newly installed investment good. Finally, households are subject to nominal rigidities *à la* Calvo in their wage setting. At each period, a fraction ξ_w of the households is unable to re-optimize over its wage. Its wage $W_{j,t}$ is then automatically indexed according to current productivity growth, current and past inflation target and previous period consumer price inflation :

$$W_{j,t} = \frac{A_t}{A_{t-1}} \left(\bar{\Pi}_t^P\right)^{1-\gamma_w} \left(\bar{\Pi}_{t-1}^P \pi_{t-1}^C\right)^{\gamma_w} W_{j,t-1} \tag{5}$$

where A_t, $\bar{\Pi}_t^P$ and π^C are productivity trend, inflation target and stationarized consumer price inflation respectively, and γ_w is the weight of wage indexation on past consumer price inflation. This indexation adapts the standard wage indexation equation to the context in which domestic GDP deflator inflation and consumer price inflation do not have the same steady state. It insures a perfect indexation of all wages to the wage trend $\bar{W} = A\bar{P}$. Households resetting their wages fix their wages to maximize their utility function facing a specific demand of labor due to an imperfect competition on labor market.

Firms

We assume a large number of identical firms, with a two factor production function, where A_t is the first order integrated productivity process, z is the capacity utilization rate, K is the capital stock and L is labor.

$$Y_t = (z_t K_{t-1})^{\alpha} (A_t L_t)^{1-\alpha} \tag{6}$$

where L_t is defined as :

$$L_t = \left(\int_0^1 L_{j,t}^{\frac{1}{1+\lambda_{w,t}}} dj \right)^{1+\lambda_{w,t}} \tag{7}$$

where $\frac{1+\lambda_{w,t}}{\lambda_{w,t}}$ is the possibly time-varying wage elasticity of differentiated labor demand. A fraction of domestic intermediate firms sells their output H_i domestically, in monopolistic competition *à la* Dixit-Stiglitz:

$$H_t = \left(\int_0^1 H_{i,t}^{\frac{1}{1+\lambda_{p,t}}} di \right)^{1+\lambda_{p,t}} \tag{8}$$

where $\frac{1+\lambda_{p,t}}{\lambda_{p,t}}$ is the possibly time-varying price elasticity of domestic goods demand. The remainder of the domestic firms sell their output X_i overseas, facing the price elasticity $\frac{1+\lambda^X_{p,t}}{\lambda^X_{p,t}}$.

In both markets, there is sluggish price adjustment due to staggered price contracts *à la* Calvo. Accordingly, a firm receives permission to optimally reset prices in a given period t either with probability $1-\xi_p$ or with probability $1-\xi_p^X$, depending on whether the firm sells its differentiated output in the domestic or the foreign market. Prices which were not re-optimized are indexed on a weighted average of the current inflation target and the previous period domestic inflation:

$$P_{i,t} = \left(\Pi^P_{t-1}\right)^{\gamma_p} \left(\bar{\Pi}^P_t\right)^{1-\gamma_p} P_{i,t-1} \tag{9}$$

Fiscal and monetary authorities

We slightly modify a standard Taylor rule to take into account a potential use of both GDP deflator inflation and HICP inflation. Furthermore, to avoid high frequency noises, we assume that monetary authority reacts to year on year rather than quarterly data:

$$R_t = R^{\rho}_{t-1} \left(\bar{R}_t \left[\left(\frac{\Pi^P_{t,t-4}}{\bar{\Pi}^P_t} \right)^{\theta} \left(\frac{\Pi^C_{t,t-4}}{\bar{\Pi}^C_t} \right)^{1-\theta} \right]^{r_\pi} \left[\frac{Y_t e^{-4a}}{Y_{t-4}} \right]^{r_y} \right)^{1-\rho} e^{\varepsilon^R_t} \tag{10}$$

where $\Pi^P_{t,t-4}$ and $\Pi^C_{t,t-4}$ are the quarterlized year on year GDP deflator and consumer price inflation. ρ, θ, r_π and r_y are the estimated parameters of the Taylor Rule. Here, $\bar{\Pi}^P$ is the target of the central bank and is chosen exogenously, contrary to Ireland (2007)[1].

The fiscal authority expenditures are simply represented by an exogenous AR(1) process.

Rest of the world

The modeling of the rest of the world in our model consists of a simplified symmetric version of the domestic economy, excluding capital stock and investment from the economy. Besides, we assume a linear production function of foreign intermediate goods producers:

$$Y^*_t = A^*_t L^*_t \tag{11}$$

[1]The balanced growth path for the consumer price inflation $\bar{\Pi}^C$ and the inflation target $\bar{\Pi}^P$ are related by the equation: $\bar{\Pi}^C = e^{\bar{\Omega}(\bar{g}_Y - \bar{g}^*_Y)}\bar{\Pi}^P$.

Trade balance and net foreign asset position

Equilibrium in the balance of payment occurs through purchasing or selling foreign bonds[2] B_t^F, returning R_t^B units of foreign currency at date $(t+1)$:

$$B_t^F = R_{t-1}^B B_{t-1}^F + \left(P_t^X X_t - S_t P_t^M M_t\right) \tag{12}$$

Where P^X is the relative price of exported goods in domestic currency, P^M the relative price of imported goods in foreign currency and S is the nominal effective exchange rate of the euro area in indirect quotation.

As in Schmidt-Grohe et al. (2003), we assume that the supply of foreign assets depends on the level of total assets to insure the stationarity of the net foreign asset position. Hence, there is a time-varying spread between the risk-free foreign interest rate and the interest rate faced by the domestic country :

$$R_t^B = R_t^* \exp\left(-\Phi_b \frac{B_t^F}{P_t Y_t S_t} - \varepsilon_t^Q\right) \tag{13}$$

Where ε^Q is a shock on the external risk premium.

Market Clearing Conditions

The accounting equation for domestically produced goods gives the aggregate demand:

$$Y_t = C_t^D + I_t + G_t + X_t \tag{14}$$

where Y, C^D, I, G and X correspond to total production, domestic goods consumption, investment, government expenditure and exports (in volume). Turning to the rest of the world , the accounting equation is simpler:

$$Y_t^* = C_t^{D*} + M_t \tag{15}$$

3.2 Balanced growth path

In this section, we present the balanced growth path of the model. It consists of the equilibrium path of the considered macroeconomic variables, when neither transitory nor permanent exogenous shocks hit the economy. As we allow unit roots, this balanced growth path may change over time. We prove the existence of such a balanced growth path under three assumptions: the consumer preferences over domestic and foreign goods are modeled as a Cobb-Douglas function; in the long run, producer pricing insures that the law of one price holds for both domestic and foreign goods; and the trade balance and net foreign asset position are stationary with zero mean.

Main Hypothesis

First hypothesis: as we assume Cobb-Douglas preferences, the share of imports in the consumption basket is exogenous and given by the foreign bias:

[2] In all subsequent sections, net foreign asset position will be only linearized, and not log-linearized, allowing both positive and negative values, and a null steady state equilibrium value.

$$\frac{\bar{P}_t\bar{C}_{Dt}}{1-\bar{\Omega}_t} = \frac{\bar{P}_{Mt}\bar{M}_t}{\bar{\Omega}_t} = \bar{P}_{Ct}\bar{C}_t \tag{16}$$

Which results from maximization of equation (2).

Second hypothesis: assuming constant and equal long-term markup pricing on both domestic and foreign products, the law of one price holds along the balanced growth path for both goods in our economy, as in Christoffel et al. (2008). Denoting by P_X and P_M, the prices of exports and imports, and by S the effective exchange rate of the euro area in indirect quotation, the following producer pricing equations thus hold in the long run:

$$\bar{P}_{Xt} = \bar{S}_t\bar{P}_t \tag{17}$$

$$\bar{P}^*_t = \bar{S}_t\bar{P}_{Mt} \tag{18}$$

Third hypothesis: we assume that the trade balance and the net foreign asset position are null in the long run which find support in Figure 1. The latest assumption translates into the following relation between exports and imports in value:

$$\bar{P}_{Xt}\bar{X}_t = \bar{S}_t\bar{P}_{Mt}\bar{M}_t \tag{19}$$

Real Effective Exchange Rate

We compute the long term equilibrium path of the real variables of the economy, using the accounting equation (14):

$$\bar{Y}_t = \bar{C}_{Dt} + \bar{I}_t + \bar{G}_t + \bar{X}_t \tag{20}$$

Along the balanced growth path, we assume that output, government expenditures, capital stock, investment and wages grow at the same rate as productivity (following King et al., 1988). In the accounting equation for the domestically produced goods, if the share of investment and government expenditures over total output remains constant over time, then the shares of final consumption goods production over output has also to remain constant. Let us denote this constant share by k_C :

$$\bar{C}_{Dt} + \bar{X}_t = k_C\bar{Y}_t \tag{21}$$

Besides, using the fact that the trade balance must be zero along the equilibrium path, equation (19), in combination with equations (16) and (17):

$$(1-\bar{\Omega}_t)\bar{X}_t = \bar{\Omega}_t\bar{C}_{Dt} \tag{22}$$

Hence, using equation (21):

$$\begin{cases} \bar{C}_{Dt} = k_C(1-\bar{\Omega}_t)\bar{Y}_t \\ \bar{X}_t \;\;= k_C\bar{\Omega}_t\bar{Y}_t \end{cases} \tag{23}$$

Under our assumptions, the conditions leading to a sustainable balanced globalization lead to a volume share of exports in final consumption goods production exactly equal to the value share of imports in the consumption basket.

