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Short-Term Gain or Pain? A  
DSGE Model-Based  
Analysis of the Short-Term  
Effects of Structural  
Reforms in Labour  
and Product Markets

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**SHORT-TERM GAIN OR PAIN? A DSGE MODEL-BASED ANALYSIS OF THE SHORT-TERM EFFECTS OF STRUCTURAL REFORMS IN LABOUR AND PRODUCT MARKETS**

**ECONOMICS DEPARTMENT WORKING PAPER No. 948**

**by**

**Matteo Cacciatore, Romain Duval and Giuseppe Fiori**

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## ABSTRACT/RESUMÉ

**Short-Term Gain or Pain? A DSGE Model-Based Analysis of the Short-Term Effects of Structural Reforms in Labour and Product Markets**

This paper explores the short-term effects of labour and product market reforms through a dynamic general equilibrium model that features endogenous producer entry, equilibrium unemployment and costly job creation and destruction. Unlike in existing work, the link between labour and product market dynamics and the policy factors driving it are modelled explicitly. The analysis yields three main findings. First, it takes time for reforms to pay off, typically at least a couple of years. This is partly because their benefits materialise through firm entry and increased hiring, both of which are gradual processes, while any reform-driven layoffs are immediate. Second, all reforms appear to stimulate GDP already in the short run, but some of them -- such as job protection reforms -- are found to increase unemployment temporarily. Implementing a broad package of labour and product market reforms enables governments to minimise or even alleviate such transitional costs. Third, reforms are not found to have noticeable deflationary effects, suggesting that the inability of monetary policy to deliver large interest rate cuts in their aftermath -- either because of the zero bound on policy rates or because the country belongs to a large monetary union -- may not be a relevant obstacle to reform implementation. Alternative simple monetary policy rules have little impact on the transitional costs from reforms.

*JEL classification codes:* E24; E32; J64

*Keywords:* Structural reforms; job protection; unemployment benefits; activation policies; product market regulation; firm entry; matching frictions; DSGE

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**Gain ou perte à court terme ? Une analyse à partir d'un modèle DSGE des effets de court terme des réformes sur les marchés du travail et des produits**

Cet article évalue les effets de court terme des réformes des marchés du travail et des produits à l'aide d'un modèle d'équilibre général dynamique incorporant une entrée endogène des firmes, un chômage d'équilibre et des coûts de création et destruction d'emplois. Contrairement aux travaux existants, le lien entre les dynamiques des marchés du travail et des produits et les facteurs politiques qui le gouvernement sont modélisés explicitement. L'analyse fournit trois conclusions principales. Premièrement, il faut du temps pour que les réformes paient, typiquement au moins quelques années. Deuxièmement, il apparaît que toutes les réformes stimulent le PIB dès le court terme, mais que certaines d'entre elles -- telles que les réformes de la protection de l'emploi -- augmentent le chômage temporairement. Mettre en œuvre simultanément un ensemble de réformes des marchés du travail et des produits permet au gouvernement de minimiser voire d'éviter ces coûts transitoires. Troisièmement, les réformes n'apparaissent pas avoir d'effets déflationnistes majeurs, ce qui suggère que l'incapacité de la politique monétaire à mettre en œuvre de fortes baisses de taux d'intérêt dans leur foulée -- soit du fait du plancher zéro sur les taux directeurs soit du fait de l'appartenance à une large zone monétaire -- n'est pas un obstacle pertinent à la mise en œuvre des réformes. Des règles monétaires simples alternatives n'ont qu'un faible impact sur les coûts de transition des réformes.

*Classification JEL :* E24 ; E32 ; J64

*Mots clé :* Réformes structurelles ; protection de l'emploi ; indemnités chômage ; politiques d'activation ; réglementation des marchés de produits ; entrée des firmes ; frictions d'appariement ; DSGE

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## TABLE OF CONTENTS

1. Introduction and main findings .....	5
2. Main features of the model.....	7
3. The short-term effects of labour and product market reforms: baseline simulation results .....	9
3.1. Labour market reforms .....	10
3.2. Product market reforms .....	16
4. Interactions across policies and institutions and reform packages .....	18
5. The role of macroeconomic policy settings.....	21
Bibliography .....	22
Annex 1. The model.....	24

### Tables

1. Simulated steady-state effects of various structural reforms .....	9
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### Figures

1. Dynamic impact of a relaxation of job protection .....	10
2. Dynamic impact of a reduction in the unemployment benefit replacement ratio .....	12
3. Dynamic impact of a strengthening in activation policy .....	13
4. Dynamic impact of a decline in barriers to entry.....	15
5. Dynamic impact of a decline in barriers to entry in a “flexible” vs. “rigid” labour market .....	17
6. Dynamic impact of a reform package combining a decline in entry barriers, a reduction in the unemployment benefit replacement rate and a relaxation of job protection.....	18



## SHORT-TERM PAIN OR GAIN? A DSGE MODEL-BASED ANALYSIS OF THE SHORT-TERM EFFECTS OF STRUCTURAL REFORMS IN LABOUR AND PRODUCT MARKETS

by

Matteo Cacciatore, Romain Duval and Giuseppe Fiori<sup>1</sup>

### 1. Introduction and main findings

1. A wide body of economic theory points to long-term gains from structural reforms in labour and product markets. However, the typical analysis provides some insights into the long-term impact of a change in policy settings from a static comparative perspective. Much less explored has been the dynamics of the economy towards its new (post-reform) steady state, leaving largely unanswered the question of whether labour and product reforms may imply trading long-term gains for short-term pain. Yet this issue bears major implications for the political feasibility of reforms, as the transitional losses they may entail have often been put forward as an obstacle to their implementation, over and above political economy factors related *e.g.* to the uneven distribution of their effects across households and firms.

2. The short-term impact of reforms also matters for their desirability in a context where macroeconomic policies could not be used to “crowd in” their effects, in which case reforms may create economic slack. This issue is especially relevant at the current juncture, with large remaining spare production capacity in many OECD countries and little or no room for further monetary or fiscal policy stimulus. A debate has emerged recently in the literature as to whether a binding zero lower bound on interest rates could derail or on the contrary magnify the short-term impact of supply-side policies. On the one hand, in a zero lower bound situation, reform-driven shocks to *current* supply may lower prices, raise the real interest rate and thereby ultimately depress rather than stimulate the economy (a situation labelled the “paradox of toil”, see Eggertsson, 2010). On the other hand, by increasing *future* income levels, supply-side policies may generate a positive wealth effect on consumption and thereby stimulate current aggregate demand and output. When the ZLB is binding, this wealth effect should typically be larger as it is not dampened by the increase in interest rates that would occur in “normal times” (Fernández-Villaverde *et al.*, 2011). Ultimately, the short-term impact of reforms, not only in a ZLB situation but also more broadly, is likely to depend *inter alia* on their impact on current vis-à-vis future supply and the implications for output gaps, prices and real interest rates.

