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Working Paper

Cyclical inflation divergence and different labor market institutions in the EMU

ECB Working Paper, No. 619

Provided in Cooperation with:

European Central Bank (ECB)

Suggested Citation: Campolmi, Alessia; Faia, Ester (2006) : Cyclical inflation divergence and different labor market institutions in the EMU, ECB Working Paper, No. 619, European Central Bank (ECB), Frankfurt a. M.

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EUROPEAN CENTRAL BANK

WORKING PAPER SERIES

NO 619 / MAY 2006

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**CYCLICAL INFLATION
DIVERGENCE AND
DIFFERENT LABOR
MARKET INSTITUTIONS
IN THE EMU**

by Alessia Campolmi
and Ester Faia



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CYCLICAL INFLATION DIVERGENCE AND DIFFERENT LABOR MARKET INSTITUTIONS IN THE EMU¹

by Alessia Campolmi²
and Ester Faia³



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¹ We thank Ignazio Angeloni, Gianluca Benigno, Giancarlo Corsetti, Luca Dedola, Jordi Gali and seminar participants at Universitat Pompeu Fabra, European Central Bank, LUISS, Università di Tor Vergata and conference participants at the Society for Economics Dynamics 2005, World Congress of the Econometric Society 2005, European Economic Association Meeting 2005, Csef-Igier Symposium on Economic and Institutions and Riksbank conference on Structural Analysis of Business Cycle in Open Economy. Ester Faia gratefully acknowledges financial support from the DSGE grant of the Spanish Ministry. Alessia Campolmi gratefully acknowledges financial support from Marco Polo grant of Università di Bologna.

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The statement of purpose for the ECB Working Paper Series is available from the ECB website, <http://www.ecb.int>.

ISSN 1561-0810 (print)
ISSN 1725-2806 (online)

CONTENTS

Abstract	4
Non-technical summary	5
1 Introduction	6
2 A model for a currency area with labor market frictions	10
2.1 Households in the domestic and foreign country	11
2.2 The production sector in the domestic and the foreign region	13
2.2.1 Search and matching in the labor market of the home region	13
2.2.2 Open economy relations	15
2.2.3 Monopolistic firms	15
2.2.4 Bellman equations, wage setting and Nash bargaining	17
2.3 The monetary policy rule in the currency area	18
2.4 Equilibrium conditions	19
2.5 Calibration	19
3 Model results	20
4 Dynamics of the theoretical model	21
4.1 Matching the data	22
4.2 The impact of employment protection	23
5 Conclusions	23
References	24
Tables and figures	27
European Central Bank Working Paper Series	35

Abstract

This paper relates the size of the cyclical inflation differentials, currently observed for euro area countries, to the differences in labor market institutions across the same set of countries. It does that by using a DSGE model for a currency area with sticky prices and labor market frictions. We show that differences in labor market institutions account well for cyclical inflation differentials. The proposed mechanism is a supply side one in which differences in labor market institutions generate different dynamics in real wages and consequently in marginal costs and inflations. We test this mechanism in the data and find that the model replicates well the empirical facts.

JEL Codes: E52, E24

Keywords: cyclical inflation divergence, labor market institutions, EMU.

Non-technical summary

This paper relates the size of the cyclical inflation differentials currently present among euro area countries and the differences in labor market institutions among the same set of countries. As well understood, labor market frictions are an important determinant of the dynamics of real wages and of the marginal cost of firms, which are in turn a main driver of inflation. Hence it seems natural to assess the quantitative relevance of such institutions in determining the differential inflation dynamics across European countries.

To this purpose we first investigate the relation between a measure of the business cycle responses of real wages, marginal costs and inflations on the one side and the differences in labor market institutions on the other for the euro area countries during the EMU period. We find that a negative relation exists between the ratios of the standard deviations for all the three variables and the ratios of the replacement rates. Secondly, to account for the stylized facts found in the data, we build a dynamic general equilibrium model with two region sharing the same currency and monetary policy and characterized by a variety of frictions: matching frictions and wage rigidity in the labor market, monopolistic competition and adjustment cost on pricing. We use this laboratory economy to analyze the differential impact of common monetary policy and of technology shocks under different values of the replacement rates between the two countries. Calibration is done using euro area country data. We find that in the model our measure of labor market institutions is able to generate large cyclical inflation differentials, as measured by the ratios of standard deviations across countries. Particularly, the model is able to replicate the negative relation found in the data between the measures of business cycle differential responses for real wages, marginal costs and inflations on the one side and the differences in labor market institutions on the other. The main mechanism at work in our model is a supply side one.

The paper focuses on the impact of labor market institutions on inflation differentials since they signal differences in the degree of labor market efficiencies (hence of welfare costs) across euro area countries.

1 Introduction

Cyclical inflation divergence is still pronounced among euro area countries despite the creation of a single currency and the existence of limits on national fiscal policies. In addition, remarkable differences still exist in national labor market institutions. This paper tries to assess the link between these two facts. As well understood, labor market frictions are an important determinant of the dynamics of real wages and of the marginal cost of firms, which are in turn a main driver of inflation. Hence it seems natural to assess the quantitative relevance of such institutions in determining the differential inflation dynamics across European countries.

To this purpose we first investigate the relation between business cycle responses of real wages, marginal costs and inflations (as measured by the ratios of standard deviations of the three variables relative to that of output) on the one side and the differences in labor market institutions (as measured by ratios in the replacement rates¹) on the other for the euro area countries during the EMU period. We find that a negative relation exists between the ratios of the standard deviations for all the three variables and the ratios of the replacement rates. Secondly, to account for the stylized facts found in the data, we build a dynamic general equilibrium model with two region sharing the same currency and monetary policy and characterized by a variety of frictions: matching frictions and wage rigidity in the labor market², monopolistic competition and adjustment cost on pricing³. We use this laboratory economy to analyze the differential impact of common monetary policy and of technology shocks under different values of the replacement rates between the two countries. Calibration is done using euro area country data. We find that in the model our measure of labor market institutions is able to generate large cyclical inflation differentials, as measured by the ratios of standard deviations across countries. Particularly, the model is able to replicate the negative relation found in the data between the ratios of standard deviations for real wages, marginal costs and inflations (relative to that of output) on the one side and the ratios of the replacement rates on the other. The main mechanism at work in our model is a supply side one. Consider a positive technology or monetary policy shocks. On impact, output rises but employment and wages fall. This is due to the presence of price rigidity. Because of the adjustment costs, firms in the first period will not reduce the prices as they would have done without adjustment costs. Therefore,

¹Replacement rates are defined as the ratio between unemployment benefits and wages. We choose this indicator for a number of reasons. First, this measure is often used as main indicator to identify labor market institutions since it is a main determinant of the worker between the outside option and the value of an existing job. Secondly, and contrary to other labor market indicators such as the bargaining power, it can be measured in the data precisely and with a statistical procedure which is homogenous across different countries.

²The tradition of introducing matching frictions in a dynamic general equilibrium model is at this point well established for closed economy models and allows to study the impact of labor market institutions. Among others see Merz (1995), Andolfatto (1996), Cooley and Quadrini (2000), Cheron and Langot (1999), Walsh (2002), Krause and Lubik (2005) among many others.

³The introduction of sticky prices allows to obtain a relation between marginal cost of firms and inflation via a Phillips curve.

aggregate demand increases by less than in the flexible price case and the increase in productivity that allows to produce the same amount with less work generates a decrease in employment and, consequently, a decrease in real wages. In countries with lower replacement ratios workers face a worse outside option, therefore they are willing to accept a bigger reduction in wages in order to keep the job. In those countries, wages go down by more while the reduction in employment is smaller. Consequently, after a positive technology shock, the decrease in marginal costs and prices will be bigger, the lower the replacement ratio. Since the model is perfectly symmetric, in response to a negative technology shock, the increase in marginal cost and prices will be higher, the lower the replacement ratio.

The differential transmission mechanism which arises in our model also bears some important implications for the open economy dimension of the paper. Indeed the terms of trade depend from the relative distribution of work effort across the two regions. Hence differential responses of employment and marginal costs generate endogenous terms of trade depreciation with shifts in competitiveness across countries. Sustained loss in competitiveness and in national output growth can harm growth in the whole currency area itself. This is the main reason for which lasting cyclical inflation differentials represent a serious concern for policy makers.

Several commentators in the past argued that inflations differentials under the EMU were due to initial price and productivity differentials - i.e. such as the Balassa Samuelson effect -, and that they would have disappeared once the convergence process was complete. However after five years from the start of the EMU cyclical inflation differentials still persist and seem to have increased recently. Recent empirical studies also showed that euro area cyclical inflation differentials are higher than those observed in the U.S. and that factors other than price convergence are capable of explaining most of the cross-country differences.

It is worth noticing that cyclical inflation differentials due to demand channels, such as fiscal policies, are equally plausible. We focus attention on the impact of labor market institutions for a number of reasons. First, labor market institutions have a direct impact on marginal cost which in turn determine inflation dynamics. Secondly, and contrary to demand factors such as the impact of government expenditure on inflation, labor market frictions induce inefficient movements in inflation, hence they are likely to be undesirable from a welfare perspective.

The paper proceeds as follow. Section 2 reviews the empirical literature on inflation differentials and presents the stylized facts. Section 3 presents the model. Section 4 shows model results. Section 5 concludes. Figures and tables follow.

1.1 Related Literature and Stylized Facts

There has been recently a growing interest in the empirical analysis of inflation differentials in the euro area. Unfortunately few studies distinguish between the cyclical and the long run components

of inflation divergence. Hence in this section we will refer more generically to inflation differentials. However it needs to be stressed that our main focus is in fact in the cyclical component.