Turning back to the hypothesis of a null trade balance at the equilibrium, equation (19), we obtain:

$$\bar{\Omega}_t^* \bar{P}_{Ct}^* \bar{C}_t^* = \bar{S}_t \bar{\Omega}_t \bar{P}_{Ct} \bar{C}_t$$
$$\bar{S}_t = \frac{\bar{\Omega}_t^* \bar{P}_{Ct}^* \bar{C}_t^*}{\bar{\Omega}_t \bar{P}_{Ct} \bar{C}_t}$$

$$\bar{Q}_t = \frac{\bar{\Omega}_t^* \bar{C}_t^*}{\bar{\Omega}_t \bar{C}_t} \tag{24}$$

The long-term real effective exchange rate Q, in indirect quotation, depends negatively on the relative level of consumption, in conflict with Backus-Smith (1993). Furthermore, our model predicts that, in the long run, the real exchange rate should depreciate when productivity increases, contrary to models including Balassa-Samuelson effects. This contrasting prediction results from the monopolistic competition between goods, without any distinction between tradable and non-tradable goods contrary to Burstein et al. (2006). Here, we follow most DSGE models in open economy framework. Finally, the long-term real exchange rate depends -quite conventionally- negatively on the relative degree of openness.

A necessary condition for a balanced growth path

Along the balanced growth path, the no-arbitrage condition between holding domestic or foreign currency should hold:

$$\bar{R}_t = \bar{R}_t^* E_t \frac{\bar{S}_t}{\bar{S}_{t+1}} \tag{25}$$

where R and R^* are the domestic and foreign nominal interest rates. Furthermore, first order conditions of the optimizing problems of households, equation (1), results in:

$$1 = E_t \left[\frac{\bar{C}_{t+1}}{\bar{C}_t} \frac{\bar{C}_t^*}{\bar{C}_{t+1}^*} \frac{\bar{Q}_{t+1}}{\bar{Q}_t} \right] \tag{26}$$

Which, using the expression of the long-term real effective exchange rate, equation (24), leads to:

$$\frac{\bar{\Omega}_t^*}{\bar{\Omega}_t} = E_t \left[\frac{\bar{\Omega}_{t+1}^*}{\bar{\Omega}_{t+1}} \right] \tag{27}$$

All in all, existence of a balanced growth path imposes a condition on the growth rate of the share of imported goods in the consumption basket. In other words, to get a balanced growth path consistent with openness trends requires that all countries open to international trade at the same pace. A sufficient condition for the uncovered interest parity to hold in the long run, in our model, is to impose that there exists a constant, k_Q such that:

$$\bar{\Omega}_t^* = k_Q \bar{\Omega}_t \tag{28}$$

We will assume that equation 28 holds for the remainder of the analysis. It allows, in a very simple and tractable way, a sustainable permanent growth in international trade along the equilibrium path of the model. In what follows, we analyze the effects of transitory deviations from the above described balanced globalization path.

3.3 Sources of fluctuations

We choose to include five underlying trends to fit almost all the long term movements and co-movements observed in the data.

We include two first order integrated process for domestic and foreign productivity, in order to meet the common trend in output, capital stock, investment, government expenditures and wages, in the two countries.

We also define two time-varying inflation targets to fit the progressive changes in the domestic and foreign monetary rules during and before the 'Great Moderation' following Ireland (2007) and Fève et al. (2008). For instance, from 1990 to the introduction of the euro in 1999, average inflation decreased from more than 6% to 1.8% in the euro area. We fit this structural break through a first order integrated inflation target chosen by the central bank. Furthermore, in our setup we allow the foreign and domestic inflation targets to differ permanently as there is no reason to assume the same process in the two zones.

Last but not least, we introduce a fifth first order integrated process, which we call the globalization process, allowing the description of the considerable expansion in international trade during the last twenty years.

Fluctuations of the openness

The trend of the domestic foreign bias, $\bar{\Omega}_t$, is a non-stationary process bounded between 0 and 1. We define it such that:

$$\frac{\bar{\Omega}_t}{1-\bar{\Omega}_t} = \frac{\bar{\Omega}_{t-1}}{1-\bar{\Omega}_{t-1}} e^{\bar{\omega}+\varepsilon_t^{\Omega}} \tag{29}$$

where $\bar{\omega}$ is the steady state globalization drift and ε_t^{Ω} is the permanent globalization innovation shock. We define $\bar{\Omega}_t^*$ according to equation (28) to warrant the existence of a balanced growth path.

Due to our assumption of a null long-term trade balance, an asymmetric preference shock can only be specified as a transitory shock. Hence, our model also includes a transitory globalization process ε_t^{γ}, and a transitory asymmetric preference shock ε_t^{δ}, both following a first order autoregressive process. Thus, the foreign biases are defined as:

$$\begin{cases} \Omega_t = \bar{\Omega}_t(1+\varepsilon_t^{\gamma}+\varepsilon_t^{\delta}) \\ \Omega_t^* = k_Q\bar{\Omega}_t(1+\varepsilon_t^{\gamma}-\varepsilon_t^{\delta}) \end{cases} \tag{30}$$

It is this last transitory shock affecting foreign biases in an unsustainable manner that will be of particular interest for our analysis of the effect of global imbalances.

Shocks

Our model features 18 structural shocks:

- including five permanent shocks : domestic and foreign permanent productivity shocks ε^A and ε^{A^*}, domestic and foreign inflation target shocks ε^Π and ε^{Π^*}, the globalization trend ε^Ω

- and thirteen transitory shocks matching the short term fluctuations of the thirteen observable variables of our model: domestic and foreign preference shocks ε^B and ε^{B^*}, investment shock ε^I, government expenditures shock ε^G, wage shock ε^W, domestic and foreign cost push shocks ε^P and ε^{P^*}, imports price shock ε^M, domestic and foreign interest rate shocks ε^R and ε^{R^*}, external risk premium shock ε^Q, transitory globalization shock ε^γ and transitory asymmetric preference shock ε^δ.

The permanent shocks on openness and on inflation targets are white noises, while the other shocks follow AR(1) processes. Standard errors of the innovations as well as the persistence of the shocks are estimated along with the structural parameters of the model.

4 Bayesian Inference

We estimate the model using Dynare on gross data for the euro area and the rest of the world from the first quarter of 1985 to the last quarter of 2009. We first present the methodology for this estimation. Then, we verify the economic and statistical relevance of the de-trended variables of our model, and compare the cycles we obtain to those obtained through traditional HP-filtering.

4.1 Estimation

Data

We use seasonally adjusted quarterly data from three databases, for the period comprising 1985Q1 to 2009Q4.

Euro Area data prior to the last quarter of 2001 are extracted from the AWM database, created by Fagan et al. (2005) : GDP, private consumption, investment, compensation to employees, total employment, labor force, GDP deflator, HICP, short-term interest rate, nominal effective exchange rate, exports, and imports. From the first quarter of 2002 onwards, we complete this database with the corresponding Eurostat series, ECB data for short-term interest rates and nominal effective exchange rate, and OECD data for Euro Area exports, imports, and harmonized unemployment rate. For the rest of the world, we use OECD data for GDP and GDP deflator, as well as federal reserve interest rate.

We slightly transform this data to estimate our DSGE model by using model consistent stationary data. However, this transformation causes no information loss contrary to standard statistical filters. In fact we mainly use first difference data and ratios rather than levels for input data. Table 1 recaps the definition of data used for estimating our DSGE model.