3. A number of recent papers have used large-scale Dynamic Stochastic General Equilibrium (DSGE) models to assess both the short- and long-run macroeconomic effects of reforms (Everaert and Schule, 2008, using the IMF’s Global Economy Model; Gomes *et al.*, 2010, using the ECB’s EAGLE model; Hobza and Mourre, 2010, or Arpaia *et al.*, 2007, using the European Commission’s QUEST model). Reforms appear to pay off only gradually – it typically takes several years for half of the long-term effect to materialise, depending on the model and the reform considered – and can even entail short-run economic losses due *e.g.* to adverse demand or terms-of-trade effects. However, modelling exercises differ

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1. The authors are respectively researcher at HEC Montréal and CIRPÉE, Head of the Structural Surveillance Division at the OECD Economics Department and researcher at the University of São Paulo. They would like to thank Orsetta Causa, Jorgen Elmeskov and Jean-Luc Schneider for helpful comments, and Celia Rutkoski for editorial support. The authors retain full responsibility for errors and omissions.

with respect to which of labour or product market reforms are more likely to lead to short-term losses. Labour market reforms as modelled generally weaken the bargaining position of workers and thereby initially reduce real wages. This stimulates labour demand but at the same time can weaken consumer demand, especially if -- as in a single country within a monetary union -- monetary policy cannot react. Product market reforms raise real wages by reducing price mark-ups, and quickly stimulate output and employment in general -- although some of the associated income gain may be dampened by a decline in terms of trade associated with increased supply of domestic goods. However, if carried out in a monetary union or if implemented gradually -- inducing households to expect lower prices in the following years --, they may raise the domestic real interest rate and thereby reduce short-term consumption and output.

4. This paper builds and simulates a new DSGE model to explore the dynamic effects of various labour and product market reforms (for some new OECD empirical analysis of such reforms based on the main policy changes implemented across the OECD over the past three decades, see Bouis *et al.*, 2012). The recent literature mentioned above has two main weaknesses in this context, which this paper seeks to address: *i)* labour and product market reforms are modelled in a very stylised way, as reductions in price and wage mark-ups in product and labour markets, respectively; and *ii)* the models used so far in the literature are not ideally suited to capture the short-term effects of structural reforms as both firm and labour market (hiring-firing) dynamics are absent. These two drawbacks are addressed here through explicit modelling of labour and product market dynamics and the policy factors driving them.

5. The main findings from the paper are the following:

- In the long run, product market and – to a lesser extent – labour market reforms have positive effects on GDP and consumption, and also reduce unemployment.<sup>2</sup>
- However, it takes time for reforms to pay off in terms of aggregate consumption and employment, typically at least a couple of years, consistent with findings of previous studies in this area. This is partly because their benefits materialise through firm entry or increased hiring, both of which are gradual processes, while any reform-driven layoffs are immediate. The gains from product market reforms are reaped more slowly than those from labour market reforms, although they are also typically larger for plausible changes in policy settings.
- Furthermore, some reforms can entail transitional costs. All reforms are found to stimulate GDP already in the short run, but some of them temporarily – typically for one to two years in the simulations – increase unemployment. In particular, job protection reform initially increases layoffs more than it creates jobs, and product market reform can also temporarily lead to net job destruction as incumbents downsize and the reallocation of laid-off workers takes time. By contrast, in the framework of this model a cut in unemployment benefits or some strengthening of activation policies quickly reduce unemployment as they stimulate hiring without affecting firing.
- One way to minimise or even alleviate the transitional costs or the negative real wage effects of certain reforms is to implement a broad package of labour and product market reforms. In particular, reducing entry barriers in product markets in parallel to labour market reforms reverses the wages losses that would result from the latter alone. This result is consistent with the view that deregulating product markets first can both mitigate the negative short-term impact, and

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2. These findings are qualitatively in line with existing DSGE model-based and empirical literature, with the partial exception of job protection reform whose unemployment impact has been shown to be theoretically and empirically ambiguous. With the model, the calibration and the simulation -- a reduction not only of firing costs but also of the bargaining power of individual workers -- considered here (see below), job protection reform appears to reduce unemployment.

facilitate the subsequent implementation of labour market reforms (Blanchard and Giavazzi, 2003).

- The short-term effects of structural reform in one area depend in part on existing policy and institutional settings in other areas. In particular, the short-term dynamics of the economy in the aftermath of product market reform is found to be smoother if the labour market is more “flexible”. However, the long-term gains from product market reform are then smaller, *i.e.* there is long-run substitutability (rather than complementarity) between product and labour market reforms.
- Structural reform are not found to have noticeable deflationary effects, suggesting that the inability of monetary policy to deliver large interest rate cuts in their aftermath – either because of the zero bound on policy rates or because the country belongs to a large monetary union – may not be an obstacle to reform implementation. Alternative simple, empirically relevant monetary policy rules do not appear to make much of a difference in mitigating the transitional costs from labour market reforms. This is because dynamic adjustment to reform is primarily driven by firms and consumers’ expectations of the long-run effects of reforms, which do not depend on the conduct of monetary policy. Even so, a central bank that responds aggressively to inflation is found to slightly reduce the transitional welfare losses incurred in the aftermath of labour and -- especially -- product market reforms. Welfare losses are also marginally smaller if the reforming country has a floating exchange rate than if it belongs to a monetary union.

6. Although these findings are qualitatively robust to alternative model parameter values, they should be interpreted with care due to a number of caveats. The model shares the usual features of DSGE models including forward-looking agents and rational expectations, and rules out any effect of reforms on income uncertainty and precautionary savings. Both caveats go in the direction of over-estimating the potential short-term gains from real-world reforms, *ceteris paribus*. Another, more specific caveat is that even though economy-wide product market reform is adequately modelled as a decline in firm entry costs, one implication from the theoretical framework is that price mark-ups are unaffected in the long run and the gains from reform stem essentially from an increased number of differentiated product varieties. In the real world, product market liberalisation in specific sectors might trigger quick entry and fast declines in the prices of fairly homogenous goods, such as *e.g.* in retail trade or in certain professional services (*e.g.* taxi drivers).