Empirical studies such as Alberola (2000), Rogers (2002) and Ortega (2003) show that factors other than the price convergence hypothesis and the Balassa Samuelson effect have played a significant role in explaining price and inflation divergence in Europe. In particular they stress the importance of wages differences as main determinant of inflation differentials. On the other side Honohan and Lane (2003) stress the importance of the differential impact on different member states of the euro weakness. A variety of determinants for inflation differentials are instead considered in an extensive empirical study conducted by the ECB (the “Inflation Differential” report of the 2003). This is a comprehensive survey of a variety of measures for price and cost developments among the EU-12 during the 1999-2002 period. The authors of the report find important evidence of the link between inflation differentials and differences in labor costs.

Some papers in the theoretical literature have also approached similar issues. Benigno (2003) and Benigno and Lopez-Salido (2003) focus on the welfare implications (more than on the causes) of inflation differentials for euro area countries. Andres, Ortega and Valles (2003) use a two country model to assess the impact of competitiveness degree in product markets on inflation differentials. Finally Angeloni and Ehrmann (2004) use a 12-country model to address the impact of various factors on the inflation dynamics. Interestingly they find that the presence of inflation persistence per se induces cyclical inflation differentials.

Contrary to the majority of the previous studies we focus on cyclical inflation dynamics and on their link with labor market institutions. To this purpose we examine next a series of stylized facts concerning the cyclical dynamics of real wages, marginal costs and inflations and their relation with the labor market institutions.

Labor market institutions. Table (1) shows averages over 1985 to 1995 of replacement rates for a series of euro area countries. Data are taken from Nickell and Nunziata (2001)⁴. The data show that there is considerable variation in this measure that ranges from 0.09 to a maximum of 0.78⁵.

We choose to focus on this indicator as proxy for labor market institutions for a number of reasons. First, this measure is often used in the literature to identify labor market institutions since it is a main determinant in the worker decision to keep a job. Secondly, and contrary to other labor market indicators such as the bargaining power, it can be measured in the data precisely and with a statistical procedure which is homogenous across different countries.

⁴They use the Benefit Replacement Rate (benefit as percentage of average earnings before taxes) provided by OECD. Then, they build up a weighted average of the BRR over the first 5 years of unemployment, where more weight is given to the first two years.

⁵It is worth noticing that at the same time those data do not show much variation across time and this fact makes them suitable to study the impact of labor market institutions on the business cycle.

The empirical link between cyclical inflation differentials and labor market institutions. For our empirical analysis we consider euro area countries during the period 1998-2004⁶. In figure (1) we plot the ratio of the standard deviations of inflation⁷ (relative to that of output) for each pair of countries vs the ratio of the replacement rates. The coefficient of the OLS regression is negative and significantly different from zero⁸. Since we will use this country pair analysis several times in this work, it is important to underline now how to read the picture. If we consider the point (1,1) as the origin, all data points displayed in the upper left quadrant and in the lower right quadrant represent pairs of countries where the country with lower unemployment benefit has a higher volatility of inflation, i.e. these are data that are consistent with the mechanism proposed in order to partially explain differences in the volatility of inflation across countries. Consistently with that, the regression line almost pass through (1,1).

At this stage it is important to remember that the theoretical channel of this transmission mechanism is that the unemployment benefit has an impact on the dynamics of real wage. This, in turn, has an impact on the volatility of the marginal cost and affects, via the Phillips Curve, the volatility of inflation. Therefore, before moving to the theoretical model, this is a channel that can be investigated more in detail in the data. Indeed, if this is the mechanism at work, we should expect to find a negative relation between the standard deviation of real wages and the replacement rates, and also a negative relation between the standard deviation of the marginal costs and the replacement rates. This is exactly the kind of relation we will investigate in the next sections.

The empirical link between cyclical real wages differentials and labor market institutions. As measure of real wages we consider the *Compensation per employee* divided by the CPI⁹. Since we are interested in the cyclical behavior of the series, the standard deviation has been computed on the filtered series of real wage (using Hodrick-Prescott)¹⁰. For the period considered there are no data available for Portugal and Greece, therefore we need to exclude these two countries. Figure (2) plots the ratio between the standard deviations of the real wages (relative to that of output) for each pair of countries with the ratios of the replacement rates. The relation is negative and significantly different from zero, bringing more evidence in favour of the aforementioned mechanism.

Therefore, it seems that countries with lower unemployment benefit, tend to have both a higher volatility of inflation and a higher volatility of real wages. The last channel we need to check, in order to better evaluate whether the mechanism at work is the one theorized, is the one of marginal cost.

⁶We need to exclude Greece and Luxembourg from the sample since for those countries there are no data for our measure of labor market institutions.

⁷Source: OECD and IMF.

⁸Notice that Finland represent somehow an outlier. But this case is well explained by the major turmoil occurred in Finland after the collapse of the Soviet Union.

⁹The source for *Compensation per employee* is EUROSTAT while the CPI is taken from OECD.

¹⁰The Hodrick-Prescott filter has been applied on the series starting from the 1989 to the 2004 in order to cover at least one cycle.

The empirical link between cyclical marginal costs differentials and labor market institutions. As a measure of marginal cost, we use the *unit labour costs index* provided by EUROSTAT for all countries but Portugal and Greece. Therefore, as we have been obliged to do for the wage, we need to exclude these two countries from the analysis. Also in this case, in order to consider the cyclical component, the series have been de-trended using the Hodrick-Prescott filter.

Again, figure (3) give evidence of a negative relation between the ratio of marginal costs volatilities (relative to that of output) for each pair of countries and the ratios of the replacement rates. The only remarkable exception being Spain that has a relatively low volatility of the marginal cost (indeed once Spain has been excluded from the sample of countries, the coefficients of the OLS regressions becomes significant).

Therefore, the empirical evidence seems to support the original intuition that differences in the replacement rates across countries could partially account for differences in the volatility of inflation. In particular, there seems to be evidence in the data for the cost mechanism at study, with countries with lower unemployment benefit exhibiting not only higher volatility of inflation, but also higher volatility of wages and of marginal costs.

Before closing this section it is worth noticing that the negative relations found are robust to several checks. We have indeed verified that the same relation can be found when we plot the level of the standard deviations versus the level of the replacement rates as well as the difference in the standard deviations versus the difference in the replacement rates.

2 A Model for A Currency Area with Labor Market Frictions

There are two countries of equal size. Each country is inhabited by a continuum of agents with measure one. Countries are symmetric for everything apart from the labor and product market institutions.

Each economy is populated by households who consume different varieties of domestically produced and imported goods, save and work. Households save in both domestic and internationally traded bonds. Each agent can be either employed or unemployed. In the first case he receives a wage that is determined according to a Nash bargaining, in the second case he receives an unemployment benefit. The labor market is characterized by matching frictions and endogenous job separation.

The production sector acts as a monopolistic competitive sector which produces a differentiated good using capital and labor as inputs and faces adjustment costs a' la Rotemberg (1982).

Let $s^t = \{s_0, \dots, s_t\}$ denote the history of events up to date t , where s_t denotes the event realization at date t . The date 0 probability of observing history s^t is given by ρ_t . The initial state s^0 is given so that $\rho_0 = 1$. Henceforth, and for the sake of simplifying the notation, let's define the operator $E_t\{\cdot\} \equiv \sum_{s_{t+1}} \rho(s^{t+1}|s^t)$ as the mathematical expectations over all possible states of nature conditional on history s^t .

2.1 Households in the Domestic and Foreign Country

Let's denote by $c_t \equiv [(1 - \gamma)^{\frac{1}{\eta}} c_{h,t}^{\frac{\eta-1}{\eta}} + \gamma^{\frac{1}{\eta}} c_{f,t}^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}}$ a composite consumption index of domestic and imported bundles of goods, where γ is the balanced-trade steady state share of imported goods (i.e., an inverse measure of home bias in consumption preferences), and $\eta > 0$ is the elasticity of substitution between domestic and foreign goods. Each bundle is composed of imperfectly substitutable varieties (with elasticity of substitution $\varepsilon > 1$). Optimal allocation of expenditure within each variety of goods yields the following:

$$c_{h,t}^i = \left(\frac{p_{h,t}^i}{p_{h,t}} \right)^{-\varepsilon} c_{h,t}; \quad c_{f,t}^i = \left(\frac{p_{f,t}^i}{p_{f,t}} \right)^{-\varepsilon} c_{f,t} \quad (1)$$

where $c_{h,t} \equiv \int_0^1 [(c_{h,t}^i)^{\frac{\varepsilon-1}{\varepsilon}} di]^{\frac{\varepsilon}{\varepsilon-1}}$ and $c_{f,t} \equiv \int_0^1 [(c_{f,t}^i)^{\frac{\varepsilon-1}{\varepsilon}} di]^{\frac{\varepsilon}{\varepsilon-1}}$. Optimal allocation of expenditure between domestic and foreign bundles yields:

$$c_{h,t} = (1 - \gamma) \left(\frac{p_{h,t}}{p_t} \right)^{-\eta} c_t; \quad c_{f,t} = \gamma \left(\frac{p_{f,t}}{p_t} \right)^{-\eta} c_t \quad (2)$$

where $p_t \equiv [(1 - \gamma)p_{h,t}^{1-\eta} + \gamma p_{f,t}^{1-\eta}]^{\frac{1}{1-\eta}}$ is the CPI index. There is continuum of agents who maximize the expected lifetime utility.