Then the relations between input data and the variables of the model are straightforward. However, our model is not able to reproduce two long term fluctuations. These two trends concern the government expenditures which has grown with a larger rhythm than the productivity and the real wage which has decreased compared to GDP. To completely bridge the gap between data facts and our model properties, we need to add two *ad hoc* deterministic trends without deep microeconomic justification.

data	definition
dY	Real GDP
dC	Private Consumption deflated by HICP
dI	Real Investment
dW	Real Compensation per Employee times Labor Force
$d\Pi^P$	GDP Deflator Inflation
$d\Pi^C$	HICP Inflation
dR	Nominal Interest Rate
dQ	Real Effective Exchange Rate
$d\frac{X}{Y}$	Exports-over-GDP ratio in value
$d\frac{M}{Y}$	Imports-over-GDP ratio in value
dY^*	Foreign Real GDP
$d\Pi^*$	Foreign GDP Deflator Inflation
dR^*	Fed Funds Rate

Table 1: Definition of observable variables used to estimate the model. All variables are taken in log first difference. Except for domestic consumption, we deflate real variables by GDP deflator.

Calibrations

We calibrate a few parameters for which data are not informative enough or for which we have a very precise *a priori*. The details of the calibration are given in the table 2.

The euro area average ratio of imports over consumption is calibrated to 0.2. Consistent with the fact that the euro area is four times smaller than the rest of the world, in terms of GDP, the foreign openness is calibrated to 0.05 (we assume a symmetric openness weighted by the GDP of each area). Steady state GDP share of consumption k_C and investment k_I are calibrated to their average value over the sample. The Cobb-Douglas parameter α is calibrated to the standard value of 0.34.

The households' discount factor is calibrated to 0.999 corresponding to a steady state value of interest rate in the euro area of 4.37%, accounting for a 1.8% steady state for CPI inflation, a 2.17% steady state growth of consumption and a contribution from the discount rate of 0.4%. The inverse of the domestic and foreign Frish elasticities, σ_l and σ_l^*, are calibrated to 2, as in Christoffel et al (2008). The annual depreciation rate of fixed capital is set to 10%. Relative convexity of the capital utilization cost and interest rate elasticity of the net foreign asset position are quite arbitrarily set to 0.2 and 0.001 respectively.

All steady-state mark-ups are calibrated to 0.1. Given we do not observe foreign wages and export prices, we calibrate the parameters ξ_w^* and ξ_p^X of these two Calvo contracts to the standard value of 0.75. The weight of foreign wage indexation on past CPI γ_w^* is set to 0.5, while the weight of export price indexation on past export price inflation is set to 0.15.

Finally, we fix the CPI inflation target in the euro area to 1.8% from 1999Q1 onwards. We calibrate the standard deviation of the domestic inflation target shock to its estimated value on the subsample from 1985Q1 to 1998Q4 of 0.0908, to avoid any bias in its estimation over the whole sample. As written above, we set the persistence of the domestic and foreign inflation target shocks and of the globalization trend to 0.

Priors and Posteriors

The priors chosen for the estimated parameters are quite standard and follow Barthélemy (2009). The priors on standard deviations of shocks follow an inverse gamma distribution, as in Smets and Wouters (2007), with standard deviation set to infinity, so as to let the estimation procedure converge as freely as possible. The mean of the prior distribution is an adequately chosen scaling parameter. For the persistence of the shocks, we choose beta distributions, as in Smets and Wouters (2007).

Long-term growth parameters are also estimated during the procedure. Their priors are defined as a normal distribution with mean and standard deviation equal to the measured mean of the estimated growth rates in the data sample. Domestic and foreign deep-habit formation parameters, as well as prices and wages dynamics are estimated with beta distribution, as in Smets and Wouters (2007). Finally, all parameters from the domestic and foreign Taylor rules are estimated with standard priors.

Tables 3 and 4 gather estimation results. First of all, contrary to standard findings in the literature (Smets and Wouters (2007) for instance), the estimated persistence of all shocks but the government expenditures shock ρ^G and the external risk premium shock ρ^Q are below 0.8, corresponding to a half-life of less than a year. The model describes very well the propagation mechanism for most shocks, mitigating the need for high exogenous persistence. However, improvements have to be done in the understanding and modeling of fiscal policy and exchange rates. Estimation of the 'taste and technology parameters' remain very close to standard estimates of the literature. Finally, the weight of GDP deflator inflation in the Taylor rule is of 63%, indicating a higher tendency of reacting to GDP deflator rather than CPI inflation.

4.2 Sources of fluctuations

Figures 9 and 10 show the historical decomposition of GDP, consumption, investment, domestic consumption, exports, imports, GDP deflator and CPI inflation, and nominal interest rates. Each area corresponds to the contribution of a particular shock. So, if we add all the shock's contribution to the balanced growth path and the initial value of the endogenous variable, we exactly fit the actual data. The structural decomposition of the cycle remains very similar to those found by Barthélemy et al. (2009) in closed economy. The business cycle remains mainly driven by domestic factors, in particular the government expenditures shock ε^G (hatched yellow), the investment shock ε^I (hatched sky blue), the domestic preference shock ε^B (dark blue), the permanent domestic productivity shock ε^A (hatched green) and the domestic interest rate shock ε^R (orange).

The external risk premium shock ε^Q (dark grey) and the imports price shock ε^M (hatched pink) have important consequences on consumption, investment, exports, imports and CPI inflation. However, their impact on overall GDP remains quite limited. The transitory skew-symmetric preference shock ε^δ (hatched brown) is one of the key determinants for explaining the fluctuations of most macroeconomic variables. In particular, asymmetric developments in international trade since 2000 has contributed greatly to the low inflation pressures observed during the last decade, and the particularly low nominal interest rates. But we will come back to this core result later.

4.3 Five unit roots for fitting multiple macrovariables

Due to the integration of five unit roots, our model splits all variables into a stationary component - a deviation to the balanced growth path - and a non-stationary component which dominates the long term fluctuations. This subsection describes the two components, compares them to a standard HP-filter and analyzes their spectral decomposition. The purpose is to demonstrate that our model is able to divide adequately the macroeconomic fluctuations into convincing stationary and non-stationary components.

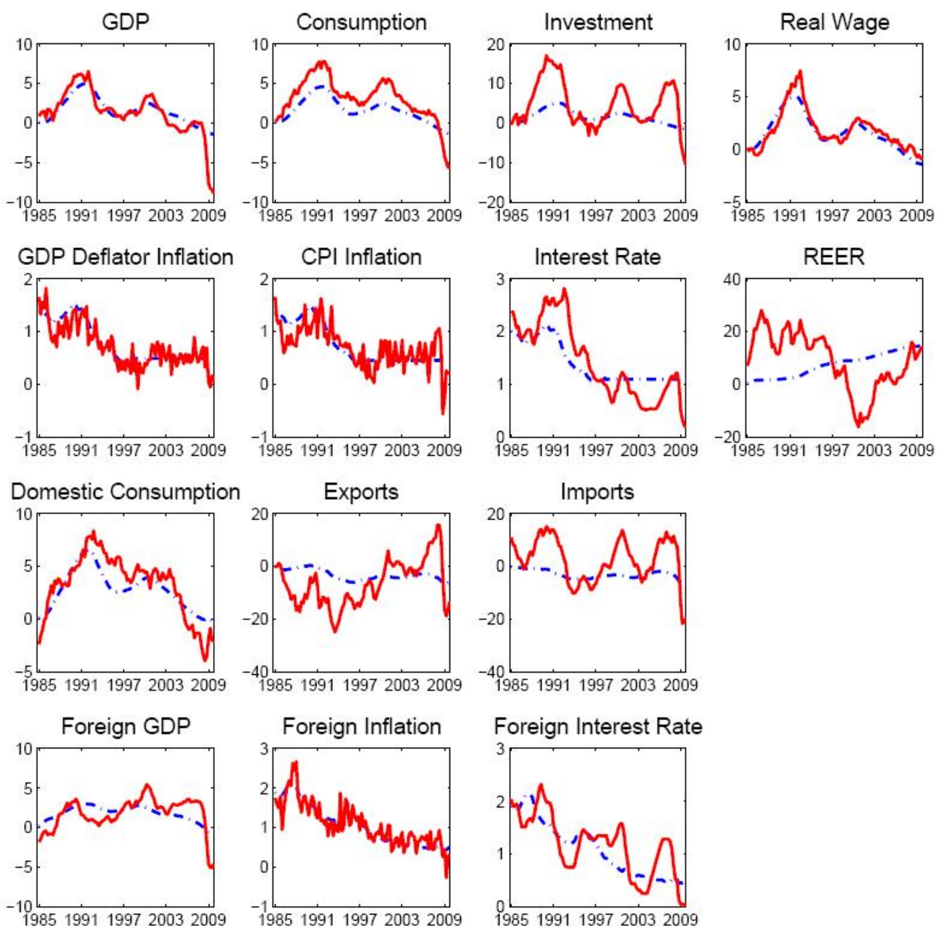

Figure 3: Model-based trends and associated variables

Figure 3 compares the data, from which we removed a deterministic drift (in red), to the estimated model-based trends (in dashed blue). The trends clearly capture all the long term fluctuations, except for the real exchange rate (REER), which indicates that our model is not able to predict its long term fluctuations; and the interest rate, which might indicate long-term movements in the equilibrium real interest rate. Overall, the estimation of the trends of the observable variables is quite satisfactory.