## 2. Main features of the model

7. The model is an extension of Cacciatore and Fiori (2010), who analyse the dynamic impact of product and labour market reforms in a DSGE setting featuring endogenous producer entry, labour market search and matching frictions. The original model is extended along a number of dimensions, the two main ones being: *i)* the introduction of nominal rigidities and some analysis of alternative monetary policy rules; *ii)* the extension to an open economy framework, focusing on a small open economy operating under either a flexible or fixed (relative to the rest of the world) exchange rate regime. Full details on the structure, equations and calibration of the model are provided in Annex 1.

8. The main building blocks of the small open economy model are:

- Households consist of a continuum of members and maximise the present value of their utility, based on an instantaneous utility function that implies a constant inter-temporal elasticity of substitution of aggregate consumption. Aggregate consumption in turn consists of differentiated final goods, both domestic and foreign. There is habit formation in consumption behaviour to capture the real-world persistence of consumption. Due to labour and product market



imperfections (see below), some members of the household will be unemployed in equilibrium while others will be producing. Unemployed workers receive unemployment benefits from the government, which finances them through (distortive) labour income taxes and (at the margin) a lump sum tax.

- Household members are employed by perfectly competitive firms to produce a non-tradable intermediate input that is sold to monopolistically-competitive final good producers. The latter use the intermediate input to produce differentiated varieties that are both consumed domestically and exported, under the assumption of producer currency pricing. The number of final good producers is endogenously determined and varies in response to aggregate shocks. In particular, it depends on entry barriers, which are modelled through a sunk entry cost that firms have to pay upon entering the market. This cost is akin to (sunk) investment upon entry. While firm entry is endogenous, firm exit is exogenous and occurs when a firm is hit by a “death shock”. This entry-exit process creates firm dynamics in the final goods market. Finally, final good producers face (quadratic) price adjustment costs, resulting in sticky prices and -- insofar as reforms affect marginal costs -- varying mark-ups.
- Labour markets are characterised by search frictions with endogenous job creation and destruction as in Mortensen and Pissarides (1994), as well as by the presence of firing costs. To hire a new worker, firms have to post a vacancy incurring a fixed cost. The probability of finding a worker depends on a constant return to scale matching technology which converts aggregate unemployed workers and aggregate vacancies into aggregate matches. Firms and workers can separate for exogenous and endogenous motives. One endogenous motive is that jobs are subject to idiosyncratic productivity shocks in each period. When a firm finds a match to be no longer profitable, it can dismiss the worker but incurs a firing cost. Unlike entry costs which constitute investment, firing costs are modelled as a pure “loss”, and as such they should be seen as capturing the administrative costs of lay-off procedures but not the cash transfer component (severance payments) to the laid-off worker.<sup>3</sup> The hiring-firing process creates dynamics (turnover) in the labour market, and (un)employment varies depending on the endogenous variations in job creation and job destruction rates.
- Wages are determined through an individual Nash bargaining process, where the surplus of the match is split according to a standard sharing rule featuring an exogenous bargaining weight. This bargaining weight captures the bargaining power of individual workers. Real wage rigidity is then introduced by assuming gradual adjustment of real wages from their initial (pre-reform) levels to their Nash-bargaining levels (which differ from the initial real wage levels insofar as the reform considered changes the Nash-bargaining levels).
- International financial markets are incomplete. The representative household can invest in three types of asset: shares in a mutual fund of domestic firms, domestic and foreign bonds. This results in current account dynamics.
- The model is closed either by assuming an (exogenous) floating exchange rate regime – under which the nominal exchange rate adjusts to ensure external balance of payments equilibrium -- and a Taylor rule for monetary policy, or by assuming a fixed exchange rate regime -- in which case the domestic nominal interest rate remains fixed. Three alternative Taylor rules are assumed, namely: *i*) a benchmark rule under which the central bank reacts to both inflation and the

---

3. One limitation of this approach is that firing costs do not cover all aspects of job protection. Rules governing temporary contracts, in particular hiring regulations, cannot be captured.

(welfare-relevant) output gap<sup>4</sup> with some interest rate persistence; *ii*) a rule under which the central bank reacts more aggressively to inflation than in the benchmark case; *iii*) a rule under which the central bank puts more weight on the output gap than in the benchmark case. There is no fiscal policy in the model, which features only a passive government that finances unemployment benefits by (distortive) labour income taxes. Therefore possible feedback effects *via* lower taxes are ignored, which tends to under-estimate the GDP gains from a reduction in (the level and/or the duration of) unemployment benefits -- and from revenue-raising reforms more broadly --, *ceteris paribus*.

- The model is calibrated by taking some parameter values from existing evidence and others so as to match specific moments of the data. While this is standard procedure, it should be acknowledged that, as would be expected, radically different parameter values could alter some of the results below, especially when the latter reflect the net of offsetting effects -- *e.g.* the unemployment impact of reforms, which is the outcome of sometimes offsetting job creation and job destruction effects.

### 3. The short-term effects of labour and product market reforms: baseline simulation results

9. The model is used to simulate the dynamic macroeconomic impacts and the welfare effects of a range of reforms. In all cases, a permanent and unexpected reform is assumed, and the model simulates the dynamic path of the economy away the pre-reform steady state towards the post-reform one. In other words, the stochastic features of the model are not exploited in this exercise, meaning that it is essentially used as a DGE (Dynamic General Equilibrium) rather than as a DSGE model.

10. Four types of permanent, unanticipated reforms are considered: *i*) a relaxation of job protection, modelled as a simultaneous reduction in firing costs and the bargaining power of individual workers; *ii*) a cut in the unemployment benefit replacement rate; *iii*) a strengthening of ALMPs, modelled in a more tentative and stylised way as a simultaneous increase in the efficiency of the job matching process and a reduction in the utility of being unemployed;<sup>5</sup> *iv*) a reduction in barriers to entry for new firms. For illustrative purposes, the size of the unemployment benefit, job protection and product market reforms is pinned down by assuming that all relevant policy parameters are lowered from average levels prevailing across euro area countries (the values of these parameters in the benchmark calibration) to average levels prevailing across a group of (non-euro area) OECD countries where such parameters are estimated to be

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4. The welfare-relevant output gap is the gap between actual and natural output, where natural output is the output level that would prevail under flexible wages and prices. Natural output can, and typically does differ from steady-state output.