$$E_t \left\{ \sum_{t=0}^{\infty} \beta^t \left(\frac{c_t^{1-\sigma}}{1-\sigma} + (1 - \chi_t)b - \chi_t h \right) \right\} \quad (3)$$

where c denotes aggregate consumption in final goods, h is the time spent working¹¹, χ is an indicator function which takes the value of 1 if the worker is employed and zero if he is unemployed and b is the unemployment benefit. The household receives at the beginning of time t a labor income of $w_t h_t$ if he is employed, where w_t is the real wage bill. The contract signed between the worker and the firm specifies working time and wage and is obtained through a Nash bargaining process. In order to finance consumption at time t each agent also invests in non-state contingent nominal bonds b_t which pay a gross nominal interest rate $(1 + r_t^n)$ one period later and in non-state contingent nominal bonds which are internationally traded, b_t^* , and which pay a gross nominal interest rate, $(1 + r_t^{n,f})$, one period later. As in Andolfatto (1996) and Merz (1995) it is assumed that workers can insure themselves against earning uncertainty and unemployment. For this reason the wage earnings have to be interpreted as net of insurance costs. Finally agents receive profits from the monopolistic sector which they own, Θ_t , and pay lump sum taxes, τ_t . The sequence of budget constraints in terms of domestic CPI consumption goods reads as follows:

¹¹For simplicity we assume a linear labor disutility. However it is worth noticing that quantitative results would not be changed with a non-linear labor disutility.



$$c_t + \frac{b_t}{p_t} + e_t^r \frac{b_t^*}{p_t^*} \leq \chi_t w_t h_t + \frac{\Theta_t}{p_t} - \frac{\tau_t}{p_t} + (1 + r_{t-1}^n) \frac{b_{t-1}}{p_t} + (1 + r_{t-1}^{n,f}) e_t^r \frac{b_{t-1}^*}{p_t^*} \quad (4)$$

where e_t^r is the real exchange rate which in the currency area is given by $e_t^r = \frac{p_t^*}{p_t}$. Households choose the set of processes $\{c_t, h_t, b_t, b_t^*\}_{t=0}^\infty$ taking as given the set of processes $\{p_t, w_t, r_t^n, r_t^{n,f}, \chi_t\}_{t=0}^\infty$ and the initial wealth b_0, b_0^* so as to maximize (3) subject to (4). The following optimality conditions must hold:

$$c_t^{-\sigma} = \beta(1 + r_t^n) E_t \left\{ c_{t+1}^{-\sigma} \frac{p_t}{p_{t+1}} \right\} \quad (5)$$

$$c_t^{-\sigma} = \beta(1 + r_t^{n,f}) E_t \left\{ c_{t+1}^{-\sigma} \frac{p_t^*}{p_{t+1}^*} \frac{e_{t+1}^r}{e_t^r} \right\} \quad (6)$$

$$c_t^{-\sigma} = \lambda_t \quad (7)$$

Equation (5) is the Euler condition with respect to domestic bonds. Equation (6) is the optimality condition with respect to internationally traded bonds. Equation (7) is the marginal utility of consumption. Optimality requires that No-Ponzi condition on wealth is also satisfied.

Arbitrage condition and accumulation of assets. Due to imperfect capital mobility and/or in order to capture the existence of intermediation costs in foreign asset markets workers pay a spread between the interest rate on the foreign currency portfolio and the interest rate of the foreign country. This spread is proportional to the (real) value of the country's net foreign asset position:

$$\frac{(1 + r_t^{n,f})}{(1 + r_t^{n,*})} = \zeta \left(e_t^r \frac{b_t^*}{p_t^*} \right) \quad (8)$$

where $\zeta > 0^{12}$, $\zeta' > 0$. In addition we assume that the initial distribution of wealth between the two countries is symmetric. Aggregating the budget constraints of the workers, substituting for (8) and assuming that domestic bonds are in zero net supply we obtain the following law of motion for the accumulation of bonds:

$$e_t^r \frac{b_t^*}{p_t^*} \leq (1 + r_{t-1}^{n,*}) \zeta \left(e_t^r \frac{b_{t-1}^*}{p_{t-1}^*} \right) \frac{b_{t-1}^*}{p_t^*} + [\chi_t w_t h_t + \frac{\Theta_t}{p_t} - \frac{\tau_t}{p_t}] - c_t \quad (9)$$

Workers in the Foreign Region. We assume throughout that all goods are traded, that both countries face the same composition of consumption bundle and that the *law of one price*

¹²As shown in Schmitt-Grohe and Uribe (2001) and Benigno (2002) this assumption is needed in order to maintain the stationarity in the model. Schmitt-Grohe and Uribe (2001) also show that adding this spread - i.e. whose size has been shown negligible in Lane and Milesi-Ferretti (2001) - does not change significantly the behavior of the economy as compared to the one observed under the complete asset market assumption or under the introduction of other inducing stationarity elements - see Mendoza (1991), Senhadji (1994), Ghironi (2001).

holds. This implies that $p_{h,t} = e_t p_{h,t}^*$, $p_{f,t} = e_t p_{f,t}^*$. Under the currency union assumption the nominal exchange rate is equal one.

Foreign workers face an allocation of expenditure and wealth similar to the one of workers in the domestic region except for the fact that they do not pay an additional spread for investing in the international portfolio. The budget constraint of the foreign representative household will read - i.e. expressed in units of foreign consumption index -:

$$c_t^* + \frac{b_t^*}{p_t^*} \leq \chi_t^* w_t^* h_t^* + \frac{\Theta_t^*}{p_t^*} - \frac{\tau_t^*}{p_t^*} + (1 + r_{t-1}^{n,*}) \frac{b_{t-1}^*}{p_t^*} \quad (10)$$

The efficiency condition for bonds' holdings will read as follow:

$$(c_t^*)^{-\sigma} = \beta(1 + r_t^{n,*}) E_t \left\{ (c_{t+1}^*)^{-\sigma} \frac{p_t^*}{p_{t+1}^*} \right\} \quad (11)$$

All other optimality conditions are like in the home region. After substituting equation (8) into equation (6) and after merging with (6) we obtain the following relation:

$$E_t \left\{ \frac{\lambda_{t+1}^*}{\lambda_t^*} \right\} = E_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} \frac{e_{t+1}^r}{e_t^r} \zeta \left(e_t^r \frac{b_t^*}{p_t^*} \right) \right\} \quad (12)$$

which states that marginal utilities across countries are equalized up to the spread for the country risk.

2.2 The Production Sector In the Domestic and the Foreign Region

The maximization problems which characterize the production sector are symmetric across the two economies (they will only differ in terms of their parametrization). Hence in the next section we show only the ones for the home region.

Firms in the production sector sell their output in a monopolistic competitive market and meet workers on a matching market. The labor relations are determined according to a standard Mortensen and Pissarides (1999) framework. Workers must be hired from the unemployment pool and searching for a worker involves a fixed cost. Workers wages and hours of work are determined through a Nash decentralized bargaining process which takes place on an individual basis. Finally the relationship between a matched worker and a firm can be endogenously discontinued.

2.2.1 Search and Matching in the Labor Market of the Home Region

The search for a worker involves a fixed cost κ and the probability of finding a worker depends on a constant return to scale matching technology which converts unemployed workers u and vacancies v into matches, m :

$$m(u_t, v_t) = m u_t^\xi v_t^{1-\xi} \quad (13)$$

where $v_t = \int_0^1 v_{i,t} di$. Defining labor market tightness as $\theta_t \equiv \frac{v_t}{u_t}$, the firm meets unemployed workers at rate $q(\theta) = \frac{m(u_t, v_t)}{v_t} = m\theta_t^{-\xi}$, while the unemployed workers meet vacancies at rate $\theta_t q(\theta_t) = m\theta_t^{1-\xi}$. If the search process is successful, the firm in the monopolistic good sector operates the following technology:

$$y_{i,t} = z_t n_{i,t} \int_{a_{i,t}}^{\infty} a \frac{f(a)}{1 - F(a_{i,t})} da = z_t n_{i,t} H(\tilde{a}_{i,t}) \quad (14)$$

where z_t is the aggregate productivity shock which follows a first order autoregressive process, $n_{i,t}$ is the number of workers hired by each firm, and $a_{i,t}$ is an idiosyncratic shock to firms which is assumed to be identically and independently distributed across firms and times with cumulative distribution function $F : [0, \infty] \rightarrow [0, 1]$. It is assumed that the idiosyncratic shock is observed before the firm starts production. The firm will endogenously discontinue the match if the realized shock, $a_{i,t}$, is below a certain cut-off value, $\tilde{a}_{i,t}$. The threshold for endogenous separation is determined as a function of the state of the economy using firms' optimality conditions. Matches are destroyed at varying rate $\rho(\tilde{a}_{i,t})$ given by the following expression:

$$\rho(\tilde{a}_{i,t}) = \rho^x + \rho^n(\tilde{a}_{i,t})(1 - \rho^x) \quad (15)$$

where ρ^x is the exogenous break-up rate and $\rho^n(\tilde{a}_{i,t}) = F(\tilde{a}_{i,t})$ is the endogenous break-up rate.