Moreover, the trends are not simply a moving average or a band-pass filter. For instance, investment is above its trend from 2000 to 2008 while a moving average or a pass-band filter would have predicted cycles. Domestic consumption, exports, and imports also largely deviate from their balanced growth path, corresponding to a deep global imbalances. This persistent change will be later related to the skew-symmetric shock on foreign biases which explains such disequilibria by an increase or a fall in the willingness to consume foreign goods.

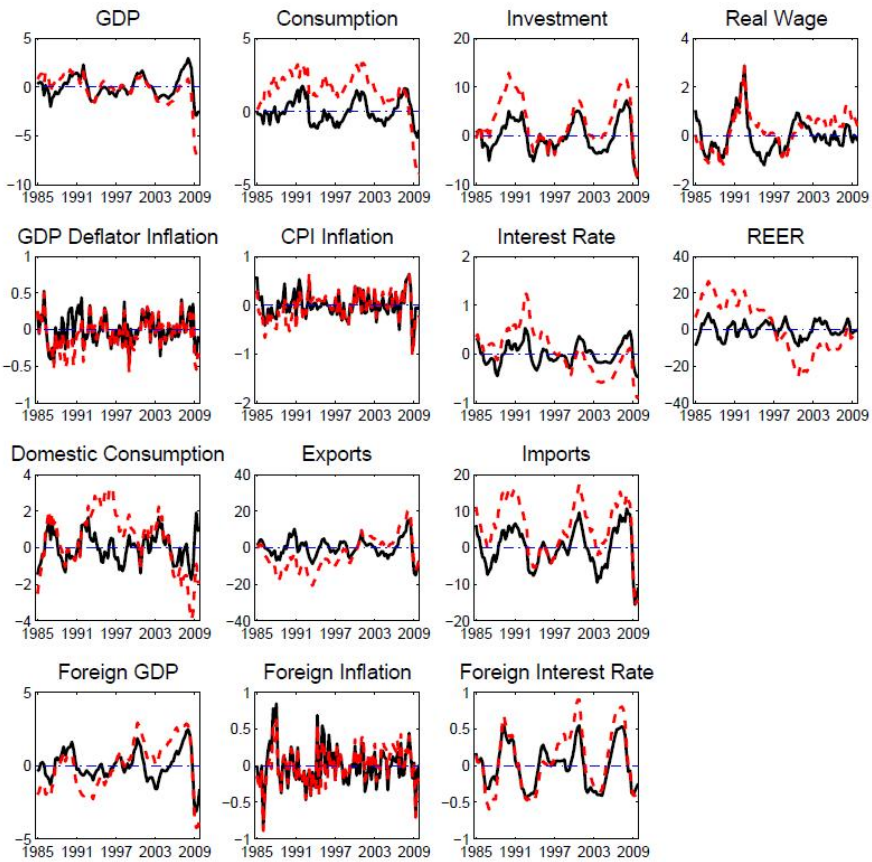

Figure 4: Model-based versus HP-filtered cycles

Figure 4 depicts the stationary component of macroeconomic variables according to our estimated model and to a standard HP-filter. It allows to compare the difference between a model-based filter and a statistical one in the vein of Ferroni (2009).

Cyclical components of inflation rates are quite similar between the two de-trending methods. GDP appears identical up to the recent boom and burst. However, while the HP-filter mitigates the movement in changing the trends, our model-based estimation of GDP trend (i.e. permanent productivity changes) is rather constant at the end of the sample, and consequently does not minimize the recent fluctuations of GDP. Some other cyclical components are slightly modified by the use of a model-based filter such as investment, real wages, domestic interest rate, real effective exchange rate, foreign GDP and foreign interest rate. Mainly, their volatilities are larger with our methodology compared to whose of HP-filter as HP-filter always catch a part of large movements.

Finally, the choice of the methodology greatly modifies the identification of the stationary components of domestic consumption, exports, and imports. These differences explain why we need a model-based filtering to analyze global imbalances as HP-filter erases the persistent deviations of these variables creating virtual cycles.

To test whether introducing five unit roots correctly reproduces the long term fluctuations of the data in a more systematic and rigorous way, we decompose our model-based filtered data through spectral analysis. Following Hamilton (1994), we first estimate an ARMA(8,8) process to fit our series and then compute the theoretical spectral analysis of such estimated processes. We have to use high order lags and leads to ensure the theoretical autocorrelogram to fit the empirical one. We also compute the spectrum analysis of a first order autoregressive process with a 0.9 persistence as a benchmark. Table A in Appendix reports the contribution of the cyclical components to the overall variance.

By construction, the HP-filter would give very good results by spectrum analysis as it selects the cycles with periods less than 8 years with the standard 1600 value for the smoothing parameter. However, our introduction of unit roots leads to stationary components as cyclical as an AR(1) process with 0.9 persistence. Exceptions are consumption and domestic consumption, the interest rate and the real effective exchange rate. The first two may stem from a slight change in the share of consumption over GDP that is not permitted by the model. As for the domestic interest rate and the real effective exchange rate, the weak variance due to short term cycles might indicate an incomplete modeling of their long-term trends, as discussed above.

Overall, the spectral analysis confirms most of our model-based cycles are statistically relevant. The decomposition of the observable in a trend and a stationary component seems both economically and statistically satisfactory.

5 Imported disinflation in the euro area

5.1 The skew-symmetric preference shock

Pre-filtering exports and imports separately prior to estimating the model, as is often done in the existing literature[3], significantly reduces the importance of the skew-symmetric preference shock. Nevertheless, thanks to our specification of the sustainable component of the globalization process, we are able to isolate strong unsustainable deviations from the equilibrium path in the data. Consequently, our methodology contributes to rehabilitate the skew-symmetric shock on the trade balances, by inducing a higher estimated persistence and amplitude of this shock. We now focus on the effects of the transitory deviations of exports and imports from their equilibrium path on the domestic and foreign economy.

We display the Impulse Response Functions to a skew-symmetric shock on foreign biases (ε_t^δ) in Figure 5. When this shock is positive, it directly leads to an increase of imports and a fall in domestic consumption in value, by definition, and in volume as a result of slow and weak changes in relative prices. Conversely, as this shock is skew-symmetric, exports decrease and foreign domestic consumption increases. In the domestic country, as consumers like more and more foreign goods, production decreases and thus leads to deflationary pressures in the domestic country. Consequently, monetary policy reacts in lowering its interest

[3]see Christoffel et al. (2008), Adolfson et al. (2007)

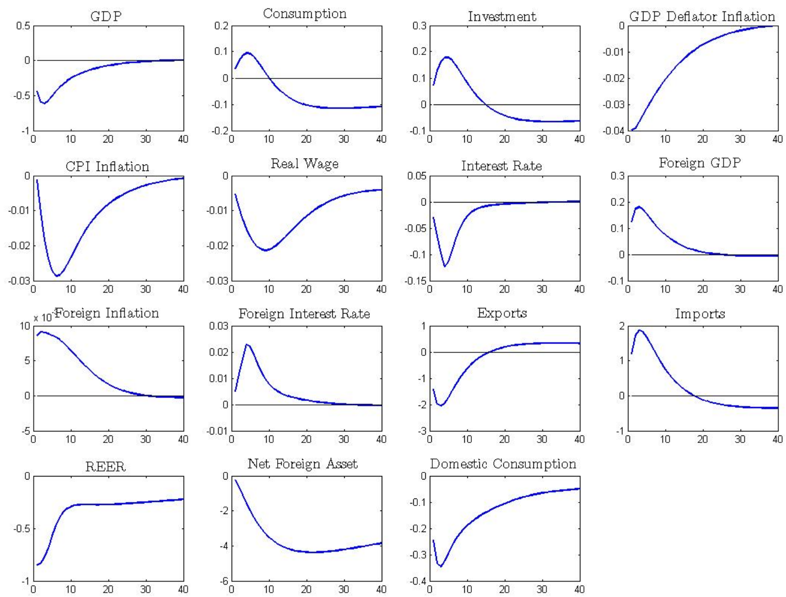

Figure 5: IRF to a skew-symmetric shock on foreign biases (ε_t^δ)

rate, which increases overall consumption and investment. However, this last feedback effect only slightly counterbalances the depressionary effect of the fall in consumption goods from domestic and foreign consumers. Obviously, the effect on the other economy is reversed and foreign production benefits from a higher demand. Therefore, foreign interest rates increase to mitigate the overheating of the economy leading to a real depreciation of the domestic currency. This depreciation is another feedback mechanism which limits the depressionary effect of the negative demand shock in deteriorating our term of trades. This very intuitive mechanism is the core of our results on inflation transfers from global imbalances. The following section gives a quantitative assessment of the importance of this shock for the euro area.