5. This modelling choice can be justified on the grounds that stronger activation policies can deliver positive labour market outcomes through at least two channels: *i*) improving the efficiency of matching between workers and jobs; *ii*) increasing the motivation and ability of the unemployed to look effectively for a job. Regarding the latter channel, so-called ‘threat effects’ from institutional mechanisms such as compulsory participation in active labour market programmes or referral to ALMPs under threat of benefit sanctions have been identified in the literature (for micro-econometric evidence that re-employment probabilities significantly increase around the formal deadline for programme entry, see Geerdsen and Holm, 2007, for Denmark and Black *et al.*, 2003, for the United States; for a recent meta-analysis of cross-country evidence, see Kluge, 2010). Indeed such activation mechanisms are not unusual in OECD countries, in particular the Denmark and Sweden, but also Australia and the United Kingdom (for a review, see OECD, 2007). The basic idea is that unemployed individuals may find that compulsory participation lowers their well-being, *e.g.* if participation in the programme may entail scarring effects or is seen as a tax on leisure.

lower.<sup>6</sup> For the more stylised ALMP reform, a more arbitrary 25% change in the initial level of policy parameters is considered.<sup>7</sup>

11. The dynamic effect of these reforms is simulated under the three alternative monetary policy rules, namely a benchmark rule and two alternative rules responding more aggressively to inflation and the output gap, respectively. Finally, the model is used to assess whether the dynamic impact of a given (labour or product market) reform varies depending on policy settings in other areas. Specifically, the dynamic impact of job protection and unemployment benefit reforms is simulated under different levels of barriers to entry, and *vice versa*. All dynamic simulation results are presented in Figures 1 to 6, while the steady-state effects are shown in Table 1. Sensitivity analysis (unreported) was carried out which shows that results below remain qualitatively unchanged under alternative values of key model parameters including the elasticity of substitution across domestic goods, the elasticity of substitution between domestic and foreign goods, workers' bargaining power or the variance of idiosyncratic productivity shocks.

### 3.1. Labour market reforms

#### *Employment protection legislation reform*

12. A relaxation of job protection reduces real wages by weakening individual workers' bargaining power, and lowers the expected cost for firms of terminating a job match (Figure 1). This boosts job creation. In the short run, however, the reduction in firing costs also reduces the profitability of less-productive job matches, inducing firms to lay-off less productive workers. While the destruction of existing jobs is immediate, job creation is only gradual because it takes time to match firms and (both previously and newly) unemployed workers. Therefore the unemployment rate increases in the aftermath of the reform, before declining gradually as new jobs are created. The initial decline in employment and real wages reduces aggregate demand, *ceteris paribus*. However, households also anticipate the future increase in income, which leads them to reduce current saving. As a result of these two offsetting forces, consumption remains roughly unchanged, before increasing gradually as employment and income rise. GDP falls slightly before rising above its pre-reform level already after a couple of quarters. The relative price of home goods (*i.e.* the terms of trade) falls slightly due to a small decline in marginal costs, which in turn reflects lower wages and firing costs.<sup>8</sup> This terms-of-trade fall generates some negative wealth effect due to the smaller revenue per exported good, but also some expenditure switching towards home goods as these become cheaper than foreign ones. The dynamics of inflation, the current account and -- regardless of the rule -- the interest rate is benign. Despite the small decline in marginal costs associated with lower wages, there is a small initial pick-up in CPI inflation in equilibrium, reflecting mainly higher prices of imported goods. Over time, the benefits from job protection reform strengthen. As jobs are created, unemployment declines, gets back to its pre-reform level -- after less than a year in the simulation -- and ultimately falls further, while economic efficiency improves. This leads to higher GDP gains, which

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6. For each reform, the initial value of the policy parameter is aligned on its average value across a basket of flexible countries, which may differ depending on the regulation parameter considered (see Annex 1 for details).

7. The parameters involved are the efficiency parameter in the matching function and the value of household production of the unemployed, which are increased and reduced, respectively. While arbitrary, the assumed 25% change in these parameters does not drive the main results from the ALMP reform simulations as these are qualitatively robust to alternative choices.

8. The overall decline in marginal costs is small, however, because the costs of recruiting new workers increase due to the congestion externality in the labour market -- *i.e.* the fact that firms posting a vacancy do not take into account its impact on overall labour market tightness, which in turn makes it harder for other firms to fill their vacancies.

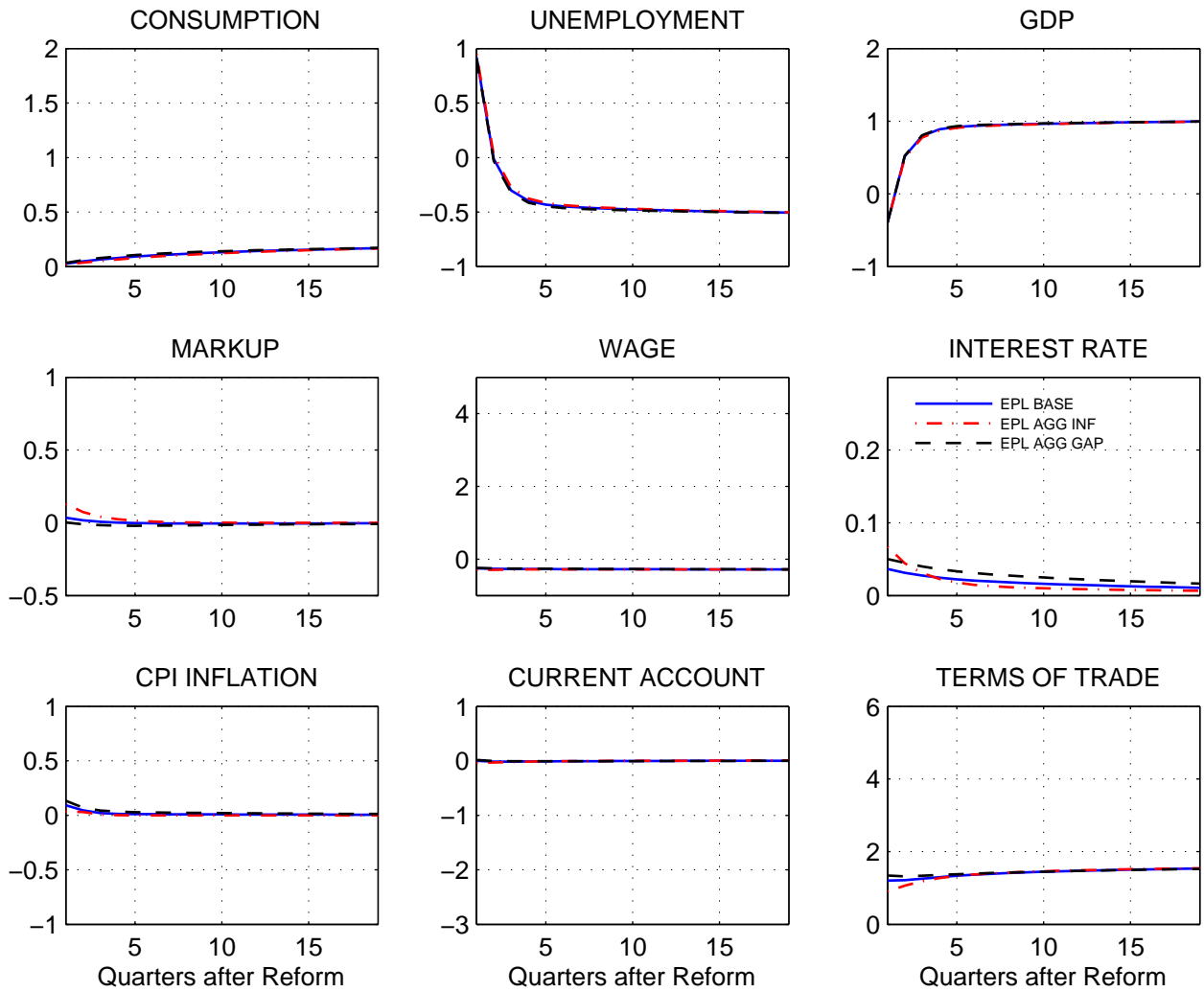
materialise in full roughly after two years in the simulation. Real wages remain durably below their pre-reform levels, however (Table 1).