We are now in the position to determine the law of motion for the workers employed and the ones seeking for a job. Labor force is normalized to unity. The number of employed people at time t in each firm i is given by the number of employed people at time $t - 1$ plus the flow of new matches concluded in period $t - 1$ who did not discontinue the match:

$$n_{i,t} = (1 - \rho(\tilde{a}_{i,t}))(n_{i,t-1} + v_{i,t-1}q(\theta_{t-1})) \quad (16)$$

Unemployment is given by total labor force minus the number of employed workers:

$$u_t = 1 - n_t \quad (17)$$

Finally we define the gross job destruction rate:

$$jd_t = \rho(\tilde{a}_{i,t}) - \rho^x \quad (18)$$

and job creation rate:

$$jc_t = \frac{(1 - \rho(\tilde{a}_{i,t}))v_{t-1}q(\theta_{t-1})}{n_{t-1}} - \rho^x \quad (19)$$

2.2.2 Open Economy Relations

The consumers and workers maximization problems have been derived assuming normalization to CPI index since the bundles consumed are aggregates of domestic and foreign goods. On the other side firms will deflate their profits by referring to the domestic GDP deflator. It is necessary at this point to introduce a series of relationships linking real quantities to the relevant relative prices. The terms of trade is the relative price of imported goods:

$$s_t \equiv \frac{p_{f,t}}{p_{h,t}} \quad (20)$$

It can be related to the CPI-PPI ratio as follows:

$$\phi_t \equiv \frac{p_t}{p_{h,t}} = [(1 - \gamma) + \gamma s_t^{1-\eta}]^{\frac{1}{1-\eta}} \quad (21)$$

The terms of trade and the inflation rates are linked through the following equation:

$$s_t = \frac{\pi_{f,t}}{\pi_{h,t}} s_{t-1} \quad (22)$$

2.2.3 Monopolistic Firms

Firms in the monopolistic sector (of the home region) use labor to produce different varieties of consumption good and face a quadratic cost of adjusting prices. Hours worked and wages are determined through the bargaining problem analyzed in the next section. Here we develop the dynamic optimization decision of firms choosing prices, $p_{h,t}^i$, number of employees, $n_{i,t}$, number of vacancies, $v_{i,t}$, and the endogenous separation threshold, $a_{i,t}$, to maximize the discounted value of future profits and taking as given the wage schedule. Let's denote the total real wage bill of firm i (measured in CPI goods) by:

$$W_{i,t} = n_{i,t} \int_{a_{i,t}}^{\infty} w(a) \frac{f(a)}{1 - F(a_{i,t})} da \quad (23)$$

where $w(a_{i,t})$ denotes the fact that the bargained wage might depend on idiosyncratic shock and other time varying factors. The representative firm in the domestic region chooses $\{p_{h,t}^i, n_{i,t}, v_{i,t}, a_{i,t}\}$ to solve the following maximization problem (in real terms):

$$Max \Pi_{i,t} = E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \left\{ \frac{p_{h,t}^i}{p_{h,t}} y_t^i - \phi_t W_{i,t} - \kappa v_{i,t} - \frac{\psi}{2} \left(\frac{p_{h,t}^i}{p_{h,t-1}^i} - 1 \right)^2 y_t^i \right\} \quad (24)$$

subject to

$$\text{s.to: } y_t^i = \left(\frac{p_{h,t}^i}{p_{h,t}} \right)^{-\epsilon} (c_{h,t} + c_{h,t}^*) = z_t n_{i,t} H(\tilde{a}_{i,t}) \quad (25)$$

$$\text{and: } n_{i,t} = (1 - \rho(\tilde{a}_{i,t}))(n_{i,t-1} + v_{i,t-1}q(\theta_{t-1})) \quad (26)$$

where $\frac{\psi}{2} \left(\frac{p_{h,t}^i}{p_{h,t-1}^i} - 1 \right)^2 y_t^i$ represent the cost of adjusting prices, ψ can be thought as the sluggishness in the price adjustment process and κ as the cost of posting vacancies. Let's define mc_t , the lagrange multiplier on constraint (25), as the marginal cost of firms and μ_t , the lagrange multiplier on constraint (26), as the marginal value of one worker. Since all firms will chose in equilibrium the same price and allocation we can now assume symmetry and drop the index i . First order conditions for the above problem read as follows:

- n_t :

$$\mu_t = mc_t z_t H(\tilde{a}_t) - \phi_t \frac{\partial W_t}{\partial n_t} + \beta E_t \left(\frac{\lambda_{t+1}}{\lambda_t} \right) ((1 - \rho(\tilde{a}_{t+1})) \mu_{t+1}) \quad (27)$$

- v_t :

$$\frac{\kappa}{q(\theta_t)} = \beta E_t \left(\frac{\lambda_{t+1}}{\lambda_t} \right) ((1 - \rho(\tilde{a}_{t+1})) \mu_{t+1}) \quad (28)$$

- $p_{h,t}$:

$$1 - \psi(\pi_{h,t} - 1)\pi_{h,t} + \beta E_t \left(\frac{\lambda_{t+1}}{\lambda_t} \right) [\psi(\pi_{h,t+1} - 1)\pi_{h,t+1} \frac{y_{t+1}}{y_t}] = (1 - mc_t)\varepsilon \quad (29)$$

- \tilde{a}_t :

$$\mu_t \rho'(\tilde{a}_t)(n_{t-1} + v_{t-1}q(\theta_{t-1})) + \phi_t \frac{\partial W_t}{\partial \tilde{a}_t} = mc_t z_t n_t H'(\tilde{a}_t) \quad (30)$$

Merging equations (27) and (28) gives the marginal value of an extra worker, μ_t , which is obtained by trading-off the cost of maintaining the match with an existing worker with the cost of posting a new vacancy:

$$\mu_t = mc_t z_t H(\tilde{a}_t) - \phi_t \frac{\partial W_t}{\partial n_t} + \frac{\kappa}{q(\theta_t)} \quad (31)$$

After substituting the marginal value of an extra worker, μ_t , into the optimality condition, (30), and using the constraint which describes the evolution of employment, (26), we obtain the condition which determines the threshold value for the idiosyncratic shock:

$$mc_t z_t H(\tilde{a}_t) - \phi_t \frac{\partial W_t}{\partial n_t} + \frac{\kappa}{q(\theta_t)} = \frac{mc_t z_t H'(\tilde{a}_t)}{\rho'(\tilde{a}_t)} (1 - \rho(\tilde{a}_t)) - \phi_t \frac{\partial W_t}{\partial \tilde{a}_t} \frac{(1 - \rho(\tilde{a}_t))}{\rho'(\tilde{a}_t) n_t} \quad (32)$$

We can finally simplify equation (32) so as to obtain a relation between the threshold value and the real wage schedule:

$$mc_t z_t \tilde{a}_t - w(\tilde{a}_t) \phi_t + \frac{\kappa}{q(\theta_t)} = 0 \quad (33)$$

2.2.4 Bellman Equations, Wage Setting and Nash Bargaining

The wage schedule is obtained through the solution to an individual Nash bargaining process. To solve for it we need first to derive the marginal values of a match for both, firms and workers. Those values will indeed enter the sharing rule of the bargaining process. Let's denote by $V_t^J(a_t)$ the marginal discounted value of a match for a domestic firm measured in terms of domestic prices:

$$V_t^J(a_t) = mc_t z_t \tilde{a}_t - \phi_t w(a_t) + E_t \left\{ \left(\beta \frac{\lambda_{t+1}}{\lambda_t} \right) [(1 - \rho(a_{t+1})) \int_{a_{t+1}}^{\infty} V_{t+1}^J(a_{t+1}) \frac{dF(a_{t+1})}{F(a_{t+1})} da] \right\} \quad (34)$$

The marginal value of a match depends on real revenues minus the real wage plus the discounted continuation value. With probability $(1 - \rho(a_{t+1}))$ the job remains filled and earns the expected value and with probability, $\rho(a_{t+1})$, the job is destroyed and has zero value. Using the equation (33) we can rewrite equation (34) as:

$$V_t^J(a_t) = \frac{-\kappa}{q(\theta_t)} + E_t \left\{ \left(\beta \frac{\lambda_{t+1}}{\lambda_t} \right) [(1 - \rho(a_{t+1})) \int_{a_{t+1}}^{\infty} V_{t+1}^J(a_{t+1}) \frac{dF(a_{t+1})}{F(a_{t+1})} da] \right\} \quad (35)$$

Since the value of a match for the firm must be zero in equilibrium the following zero profit condition must be satisfied:

$$\frac{\kappa}{q(\theta_t)} = E_t \left\{ \left(\beta \frac{\lambda_{t+1}}{\lambda_t} \right) [(1 - \rho(a_{t+1})) \int_{a_{t+1}}^{\infty} V_{t+1}^J(a_{t+1}) \frac{dF(a_{t+1})}{F(a_{t+1})} da] \right\} \quad (36)$$

Equation (36) is an arbitrage condition for the posting of new vacancies. It implies that in equilibrium the cost of posting a vacancy must equate the discounted expected return from posting the vacancy.

For each worker, the values of being employed and unemployed are given by V_t^E and V_t^U (expressed in terms of CPI):

$$V_t^E(a_t) = [w_t + E_t \left\{ \left(\beta \frac{\lambda_{t+1}}{\lambda_t} \right) [(1 - \rho(a_{t+1})) \int_{a_{t+1}}^{\infty} V_{t+1}^E(a_{t+1}) \frac{dF(a_{t+1})}{F(a_{t+1})} da + \rho(a_{t+1}) V_{t+1}^U] \right\}] \quad (37)$$

$$V_t^U = [b + E_t \left\{ \left(\beta \frac{\lambda_{t+1}}{\lambda_t} \right) [\theta_t q(\theta_t) (1 - \rho(a_{t+1})) \int_{a_{t+1}}^{\infty} V_{t+1}^E(a_{t+1}) \frac{dF(a_{t+1})}{F(a_{t+1})} da + (1 - \theta_t q(\theta_t) (1 - \rho(a_{t+1}))) V_{t+1}^U] \right\}] \quad (38)$$

where b denotes real unemployment benefits.