5.2 Quantitative assessment of the role of Global Imbalances

According to our estimates, the shock on the foreign biases, δ is one of the main drivers of short term fluctuations. In particular, it largely contributes to explain the strong persistent deviations of the trade balance. Thus, the model finds that the increase of the share of imports in the EA consumer basket is caused by the raising demand for foreign goods. As the section on global imbalances shows, this transitory change in consumer behavior leads to a fall in domestic product and thus deflationary pressures to the domestic country.

Figure 6 shows its contribution to GDP deflator inflation in the Euro Area. Up to 1999, this shock contributes positively to inflation, then its impact is reversed to account negatively for the rest of the sample. This change in sign contribution is linked to a change in the

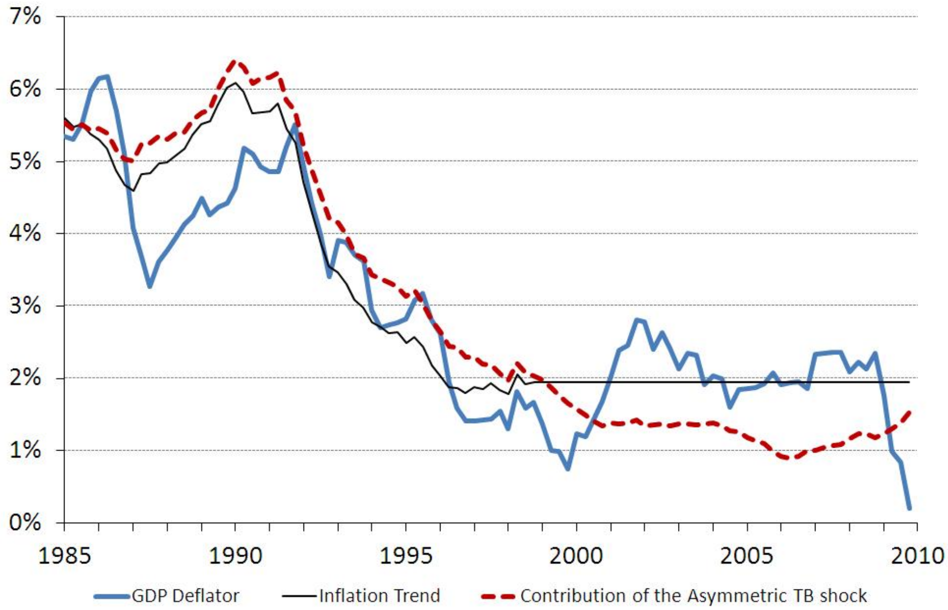

Figure 6: Historical contribution of the skew-symmetric shock on foreign biases (δ_t) to GDP deflator inflation

value of δ_t corresponding to deteriorating trade balance during the 90s. Quantitatively, its contribution is -0.7% on average on GDP deflator inflation, which is rather large compared to the average inflation. This large contribution comes from the fall in trade balance depicted in Figure 1 on the one hand and the significant impact of such a decrease of trade balance on GDP deflator if the model interprets it as a shock on foreign biases as shown in Figure 5. We provide more details on the impact of the skew-symmetric shocks on foreign biases in Table 6. The estimated impact of this shock is also strongly negative on GDP and in a less extent on HICP inflation as the Euro Area has also imported the inflation of foreign country induced by this shock. Conversely, the foreign country has benefited from this asymmetric development of trades and has suffered from inflationary pressures.

As we can see in Table 6, the contribution of this shock to the interest rate is strongly negative. Indeed, the negative skew-symmetric shock on foreign biases leads to the decrease of the overall demand for domestic goods and thus the decrease of GDP deflator inflation through the fall in the real marginal costs. Moreover, by composition, the HICP inflation falls automatically. Thus, the euro area monetary authority would have changed its interest rate as all component of its policy rule has decreased. Thus, the strong negative impact of δ during the 2000s translates into a very negative reaction of nominal interest rate. To illustrate the importance of this shock in the conduct of monetary policy in the 2000s, we present in Figure 7 a counterfactual in which we cancel the historical contribution of δ. Thanks to this counterfactual we are able to answer the following question: what would have been monetary policy interest rate if the relative appetite for foreign goods has been constant (i.e. the shocks on foreign biases had been null) ?

Figure 7 emphasizes the importance of the unbalanced globalization during the last 10

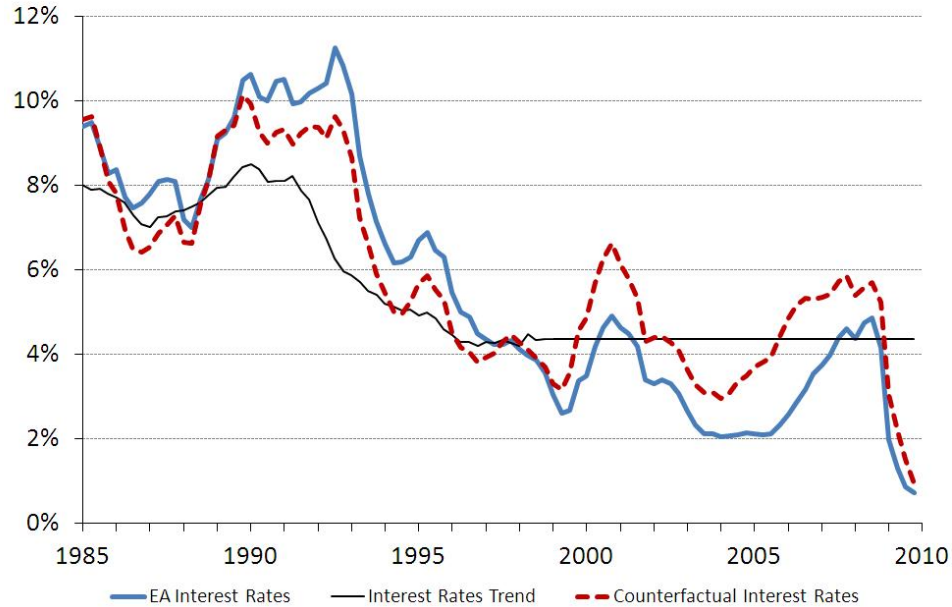

Figure 7: Counterfactual path of Nominal Interest Rate in absence of skew-symmetric shocks on foreign biases (δ_t)

years on the monetary policy. It shows that if the euro area would have known a balanced openness compared to the rest of the world, everything else being equal, the nominal interest rate would have been significantly higher (1.4 more in average from 2000 to 2008) and thus closer to the neutral nominal interest rate. This quantitatively-relevant finding suggests that global imbalances could have played a first role in the low rate/low inflation puzzle during the 2000s and finally partially confirms the intuition of Mac Farlane in his 2005 speech.

6 Conclusion

Economists often consider global imbalances as one of the main drivers of fluctuations and crisis. However, because of methodological constraints this concerns find few echoes in quantitative macroeconomic literature. We propose a simple way to include globalization process in order to assess the quantitative importance of persistent deviations to the associated balanced growth path. Thanks to the introduction of a non stationary component we are thus able to quantify the impact of deteriorating trade balance of the euro area since 1999.

We first derive a balanced growth path consistent with long term globalization, non stationary productivity and inflation target under strong but standard assumptions. Then we provide evidence of the fit to data of our model in comparing stationary components to HP-filtered data and in proceeding in a spectrum analysis. Finally, we find evidence of a strong negative impact of unbalanced globalization on inflation and interest rates since 1999. According to our estimates, this latest result is one of the key ingredient which can explain the low rate/low inflation puzzle of the mid 90s'.

To go one step further, these results emphasize the overall impact of global imbalances in the economy and maybe one indirect explanation of the subprime crisis. Indeed our findings partly explain the low nominal interest rates before the crisis which could have increased the risk taken by financial intermediaries as it is emphasized by Dubecq et al. (2009). Our microfoundation of the shock leading to such mechanism is however fragile and we do not argue that unbalanced globalization is only driven by shift in demand. Nevertheless, we believe that the results would be the same in a model where the number of goods produced in each country can fluctuate. In addition, our modeling of trade balance deviation is observably equivalent to transport costs or trade tariffs such that we can interpret our results as a broader analysis of the consequences of unbalanced globalization with different sources. Because we think of our shocks on foreign biases as a shortcut for supply and demand shocks which lead to unbalanced globalization, we do not investigate the normative consequences of our analysis. Indeed, depending of the precise nature of the shocks the normative implication of it would deeply change.