**Table 1. Simulated steady-state effects of various structural reforms  
(under the benchmark monetary policy rule)**

	Consumption (in %)	Unemployment (in percentage points)	Output (in %)	Real wage (in %)
Decline in barriers to entry	6.9	-0.8	7.1	6.2
Relaxation of job protection	0.3	-0.5	1	-0.3
Reduction in unemployment benefit replacement rate	2.5	-4.0	2.9	-1.1
Strengthening of activation policy	1.9	-3.7	3.4	-0.5
Reform package combining a decline in entry barriers, a reduction in the unemployment benefit replacement rate and a relaxation job protection	9.5	-5.2	10.7	4.6
Decline in barriers to entry (in "flexible" labour markets)	6.4	-0.2	6.6	6.4
Relaxation of job protection (in "flexible" product markets)	0.2	-0.5	1	-0.3
Reduction in unemployment benefit replacement rate (in "flexible" product markets)	2.1	-3.4	2.4	-1

Note: For details on the "size" of the reforms considered, see main text and Annex 1.

**Figure 1. Dynamic impact of a relaxation of job protection  
(under three alternative monetary policy rules)**



*Unemployment benefit reform*

13. The dynamic profile of a cut in the unemployment benefit replacement rate is qualitatively comparable to that of a relaxation of job protection, but it is more favourable in the short term (Figure 2). This is essentially because lower unemployment benefits boost job creation but do not increase job destruction, unlike lower firing costs. This results in an immediate decline in unemployment -- which also turns out to be ultimately larger for a plausible calibration of the reform shocks.<sup>9</sup> Consumption increases as a result of lower unemployment and higher income both now and in the future. GDP also rises immediately. Despite the decline in marginal costs associated with lower wages, there is a small pick-up in CPI inflation in equilibrium, reflecting higher aggregate demand and higher prices of imported goods. The current account strengthens slightly as the decline in the relative price of home goods induces expenditure switching towards them and away from foreign goods. Again, the simulated interest rate response to the unemployment benefit cut is benign in all cases. Over time, the gains from unemployment benefit reform increase. Unemployment continues to decline and GDP rises further as jobs are created, with the full effects being felt about two years after the reform in the simulation. As with job protection reform, real wages remain durably below their pre-reform levels.<sup>10</sup>

*Strengthening of activation policies*

14. The dynamic impact of ALMPs reforms is qualitatively comparable to that of a benefit replacement rate cut. Strengthening activation policies through enhanced matching efficiency and stronger enforcement of conditionality *vis-à-vis* jobseekers boosts job creation in the short run without affecting job destruction. As a result, there is an immediate and large decline in unemployment, which in the simulation continues until about two years after the reform (Figure 3). Consumption and GDP increase as a result of lower unemployment and higher income both now and in the future. Wages decline and remain durably below their pre-reform levels, putting downward pressure on the price of home goods. Nevertheless, higher aggregate demand and higher prices of imported goods push inflation somewhat higher, and the current account strengthens slightly as a result of the decline in the relative price of home goods. Again, the simulated interest rate response is benign in all cases.<sup>11</sup>

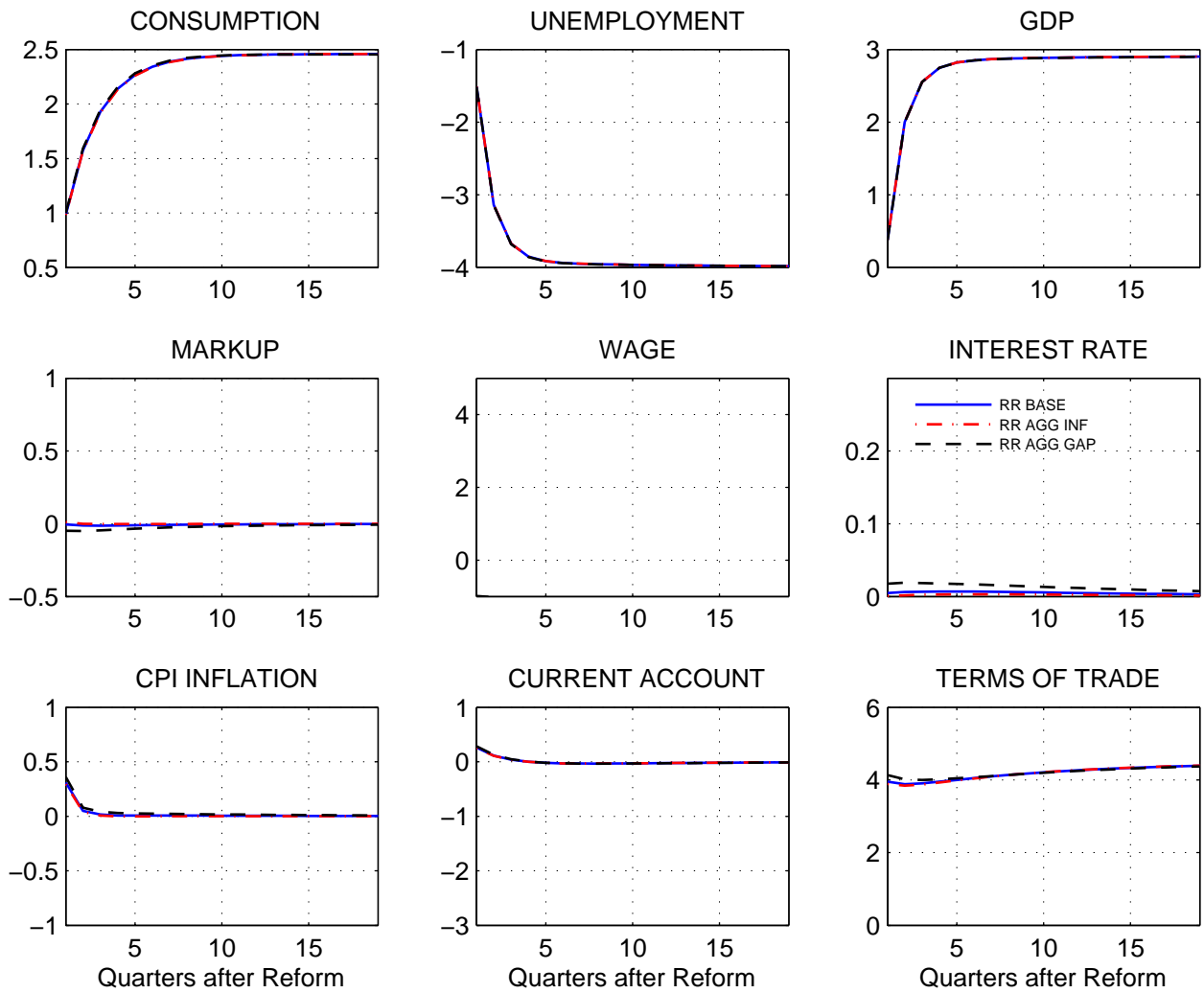
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9. The simulated impacts of different reforms are not readily comparable since they partly reflect changes in the underlying policy parameters, which in turn cannot be compared. Nevertheless, sensitivity analysis not reported here, including simulations of 20% and one-standard-deviation changes in each of the job protection, unemployment benefit and entry barrier parameters, also suggests that unemployment benefit reform has a larger long-term impact on GDP than job protection reform, with product market reform yielding the largest gain.