Nash bargaining. Workers and firms are engaged in a Nash bargaining process to determine wages and hours worked. The standard Nash bargaining problem is given by:

$$\max_w (\phi_t (V_t^E(a_t) - V_t^U))^\varsigma (V_t^J(a_t))^{1-\varsigma} \quad (39)$$

where ς stands for the bargaining weight of the workers. The optimal sharing rule is:

$$\phi_t(V_t^E(a_t) - V_t^U) = \frac{\varsigma}{1 - \varsigma} V_t^J(a_t) \quad (40)$$

After substituting the previously defined value functions it is possible to derive the following wage schedule:

$$w_t(a_t) = \varsigma(mc_t z_t a_t + \theta_t \kappa) \frac{1}{\phi_t} + (1 - \varsigma)b \quad (41)$$

Finally using the individual wage schedule, (41), the condition for the threshold value, (33), becomes:

$$\tilde{a}_t = \frac{b\phi_t}{mc_t z_t} + \frac{1}{mc_t z_t} \frac{\kappa}{1 - \varsigma} (\varsigma\theta_t - \frac{1}{q(\theta_t)}) \quad (42)$$

The average real wage is obtained by aggregating across employees:

$$w_t = \int_{\tilde{a}_t}^{\infty} w(a) \frac{f(a)}{1 - F(\tilde{a}_t)} da = \varsigma mc_t z_t \frac{1}{\phi_t} \int_{\tilde{a}_t}^{\infty} a \frac{f(a)}{1 - F(\tilde{a}_t)} da + \varsigma\theta_t \kappa \frac{1}{\phi_t} + (1 - \varsigma)b \quad (43)$$

Real wage rigidity. From equation (31) we can derive a measure of the marginal cost in our model which reads as follows:

$$mc_t = \frac{1}{z_t H(\tilde{a}_t)} \left[\phi_t \frac{\partial W_t}{\partial n_t} + \mu_t - \frac{\kappa}{q(\theta_t)} \right]$$

The first component of this measure is given by the marginal wage bargained divided by the labor productivity. Since our goal is to obtain persistent dynamics for marginal cost and inflation we introduce real wage stickiness following Hall (2003). In particular we assume that the individual real wage is a weighted average of the one obtained through the Nash bargaining process and the one obtained as a solution to the steady state¹³:

$$w_t(a) = \lambda \left[\varsigma(mc_t z_t a_t + \theta_t \kappa) \frac{1}{\phi_t} + (1 - \varsigma)b \right] + (1 - \lambda)w(a) \quad (44)$$

2.3 The Monetary Policy Rule in the Currency Area

An active monetary policy sets the short term nominal interest rate by reacting to an average of the inflation levels in the area. This rule rationalizes the behavior of the stability pact signed by euro area countries:

$$r_t^n = \exp\left(\frac{1 - \chi}{\beta}\right) (r_{t-1}^n)^\chi \left(\frac{\pi_t + \pi_t^*}{2}\right)^{b_\pi} m_t^{1 - \chi} \quad (45)$$

b_π is the weight that the monetary authority puts on the deviation of CPI inflation and is set equal to 1.5. m_t is a temporary monetary policy shock. In addition following Clarida, Gali' and Gertler (2000) and Rotemberg and Woodford (1997) we assume that monetary policy applies a certain

¹³Hall (2003) proves that such a wage rule follows inside the range defined by the bargaining set.

degree χ of interest rate smoothing. Aside from being consistent with most evidence on monetary policy rules the interest rate smoothing helps to generate more persistent effect of monetary policy shocks.

2.4 Equilibrium Conditions

Aggregate output is obtained by aggregating production of individual firms and by subtracting the resources wasted into the search activity:

$$Y_t = n_t z_t \int_{a_t}^{\infty} a \frac{f(a)}{1 - F(a)} da - \kappa v_t \quad (46)$$

Market clearing for domestic variety i must satisfy:

$$\begin{aligned} y_t^i &= c_{h,t}^i + c_{h,t}^{i,*} + \frac{\psi}{2} \left(\frac{p_{h,t}^i}{p_{h,t-1}^i} - 1 \right)^2 y_t^i \\ &= \left(\frac{p_{h,t}^i}{p_{h,t}^i} \right)^{-\varepsilon} \left[\left(\frac{p_{h,t}}{p_t} \right)^{-\eta} (1 - \gamma) c_t + \left(\frac{p_{h,t}^*}{p_t^*} \right)^{-\eta} \gamma^* c_t^* \right] + \frac{\psi}{2} \left(\frac{p_{h,t}^i}{p_{h,t-1}^i} - 1 \right)^2 y_t^i \end{aligned} \quad (47)$$

for all $i \in [0, 1]$ and t . After substituting (47) into the definition of aggregate output $y_t \equiv \left[\int_0^1 (y_t^i)^{1-\frac{1}{\varepsilon}} di \right]^{\frac{\varepsilon}{\varepsilon-1}}$, imposing symmetry and recalling that $p_{h,t} = e_t p_{h,t}^*$, we can express the resource constraint as:

$$n_t z_t \int_{a_t}^{\infty} a \frac{f(a)}{1 - F(a)} da - \kappa v_t = \left(\frac{p_{h,t}}{p_t} \right)^{-\eta} (1 - \gamma) c_t + \left(\frac{p_{h,t}}{e_t p_t^*} \right)^{-\eta} \gamma^* c_t^* + \frac{\psi}{2} \left(\frac{p_{h,t}^i}{p_{h,t-1}^i} - 1 \right)^2 y_t \quad (48)$$

We assume zero total net supply of bonds.

2.5 Calibration

Preferences. Time is taken as quarters. We set the discount factor $\beta = 0.99$, so that the annual interest rate is equal to 4 percent. We set the elasticity of substitution between domestic and foreign goods η equal to 1.5 as in Backus, Kehoe and Kydland (1994). The parameter on consumption in the utility function is set equal to one. This value is compatible with a steady state trade balanced growth path. We set the steady state balanced growth ratio of exports over GDP to $\gamma = 0.25$, value compatible with data for European countries. Finally we assume that the steady state net asset position is symmetric between the two countries. Following Schmitt-Grohe and Uribe (2002) and consistently with Lane and Milesi-Ferretti (2002) we set the elasticity of the spread on foreign bonds to the net asset position equal to 0.000742.

Production. Following Basu and Fernald (1997) we set the value added mark-up of prices over marginal cost to 0.2. This generates a value for the price elasticity of demand, ε , of 6. We set the cost of adjusting prices $\psi = 100$ to generate a slope of the log-linear Phillips curve equal to 0.10. This is compatible with the estimates by Benigno and Lopez-Salido (2003) for France and Germany.

Labor market frictions parameters. The matching technology is a homogenous of degree one function which is characterized by the parameter ξ . Consistently with estimates by Blanchard and Diamond (1989) we set this parameter to 0.4. We set the firm matching rate, $q(\theta)$, to 0.7 which is the value used by denHaan, Ramsey and Watson (1997). The probability for a worker of finding a job, $\theta q(\theta)$, is set equal to 0.6, which implies an average duration of unemployment of 1.67 as reported in Cole and Rogerson (1996). With those values it is possible to determine the number of vacancies as well as the vacancy/unemployment ratio. The bargaining power, ς , is set equal to 0.5.

We set the exogenous separation probability, ρ^x , to 0.08 and the steady state overall separation rate, $\rho(\tilde{a})$, to 0.1. With those values it is possible to obtain the endogenous separation rate, $\rho^n(\tilde{a}) = \frac{(\rho(\tilde{a}) - \rho^x)}{(1 - \rho^x)}$, and the threshold value, $\tilde{a} = F^{-1}(\rho^n)$. The idiosyncratic shock is distributed as a lognormal with unitary mean and standard deviation equal to 0.20. Finally we set the degree of wage rigidity, λ , equal to 0.5 as benchmark value.

Labor market institutions. We assign values to the unemployment benefit parameter, b , so as to generate values for the $\frac{b}{w}$ ratio which are in the range of the ones observed for euro area countries. Data for the $\frac{b}{w}$ ratio are taken from the data-set constructed by S. Nickell and L. Nunziata (2001) and are reported in table (1).

Exogenous shocks and monetary policy: We consider domestic and foreign aggregate productivity shocks, z_t and z_t^* . We follow Backus, Kehoe and Kydland (1994) and calibrate their standard deviations to 0.008, their correlation to 0.258 and their persistence to 0.95. We also consider an i.i.d. common monetary policy shock, m_t , whose standard deviation is calibrated using data from Mojon and Peersman (2002). Following several empirical studies for Europe (see Clarida, Gali' and Gertler (2000), Angeloni and Dedola (1998) and Andres, Lopez-Salido and Valles (2001) among others) we set the interest rate smoothing parameter, χ , equal to 0.8.

3 Model Results

To analyze the results we will first explain the transmission mechanism at work in the model, then we verify whether the model is able to replicate the relations found in the data.

4 Dynamics of the theoretical model

Here we analyze the impulse response functions of the main variables, in order to clarify how different values of replacement rate generate different volatilities of wages, marginal costs, and inflation. During this experiment, the home country has a smaller replacement rate than the foreign country. With respect to all the other parameters, the two countries are perfectly symmetric. For this experiment we will analyze one shock at the time.