References

[1] Adolfson, M., S. Laseen, J. Linde, and M. Villani. “Bayesian Estimation of an Open Economy DSGE Model with Incomplete Pass-through”. *Journal of International Economics*, 72(2):481–511, **2007**.

[2] Backus, D. K. and G. W. Smith. “Consumption and Real Exchange Rates in Dynamic Economies with Non-Traded Goods”. *Journal of International Economics*, 35(3-4):297–316, **1993**.

[3] Barthélemy, J., M. Marx, and A. Poissonnier. “Trends and Cycles : an Historical Review of the Euro Area”. Documents de Travail 258, Banque de France, **2009**.

[4] Blanchard, O. and G. M. Milesi-Ferretti. “Global Imbalances: In Midstream?” CEPR Discussion Papers 7693, **2010**.

[5] Burstein, A., M. Eichenbaum, and S. Rebelo. “The Importance of Nontradable Goods’ Prices in Cyclical Real Exchange Rate Fluctuations”. *Japan and the World Economy*, 18(3):247–253, **2006**.

[6] Christiano, L., M. Eichenbaum, and C. L. Evans. “Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy”. *Journal of Political Economy*, 113(1):1–45, **2005**.

[7] Christoffel, K., G. Coenen, and A. Warne. “The New Area-Wide Model of the Euro Area - a Micro-Founded Open-Economy Model for Forecasting and Policy Analysis”. Working Paper Series 944, European Central Bank, **2008**.

[8] Dubecq, S., B. Mojon, and X. Ragot. “Fuzzy Capital Requirements, Risk-Shifting and the Risk Taking Channel of Monetary Policy”. Documents de Travail 254, Banque de France, **2009**.

[9] Fagan, G., J. Henry, and R. Mestre. “An Area-Wide Model for the Euro Area”. *Economic Modelling*, 22(1):39–59, **2005**.

[10] Ferroni, F. “Trend Agnostic One Step Estimation of DSGE Models”. MPRA Paper 14550, University Library of Munich, Germany, **2009**.

[11] Fève, P., J. Matheron, and J.-G. Sahuc. “Inflation Target Shocks and Monetary Policy Inertia in the Euro Area”. IDEI Working Papers 515, Institut d’Économie Industrielle (IDEI), Toulouse, **2008**.

[12] Gorodnichenko, Y. and S. Ng. “Estimation of DSGE Models when the Data are Persistent”. *Journal of Monetary Economics*, 57(3):325–340, **2010**.

[13] Hamilton, J. “Time Series Analysis”. *Princeton University Press*, **1994**.

[14] Imbs, J. and I. Méjean. “Elasticity Optimism”. Working papers, HAL, **2009**.

[15] Ireland, P. N. “Changes in the Federal Reserve’s Inflation Target: Causes and Consequences”. *Journal of Money, Credit and Banking*, 39(8):1851–1882, **2007**.

[16] King, R. G., C. I. Plosser, and S. T. Rebelo. "Production, Growth and Business Cycles : I. The Basic Neoclassical Model". *Journal of Monetary Economics*, 21(2-3):195–232, **1988**.

[17] Melitz, M. J. "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity". *Econometrica*, 71(6):1695–1725, **2003**.

[18] Obstfeld, M. and K. R. "Global Current Account Imbalances and Exchange Rate Adjustments". *Brookings Papers on Economics Activity*, 1:67–146, **2006**.

[19] Obstfeld, M. and K. Rogoff. "Global Imbalances and the Financial Crisis: Products of Common Causes". CEPR Discussion Papers 7606, **2009**.

[20] Smets, F. and R. Wouters. "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach". *American Economic Review*, 97(3):586–606, **2007**.

A Tables

Parameters	Value
Domestic openness $\bar{\Omega}$	0.2
Foreign openness $\bar{\Omega}^*$	0.05
Domestic steady state GDP share of consumption k_C	0.5736
Domestic steady state GDP share of investment k_I	0.2163
Cobb-Douglas share of capital expenditure in total cost α	0.34
Discount factor β	0.999
Inverse of the domestic Frish elasticity σ_l	2
Inverse of the foreign Frish elasticity σ_l^*	2
Depreciation rate τ	0.025
Relative convexity of the capital utilization cost $\frac{\Psi''(1)}{\Psi'(1)}$	0.2
Interest rate elasticity of the net foreign asset position Φ_b	0.001
Domestic wage mark-up λ_w	0.1
Foreign wage mark-up λ_w^*	0.1
Domestic price mark-up λ_p	0.1
Foreign price mark-up λ_p^*	0.1
Export price mark-up λ_p^X	0.1
Import price mark-up λ_p^M	0.1
Foreign wage Calvo parameter ξ_w^*	0.75
Weight of foreign wage indexation on past CPI γ_w^*	0.5
Export price Calvo parameter ξ_p^X	0.75
Weight of export price indexation γ_p^X	0.15
Domestic inflation target shock St. D. σ^Π	0.0908
Domestic inflation target shock persistence ρ^Π	0
Foreign inflation target shock persistence ρ^{Π^*}	0
Globalization trend persistenceρ^Ω	0
Domestic CPI inflation target $\bar{\Pi}^C$	0.0045

Table 2: Parameters Calibration

Parameters	Prior	Mean	St. D.	Posterior
St. D. of shocks				
Domestic permanent productivity shock σ^{A}	Inv. Gamma	0.5	$+\infty$	0.2201
Foreign permanent productivity shock σ^{A^*}	Inv. Gamma	0.5	$+\infty$	0.2172
Foreign inflation target shock σ^{Π^*}	Inv. Gamma	0.2	$+\infty$	0.0931
Globalization trend σ^{Ω}	Inv. Gamma	0.3	$+\infty$	0.1139
Domestic preference shock σ^{B}	Inv. Gamma	15	$+\infty$	4.6435
Foreign preference shock σ^{B^*}	Inv. Gamma	15	$+\infty$	5.1665
Investment shock σ^{I}	Inv. Gamma	50	$+\infty$	19.1523
Government expenditures shock σ^{G}	Inv. Gamma	5	$+\infty$	1.4252
Wage shock σ^{W}	Inv. Gamma	1	$+\infty$	0.3432
Domestic cost push shock σ^{P}	Inv. Gamma	0.5	$+\infty$	0.1874
Foreign cost push shock σ^{P^*}	Inv. Gamma	0.5	$+\infty$	0.2493
Imports price shock σ^{M}	Inv. Gamma	5	$+\infty$	1.3404
Domestic interest rate shock σ^{R}	Inv. Gamma	0.3	$+\infty$	0.1221
Foreign interest rate shock σ^{R^*}	Inv. Gamma	0.3	$+\infty$	0.1080
External risk premium shock σ^{Q}	Inv. Gamma	2	$+\infty$	0.4681
Transitory globalization shock σ^{γ}	Inv. Gamma	3	$+\infty$	1.2067
Transitory skew-symmetric preference shock σ^{δ}	Inv. Gamma	2	$+\infty$	0.7944
Persistence of shocks				
Domestic permanent productivity shock ρ^{A}	Beta	0.75	0.05	0.7626
Foreign permanent productivity shock ρ^{A^*}	Beta	0.75	0.05	0.7558
Domestic preference shock ρ^{B}	Beta	0.5	0.25	0.2865
Foreign preference shock ρ^{B^*}	Beta	0.5	0.25	0.6822
Investment shock ρ^{I}	Beta	0.5	0.25	0.3834
Government expenditures shock ρ^{G}	Beta	0.5	0.25	0.9643
Wage shock ρ^{W}	Beta	0.5	0.25	0.0348
Domestic cost push shock ρ^{P}	Beta	0.25	0.05	0.2172
Foreign cost push shock ρ^{P^*}	Beta	0.25	0.05	0.2227
Imports price shock ρ^{M}	Beta	0.75	0.05	0.7613
Domestic interest rate shock ρ^{R}	Beta	0.5	0.25	0.6067
Foreign interest rate shock ρ^{R^*}	Beta	0.5	0.25	0.5746
External risk premium shock ρ^{Q}	Beta	0.5	0.25	0.9670
Transitory globalization shock ρ^{γ}	Beta	0.5	0.25	0.4978
Transitory skew-symmetric preference shock ρ^{δ}	Beta	0.5	0.25	0.5520