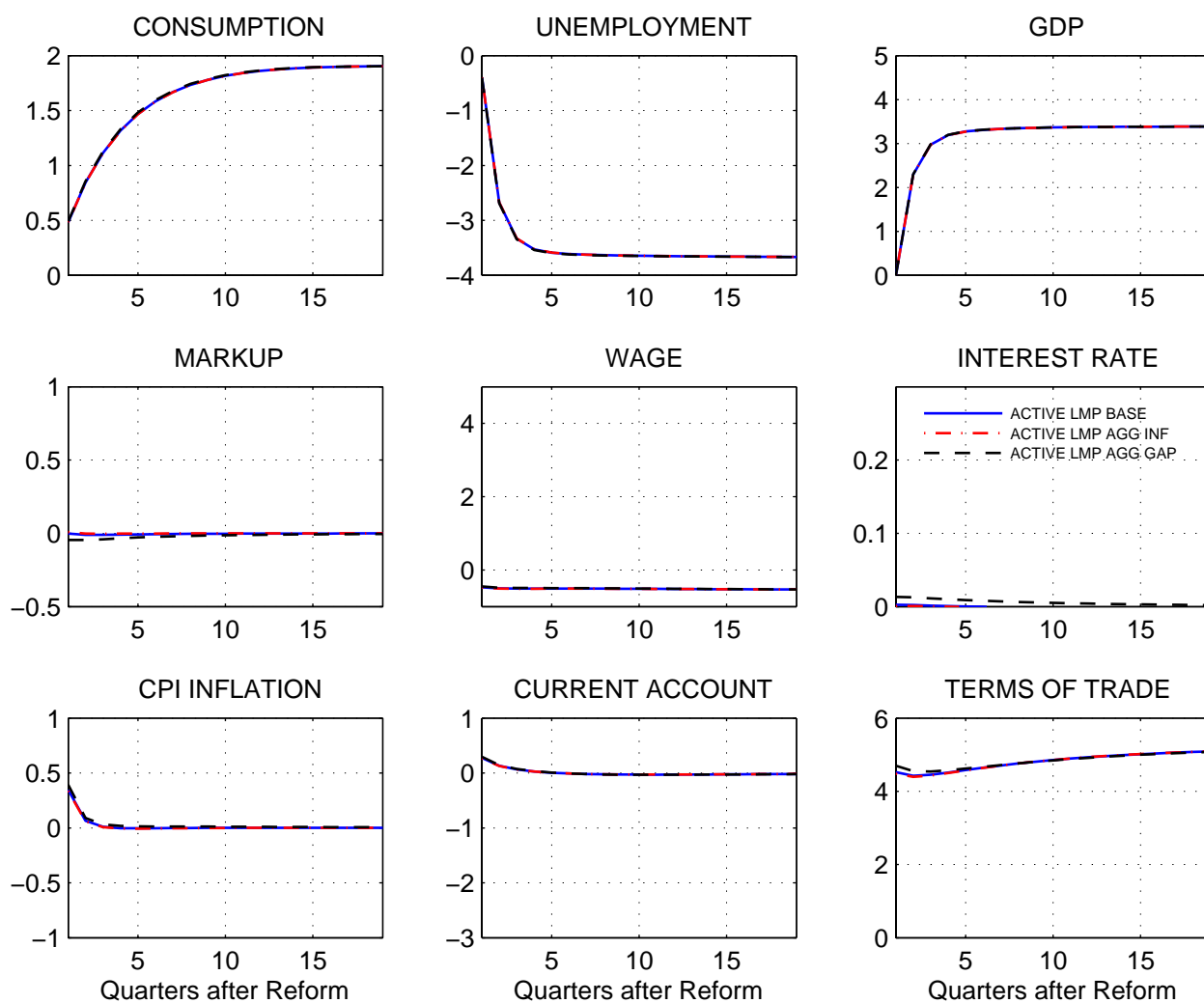
10. A word of caution is warranted in drawing strong conclusions regarding the effects of unemployment benefit reforms, which inevitably need to rely on specific but nevertheless limitative modelling choices. In particular, it is assumed here that workers' productivity is unaffected by the generosity of the system. Assuming instead that more generous unemployment benefits encourage the development of high-risk but high-productivity activities, as in Acemoglu and Shimer (2000), could deliver different results.

11. It is worth noting that improvements in matching efficiency *alone* could theoretically *increase* rather than reduce unemployment, and they do so in practice in the model considered here. This is because enhanced matching efficiency does not only facilitate new hires, but also encourages firms to lay-off less productive workers by reducing the expected cost of posting vacancies to replace them. This can result in greater labour market turnover in equilibrium.