First, let's consider which is the impact of a *positive shock in the technology of the home country* (the model is perfectly symmetric, therefore the responses to a negative shock will be symmetric to the ones obtained with a positive shock). On impact, as we can see from figure (4), output rises but employment and wages fall. This is due to the presence of price rigidity. Because of the adjustment costs, firms in the first period will not reduce the prices as they would have done without adjustment costs. Therefore, aggregate demand increases by less than in the flexible price case and the increase in productivity that allows to produce the same amount with less work generates a decrease in employment and, consequently, a decrease in real wages. The threshold for the individual productivity increases in the first period. This is due to the combination of two effects going in the opposite direction. The increase in aggregate productivity as a negative impact on the threshold, therefore \tilde{a} should decrease on impact. At the same time, the initial reduction in employment makes firms firing first the less productive workers, therefore increasing \tilde{a} . In the first period this effect dominates and \tilde{a} increases. In the subsequent periods, prices can fully adjust, aggregate demand increases and the productivity effect dominates making \tilde{a} decreasing below its steady state level. This effects will increase employment and real wages above their steady state levels. This mechanism would be observable also in a closed economy framework but in an open economy framework it is amplified by the terms of trade effect. Because of the technology shock in the home country, home produced goods become cheaper than foreign goods. This will bring two consequences. First, home consumers will substitute foreign goods with home goods (i.e. C_H will increase and C_F will decrease). Second, also foreign consumers will find the goods produced by Home cheaper, therefore they will import more goods from abroad (i.e. C_H^* will increase). Therefore, home production will increase because of both, an increase in the demand of home consumers, and an increase in exports.

Now that we have clarified the general mechanism, we can look at the impact of different values of replacement rate on the dynamics just described. In order to do so, we can compare the dynamic of the variables in the home country when there is a domestic productivity shock (figure (4)), to the dynamic of the variables in the foreign country when there is a foreign productivity shock (figure (5)). As we have just explained, after a positive technology shock, employment, as well as wages, go down. But in the home country, where the replacement rate is lower, workers face a worse outside option than the one of workers in the foreign country. Therefore, workers in

home will be willing to accept a bigger reduction in wages in order to keep the job. Indeed, in the home country, wages go down by more while the reduction in employment is smaller than the one observed in the foreign country. Consequently, after a positive technology shock, the decrease in marginal costs and prices will be bigger, the lower replacement rate. Since the model is perfectly symmetric, in response to a negative technology shock, the increase in marginal cost and prices will be higher, the lower replacement rate.

Figure (6) shows the dynamic of home and foreign variables after a tightening in the monetary policy. This will induce a contraction in output and an increase in unemployment. But, like before, in the country home, where replacement rate is lower, workers are willing to accept a higher reduction in wages in order to keep the job. Indeed, employment goes down less in home than in foreign, while wages, marginal costs and inflation go down more in home than in foreign. Concluding, since in consequence of both technology and monetary policy shock, the reaction of wages, marginal costs, and inflation is bigger in the country with the lower replacement rate, when we simulate the model and we compute the standard deviations of these variables, we find that the country with the lower replacement rate exhibits higher volatility of wages, marginal cost and inflation, exactly what we find in the data.

4.1 Matching the Data

We now verify whether the model is able to replicate the relations found in the data. Figure (7) plots the ratios of the model standard deviations (relative to the standard deviation of output) of real wages, marginal costs and inflation versus the ratios of the replacement rates. Standard deviations in the model are computed using 20 simulated series and calculations are based on the Hodrick-Prescott filtered series. The model is simulated under correlated technology shocks and common monetary policy shocks calibrated as explained in section 2.5. For this experiment we simulate both, technology and common monetary policy shocks calibrated on euro area data (see calibration section). This procedure guarantees the closest possible matching between the model statistics and the empirical statistics shown in section 2. The range of variation for the ratio of the replacement rates corresponds to the one found for the euro area countries from the Nickell and Nunziata (2001) dataset.

As we can see from the plot in figure (7) the model is able to replicate the negative relations found in the data for all the three variables, thereby confirming our mechanism. Interestingly the relations found are non-linear as the ones observed in the empirical analysis and the range of values for the relative standard deviations covers fairly well the ones obtained in the data¹⁴.

¹⁴It is worth noticing that the theoretical and the empirical graphs are not directly comparable. This is so since for practical reasons replacement rates data are ordered increasingly in the model. Hence in order to compare the ranges for the ratios of the standard deviations it is necessary to transfer the data points in the empirical graphs for all values of the replacement rates ratios that are below one. If we do so the range observed for the ratios of the

4.2 The Impact of Employment Protection

To further assess the ability of our model to replicate empirical facts regarding the impact of labor market institutions on the business cycle we repeated the entire analysis so far described by replacing the *replacement rate* with an indicator of the *employment protection*. This indicator can be considered as a proxy of the worker bargaining power and data are taken once again from the dataset of Nickell and Nunziata (2001).

In the theoretical model the bargaining power is inversely related to the replacement rate hence numerical simulations imply a positive relation between business cycle responses of real wages, marginal costs and inflations (as measured by the ratios of standard deviations of the three variables relative to that of output) on the one side and the ratios of bargaining powers. The intuition being as follows. An increase in the worker bargaining power increases the value of an existing job relative to the outside option. This implies that in response to shocks workers are more willing to accept large swings in real wages while keeping the existing jobs.

At the same time data for the EMU countries show an inverse relation between employment protection and replacement rates hence implying the same positive relation between business cycle responses of real wages, marginal costs and inflations on the one side and the ratios of employment protections¹⁵. We therefore conclude that the model implications remain valid even when labor market institutions are proxied by a different and equally important indicator.

5 Conclusions

Cyclical inflation differentials should be a concern for the newly created central bank since whenever they occur on top and above the ones associated with productivity differences, they might signal differences in efficiency of labor and product market structures due to inappropriate national policies.

This paper aims at studying the quantitative importance of labor market differences in generating differential inflation dynamics across euro area countries. It is indeed well understood that labor market frictions are an important determinant of the dynamics of marginal costs of firms, which in turn are a main driver of inflation. We find that even in response to common shocks differences in both types of institutions can generate significant cyclical inflation differentials. Furthermore we show that the sensitivity of inflation and of a number of labour market variables in response to monetary and technology shocks is higher when the worker face an outside option which is worst compared to the value of an existing job.

standard deviations in the empirical graphs come closer to the ones generated by the model. Clearly the ranges are not exactly the same since it might well be that other factors, such as demand side mechanism, account for cyclical divergences.

¹⁵The figures regarding the aforementioned relations are available upon request.

Cyclical inflation differentials due to productivity catch-ups should not be a concern for monetary policy since they are transitory and since they are associated with efficient reallocations of resources or international competition. On the contrary asymmetric development in labor market institutions are linked to various sources of inefficiencies which might be welfare detrimental for the entire currency area as well. For this reason a micro-founded model like the one used here could be used in the future also to answer questions on the welfare gains from different structural reforms. These issues, already relevant today, will become much more pressing in the future, when the euro-zone will include new entrants from eastern Europe.

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Table 1: Measures of replacement rates. Average over 1985 to 1995.

Countries	Benefit Duration
Austria	0.75
Belgium	0.77
Denmark	0.78
Finland	0.53
France	0.49
Germany	0.61
Ireland	0.54
Italy	0.09
Netherlands	0.47
Portugal	0.60
Spain	0.26

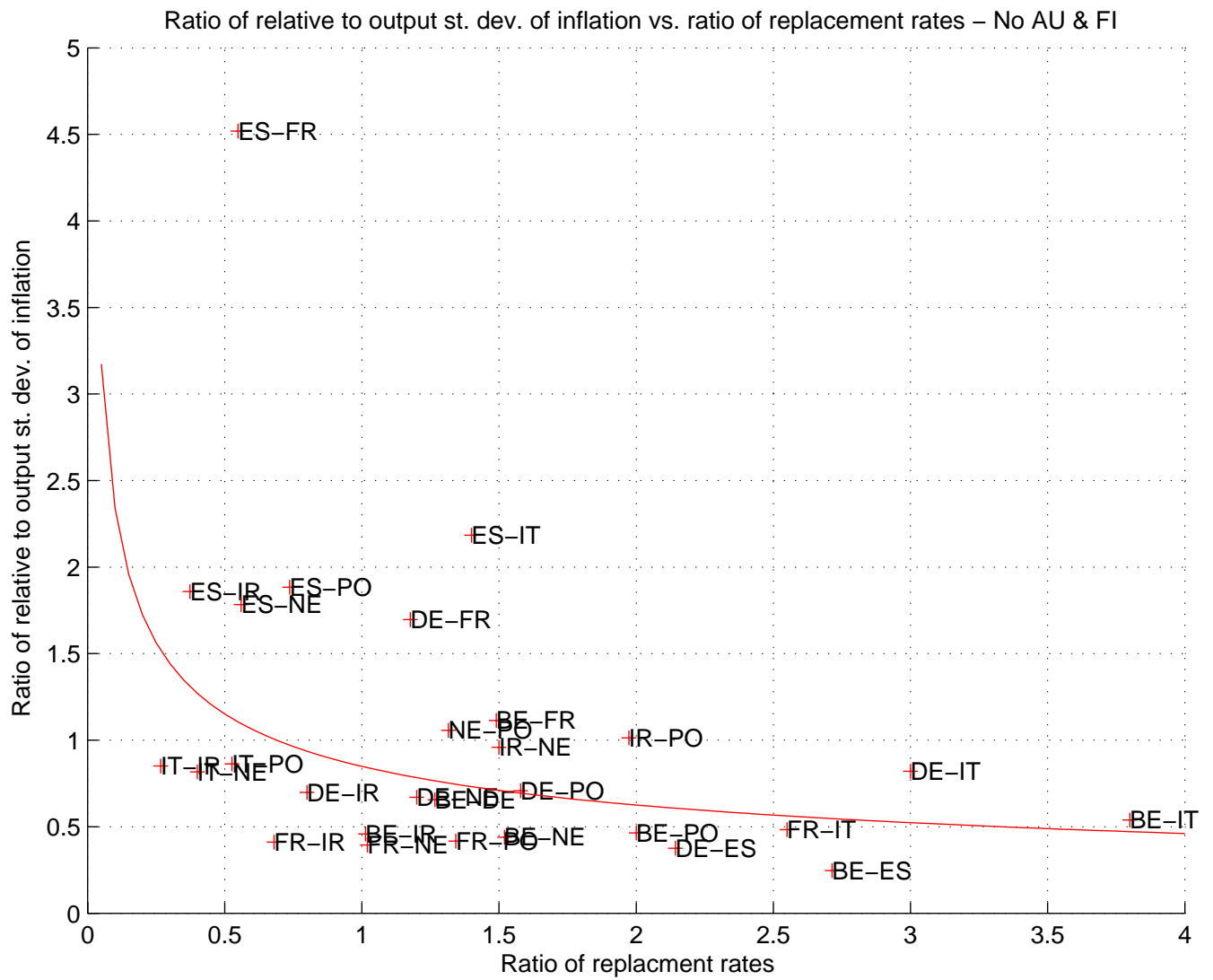


Figure 1:

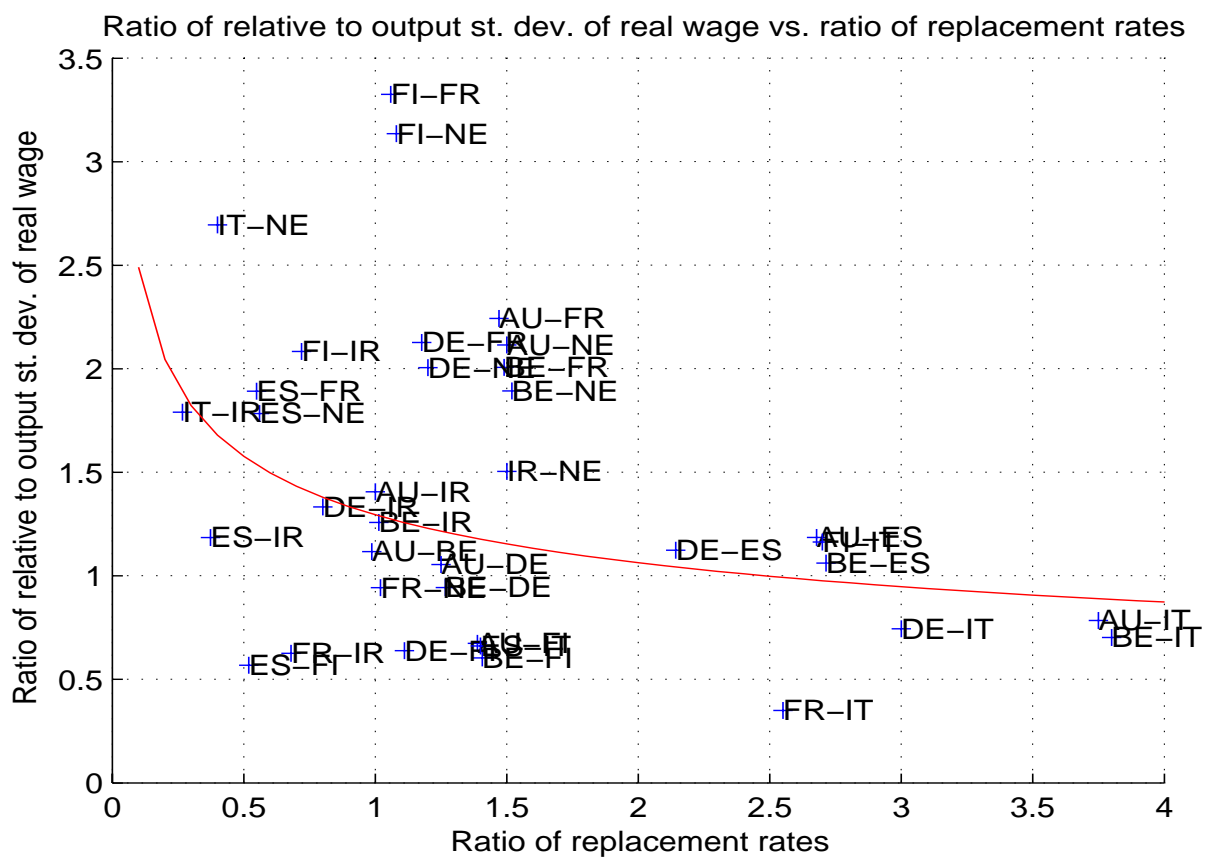


Figure 2:

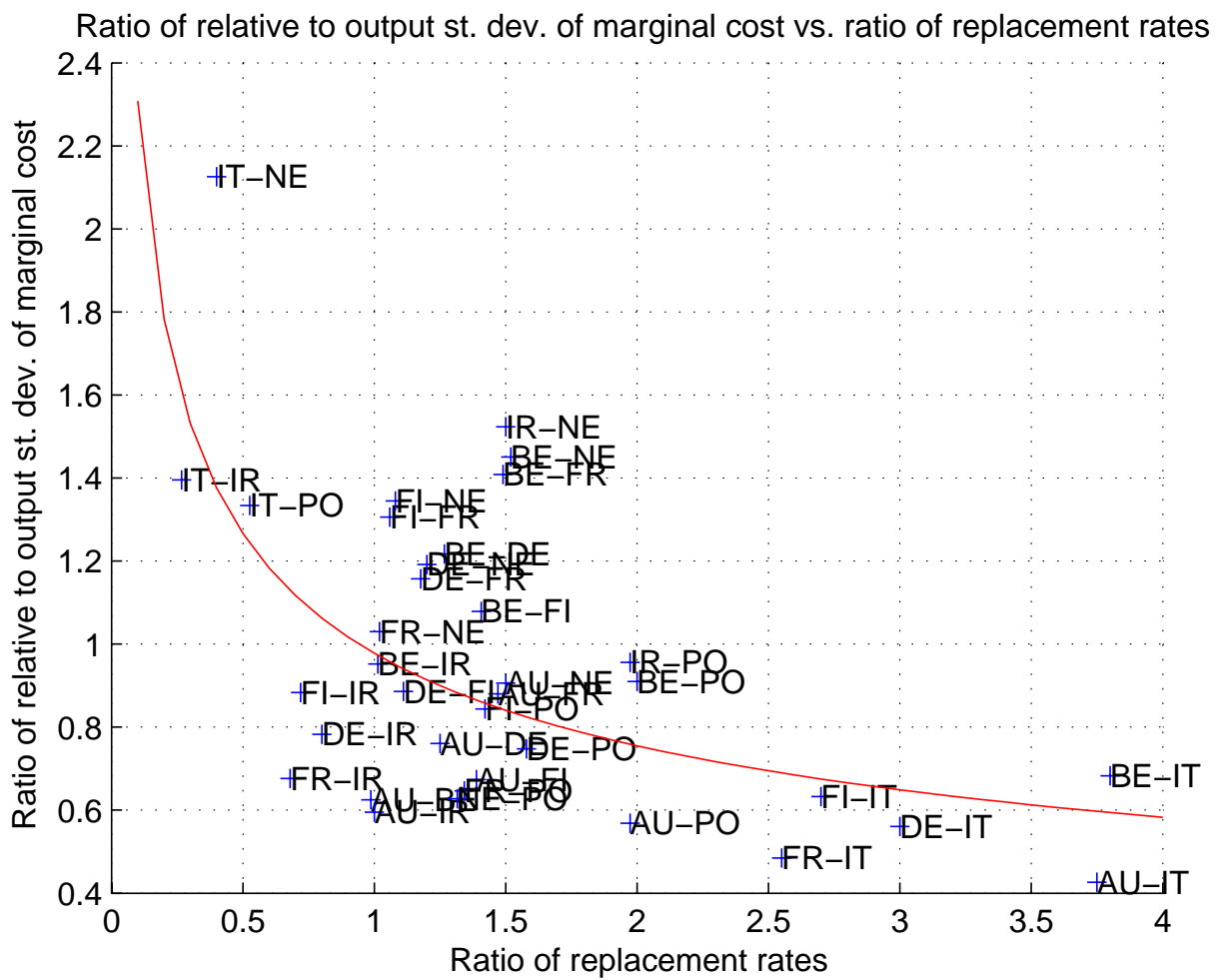


Figure 3:

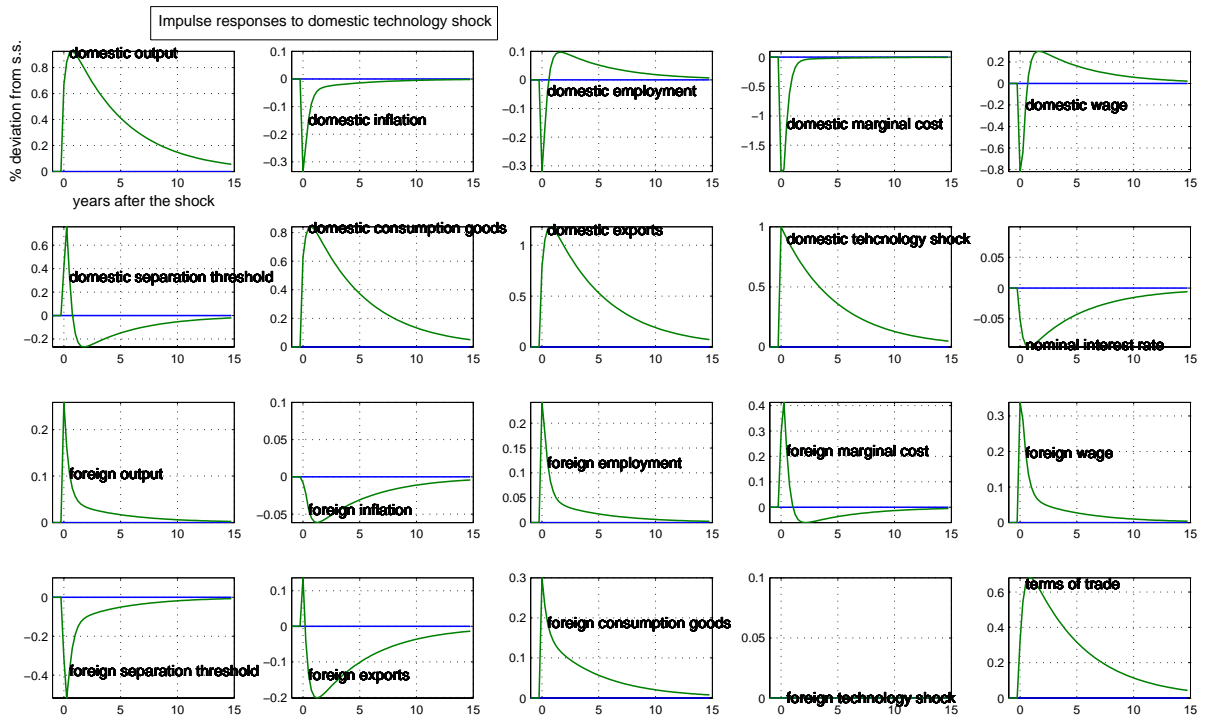


Figure 4:

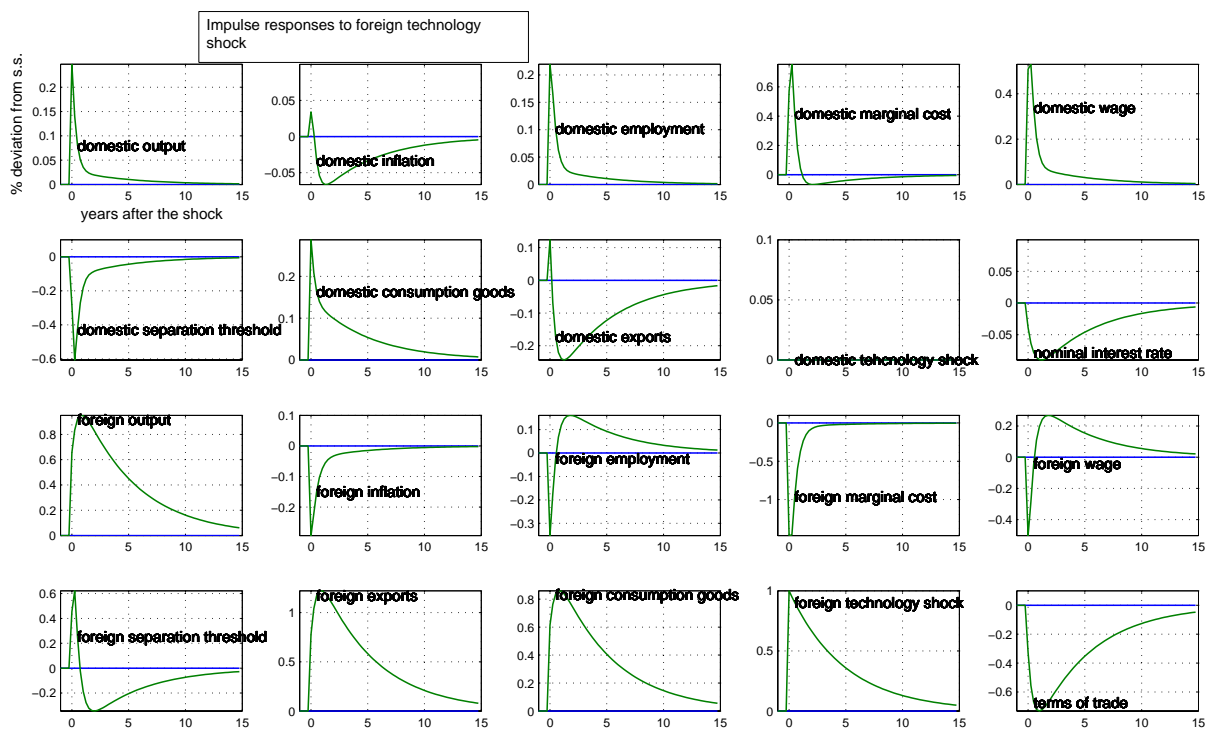


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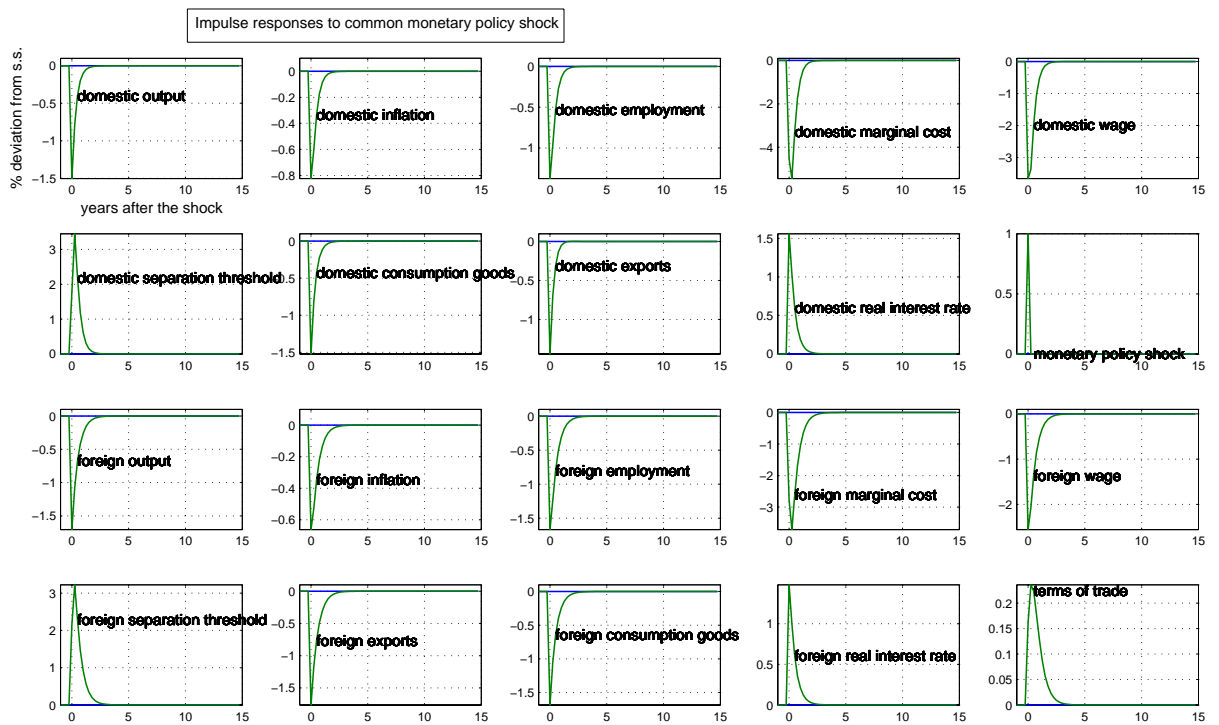


Figure 6:

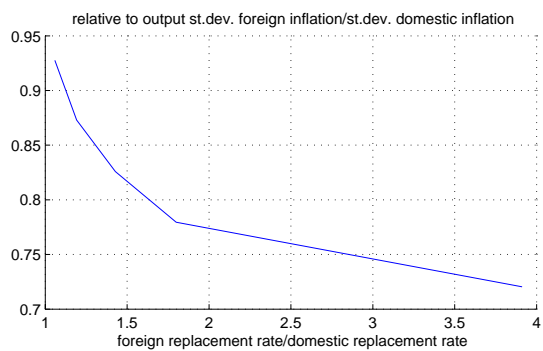
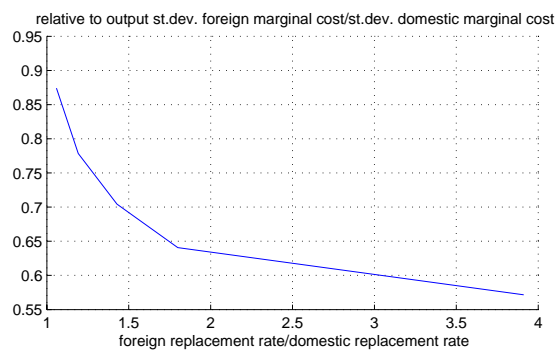
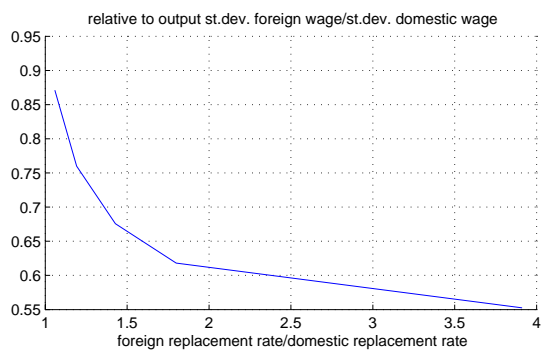


Figure 7:

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