Table 3: Parameters Estimation

Parameters	Prior	Mean	St. D.	Posterior
Long-term domestic growth rate a	Normal	0.0055	0.0055	0.0050
Long-term foreign growth rate a^*	Normal	0.0066	0.0066	0.0070
Long-term $\bar{\omega}$	Normal	0.01	0.01	0.0030
Government expenditures wedge $errg$	Normal	0.0005	0.0005	0.0008
Wages wedge $errw$	Normal	-0.0015	0.0015	-0.0011
Domestic deep-habit parameter h	Beta	0.75	0.05	0.8908
Foreign deep-habit parameter h^*	Beta	0.75	0.05	0.8631
Real rigidities on investment ϕ_i	Beta	0.5	0.25	0.0574
Domestic wage Calvo parameter ξ_w	Beta	0.75	0.05	0.7502
Weight of domestic wage indexation on past CPI γ_w	Beta	0.5	0.25	0.0375
Domestic price Calvo parameter ξ_p	Beta	0.75	0.05	0.7903
Weight of domestic price indexation γ_p	Beta	0.5	0.25	0.0287
Foreign price Calvo parameter ξ_p^*	Beta	0.75	0.05	0.7686
Weight of foreign price indexation γ_p^*	Beta	0.5	0.25	0.0698
Import price Calvo parameter ξ_p^M	Beta	0.75	0.05	0.7564
Weight of import price indexation γ_p^M	Beta	0.5	0.25	0.0410
Estimated Taylor Rules Parameters				
Inertia ρ	Beta	0.75	0.05	0.7919
Weight of GDP deflator in the policy-relevant inflation θ	Beta	0.5	0.25	0.6275
Weight of inflation r_π	Normal	2	0.5	1.8360
Weight of output r_y	Normal	0.3	0.3	0.2981
Foreign inertia ρ^*	Beta	0.75	0.05	0.7911
Foreign weight of inflationr_π^*	Normal	2	0.5	1.5212
Foreign weight of outputr_y^*	Normal	0.3	0.3	0.1696

Table 4: Parameters Estimation

	5-year	10-year	20-year
Theoretical AR(1)	**20%**	**38%**	**59%**
GDP	**20%**	74%	90%
Consumption	**8%**	**28%**	**54%**
Investment	**9%**	88%	99%
Real Wage	26%	74%	98%
GDP Deflator Inflation	73%	81%	89%
CPI Inflation	94%	98%	100%
Interest Rate	**9%**	**21%**	**41%**
REER	**6%**	**13%**	**28%**
Domestic Consumption	**11%**	**21%**	**42%**
Exports	55%	77%	90%
Imports	**16%**	82%	99%
Foreign GDP	34%	66%	85%
Foreign Inflation	77%	89%	95%
Foreign Interest Rate	**6%**	74%	88%

Table 5: Variance Decomposition by Spectrum Analysis
Share of total variance in % of cycles with periods less than 20, 10 and 5 years

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
					Domestic						
Output	-1.2	-2.4	-2.0	-2.0	-1.9	-2.3	-3.3	-3.4	-2.8	-2.3	-1.3
GDP defl. infl.	-0.1	-0.5	-0.6	-0.6	-0.6	-0.6	-0.9	-1.0	-0.9	-0.8	-0.6
HICP infl.	0.1	-0.2	-0.5	-0.5	-0.5	-0.5	-0.6	-0.8	-0.8	-0.7	-0.6
Interest Rates	-0.7	-1.6	-1.2	-1.0	-1.0	-1.1	-1.8	-2.1	-1.4	-1.0	-0.7
					Foreign						
Output	0.5	0.8	0.6	0.6	0.6	0.6	0.9	0.9	0.7	0.6	0.3
GDP defl. infl.	0.0	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.1
Interest Rates	0.1	0.3	0.3	0.2	0.2	0.3	0.4	0.5	0.3	0.2	0.2

Table 6: Yearly average contribution (in %) of the skew-symmetric preference shock ε_t^δ

	ε^{δ}	ε^{G}	ε^{I}	ε^{B}	ε^{A}	ε^{R}	ε^{Q}	ε^{B^*}	ε^{M}	ε^{P}	ε^{γ}	ε^{P^*}	others
GDP $\hat{y}$	28	18	19	9	6	12	1	1	1	1	1	0	4
Consumption $\hat{c}$	9	7	11	15	7	4	35	1	11	0	0	0	1
Investment $\hat{i}$	1	7	71	0	3	4	12	0	0	0	0	0	2
Real Wage $\hat{w} - \hat{p}$	1	2	33	0	27	2	2	0	0	13	0	0	20
GDP Deflator Inflation $\hat{\pi}$	11	6	3	3	24	11	2	1	1	33	0	0	6
CPI Inflation $\hat{\pi}^C$	3	2	2	1	6	5	9	1	58	9	0	0	3
Interest Rate $\hat{r}$	26	14	13	9	3	15	3	2	4	1	1	0	10
REER $\hat{q}$	12	2	2	0	0	2	72	1	4	0	0	0	4
Domestic Consumption $\hat{c}^D$	10	9	15	13	10	4	5	0	0	0	27	0	7
Exports $\hat{x}$	19	1	1	0	0	0	28	4	0	0	41	0	6
Imports $\hat{m}$	17	0	0	1	0	0	27	0	16	0	32	0	7
Net Foreign Asset $\tilde{b}$	27	0	0	1	0	0	70	2	0	0	0	0	0
Foreign GDP $\hat{y}^*$	4	0	0	0	0	0	0	72	0	0	0	1	22
Foreign Inflation $\hat{\pi}^*$	1	0	0	0	0	0	0	28	0	0	0	57	14
Foreign Interest Rate $\hat{r}^*$	2	0	0	0	0	0	1	52	0	0	0	5	41
Observables													
Real GDP dY	22	31	25	13	2	3	0	1	0	1	1	0	1
Private Consumption deflated by HICP dC	2	2	1	76	3	4	5	0	6	0	0	0	1
Real Investment dI	1	1	95	0	0	1	1	0	0	0	0	0	0
Real Compensation per Employee times Labor Force dW	0	0	1	0	15	0	0	0	0	24	0	0	59
GDP Deflator Inflation $d\Pi^P$	2	1	0	1	6	2	0	0	0	74	0	0	15
HICP Inflation $d\Pi^C$	0	0	0	0	1	2	6	0	63	20	0	0	8
Nominal Interest Rate dR	19	13	12	8	1	34	0	1	3	2	1	0	6
Real Effective Exchange Eate dQ	9	2	0	0	1	6	62	1	3	0	0	1	14
Exports-over-GDP ratio in value $d\frac{X}{Y}$	4	7	3	2	0	3	30	3	0	0	40	0	7
Imports-over-GDP ratio in value $d\frac{M}{Y}$	35	4	2	0	0	0	3	0	22	0	31	0	2
Foreign Real GDP dY^*	5	0	0	0	0	0	0	80	0	0	0	1	13
Foreign GDP Deflator Inflation $d\Pi^*$	0	0	0	0	0	0	0	4	0	0	0	88	9
Fed Funds Rate dR^*	1	0	0	0	0	0	0	26	0	0	0	9	64
Other Variables of Interest													
Annual GDP Growth	32	17	17	11	8	7	0	1	1	1	1	0	3
Annual Consumption Growth	4	3	2	47	7	6	13	1	15	0	0	0	2
Annual GDP Deflator Inflation	13	7	3	4	29	13	3	1	1	12	0	0	13
Annual HICP Inflation	5	3	3	2	9	8	9	1	49	4	0	0	7

Table 7: Variance Decomposition: each number corresponds to the relative contribution of a specific shock (in column) to the total variance of a particular variable (in line)

B Figures

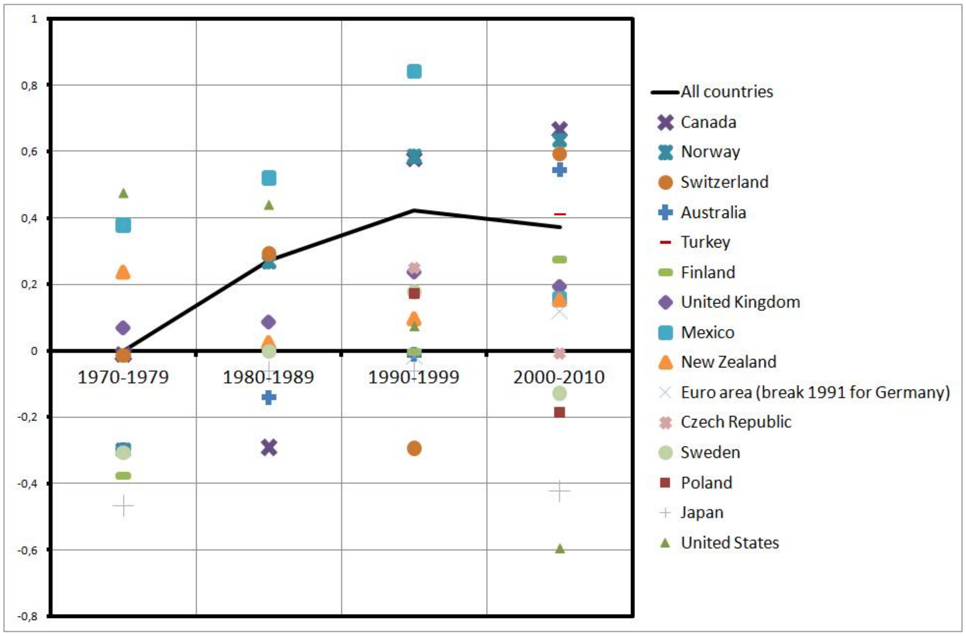

Figure 8: Correlations between cyclical components (HP-filter) of inflation and trade balance over GDP for a set of 14 countries.