**Figure 2. Dynamic impact of a reduction in the unemployment benefit replacement rate (under three alternative monetary policy rules)**



**Figure 3. Dynamic impact of a strengthening in activation policy  
(under three alternative monetary policy rules)**





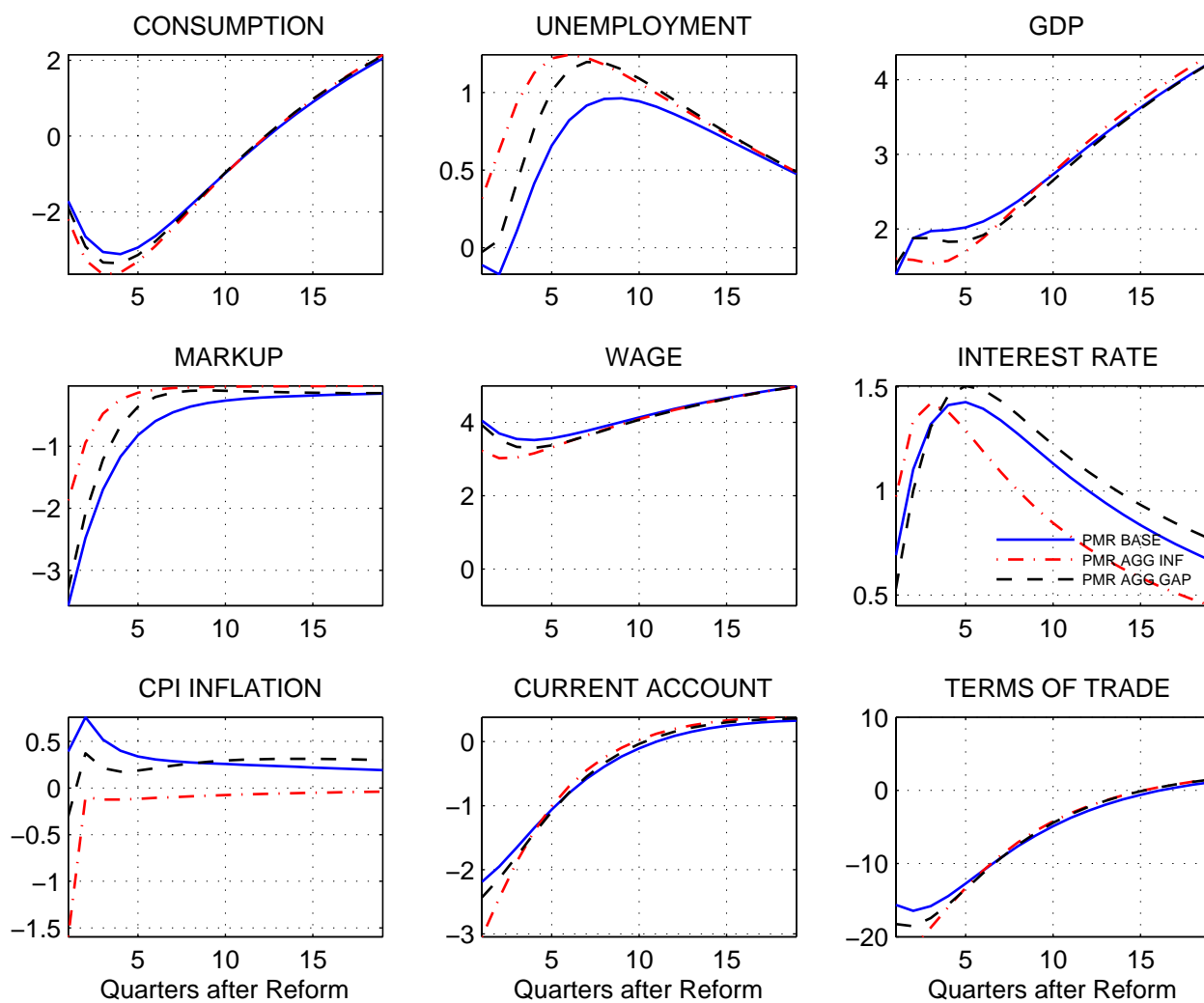
### 3.2. Product market reforms

15. A reduction in barriers to entry immediately increases GDP by stimulating investment by new firms (Figure 4). Even so, and perhaps surprisingly, consumption is found to decline in the short term, because profitable investment opportunities in new firms induce households to save more. In the model, this effect more than offsets the positive impact of higher expected future income on current consumption. Nevertheless, consumption falls less than it would in a closed economy as households borrow from abroad, resulting in a sizeable weakening of the current account. Firm entry boosts job creation, but the fall in consumption also induces incumbents to downsize. As a result, job destruction dominates job creation, and unemployment rises for a while (for almost two years in the baseline simulation). Product market reform increases the marginal production costs of incumbents for two reasons: *i*) only the more productive workers keep their jobs as downsizing firms immediately layoff less productive workers, and because remaining workers are better paid -- even when accounting for their higher productivity (see the determination of wages through Nash bargaining in Annex 1) --, marginal labour costs rise; *ii*) current and expected firing costs -- which are a component of the marginal production cost -- increase because of higher wages and the higher probability of laying-off existing workers. Higher production costs push the price of domestic goods higher -- albeit less than proportionately due to price stickiness, resulting in temporarily lower mark-ups.<sup>12</sup> The relative price of home goods (*i.e.* the terms of trade) rises. The pressure on domestic goods prices induces the central bank to raise policy rates, so that CPI inflation changes only modestly in equilibrium -- with some variation across different monetary policy rules, however, as discussed below. Higher domestic goods prices trigger some substitution away from home towards foreign goods, further weakening the current account -- as the substitution effect dominates the terms-of-trade effect. Over time, as incumbent firms stop laying-off workers and the unemployed find jobs in new firms, unemployment declines and eventually falls below its pre-reform level, but this process is slow (see Table 1). Along this process, wages, consumption and GDP increase. It takes a lot more time to reach the steady state after product market reforms than after labour market reforms, however, although the long-term gains from the former are also typically larger for plausible changes in policy settings.

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12. Increased input costs are not uncommon in the handful of DSGE model-based simulations of the dynamic effects of product market reforms (see *e.g.* De Bandt and Vigna, 2008, or Everaert and Schule, 2008 for reforms in the tradable goods sector). In the model used here, and unlike in these papers, the inflationary impact of higher input costs is not dominated by the deflationary effect of lower mark-ups. This is partly because product market reforms are modelled as a decline in entry costs rather than as a decline in mark-ups -- indeed while mark-ups may, and indeed do vary in the aftermath of reforms, they remain unchanged in the steady state. At the same time, this modelling choice has better microeconomic foundations than a decline in mark-ups, which in earlier papers is introduced in an *ad hoc* manner by increasing the elasticity of substitution across goods even though the latter is supposed to be a “deep” model parameter. Furthermore, alternative model specifications (not reported here) with translog preferences and endogenous mark-ups that decline with the number of firms did not alter this finding, *i.e.* the price of domestic goods was still found to increase in the wake of a decline in entry barriers.