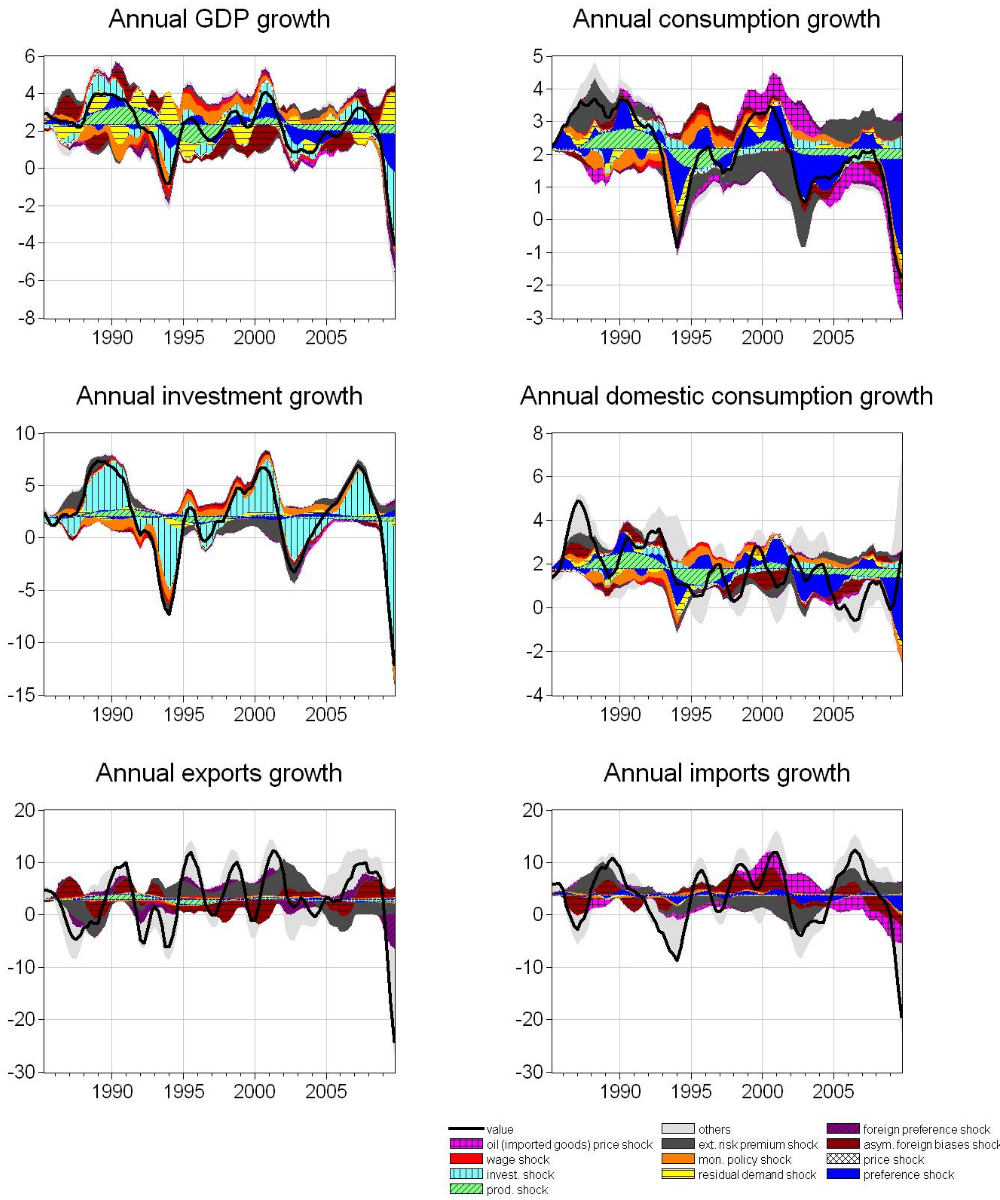

Figure 9: Historical decomposition of main real variables

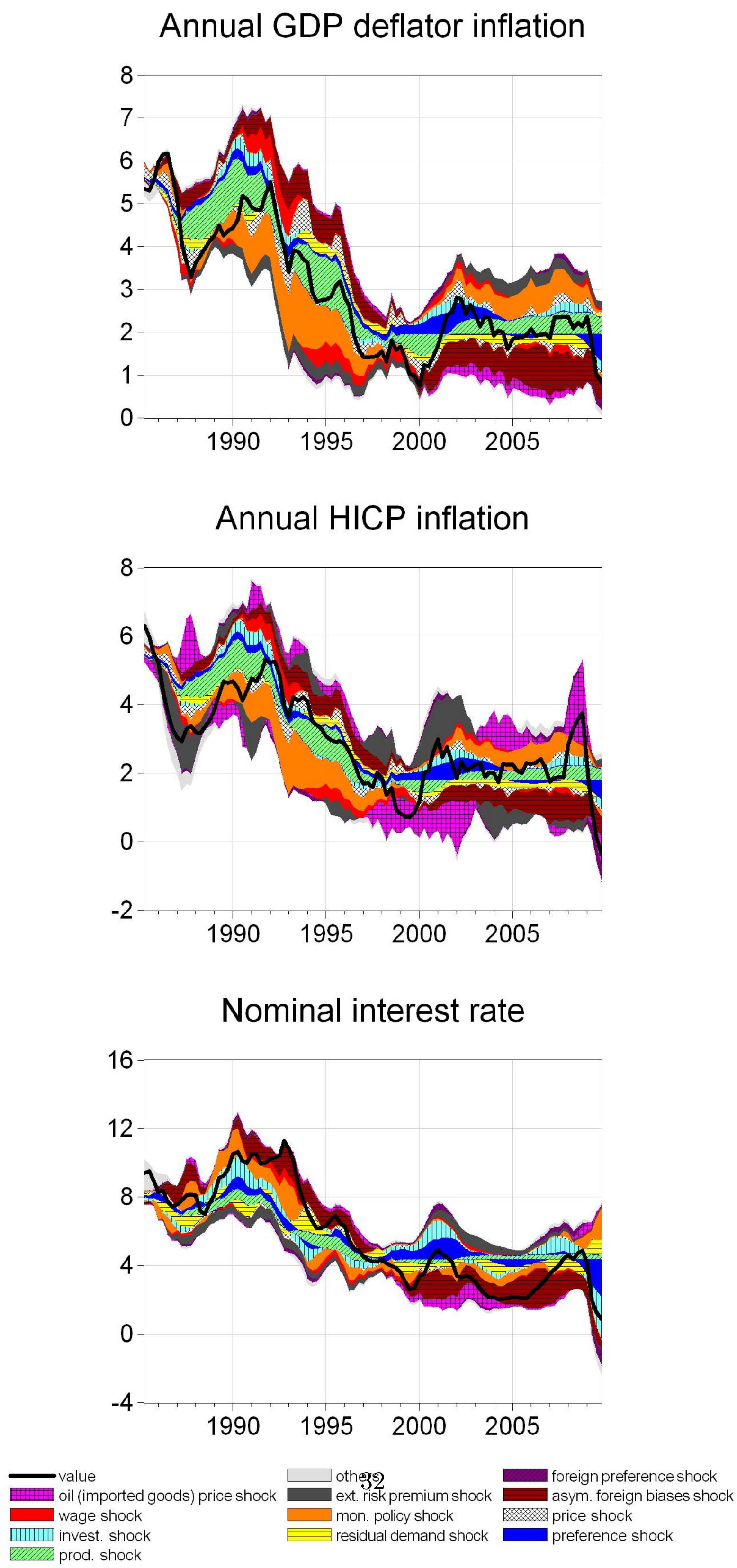

Figure 10: Historical decomposition of nominal variables

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