Figure 4. Dynamic impact of a decline in barriers to entry  
(under three alternative monetary policy rules)



#### 4. Interactions across policies and institutions and reform packages<sup>13</sup>

16. The short-term effects of structural reform in one area depend in part on existing policy and institutional settings in other areas. Most importantly, the dynamics of the economy in the aftermath of product market reform is found to be smoother if the labour market is “flexible” – as measured here by less stringent job protection and lower unemployment benefits (Figure 5). In particular, when entry barriers are lowered, new job vacancies are filled more quickly and laid-off workers find new jobs more rapidly in a “flexible” labour market. However, the long-run gains from product market reform are *smaller* if labour markets are flexible (Table 1). This is because employment is higher to start with, so that reducing barriers to entry leads to tighter -- *i.e.* to higher matching frictions in -- labour markets, lower profitability of firm entry and, ultimately, a smaller number of new firms. Likewise, the long-run gains from job protection, unemployment benefit and activation reforms are smaller if product markets are more “flexible” (Table 1) -- although the stringency of product market regulation does not affect much the short-term effects of these labour market reforms, because the latter do not have much impact on firm dynamics (results not reported). These results imply that there is *long-run* substitutability (rather than complementarity) between labour and product market reforms, *i.e.* a combination of both yields smaller gains than the sum of the effects of each of them undertaken in isolation.<sup>14</sup>

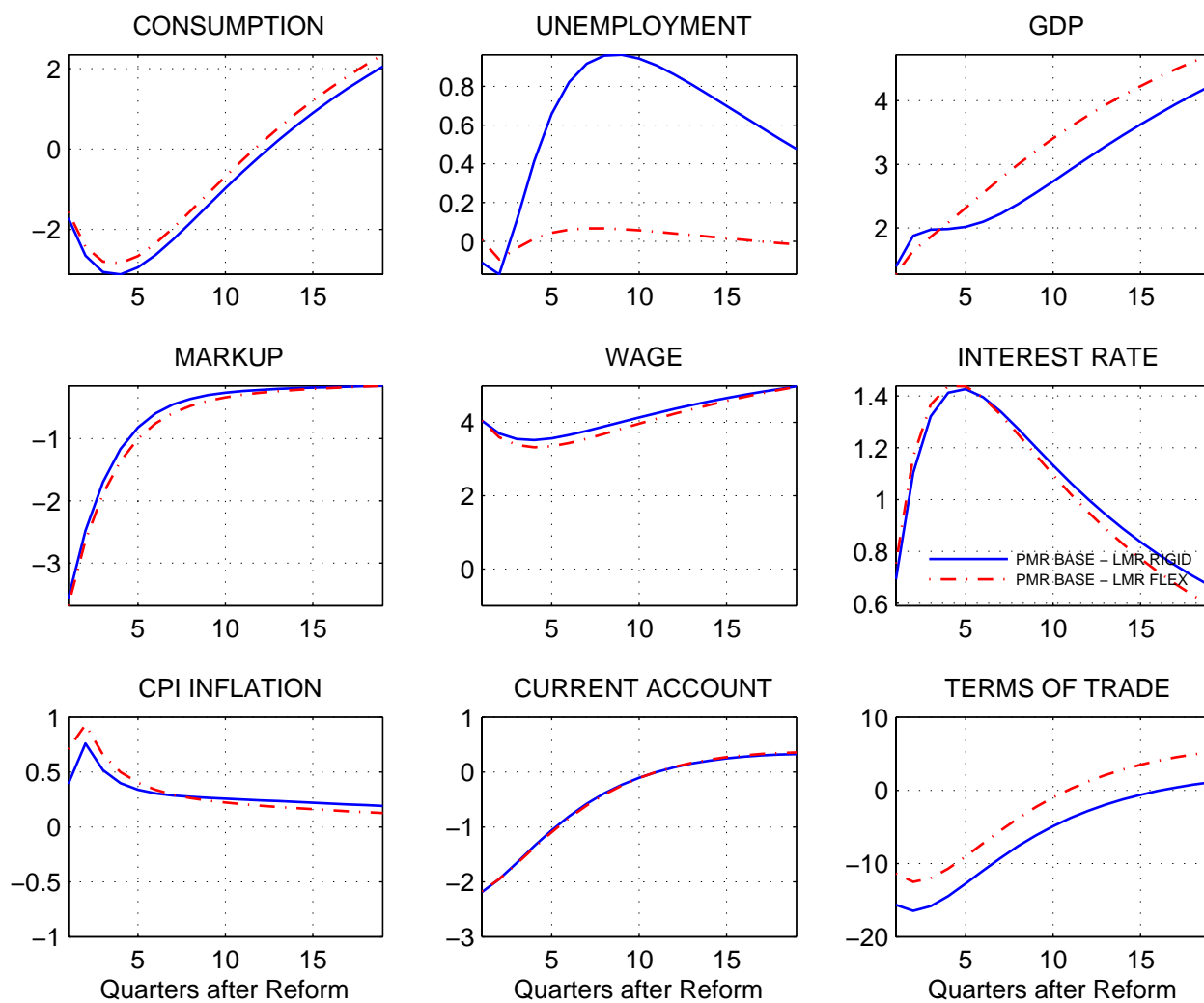
17. Although the substitutability between product and labour market reforms mitigates somewhat the long-run gains from joint reforms in both markets, a broad reform package would be highly beneficial. This is because it does not only deliver larger long-term gains than individual reforms, but also smoothes short-term dynamics and speeds up the transition to the new steady state (Table 1 and Figure 6). A combination of product market, job protection and unemployment benefit reforms is found to boost GDP, employment and wages immediately, in contrast with the effects of some of these reforms taken in isolation. In particular, reducing entry barriers in product markets in parallel to labour market reforms reverses the wages losses that would result from the latter alone. Likewise, unemployment benefit reform reverses the short-term rise in unemployment that would otherwise be associated with job protection and product market reforms. More broadly, compared with individual reforms, a broad package yields a larger income gain, the expectation of which immediately boosts aggregate demand and job creation -- although this effect is not sufficiently large to prevent some small short-term decline in consumption associated with product market reform in the simulation (see above).

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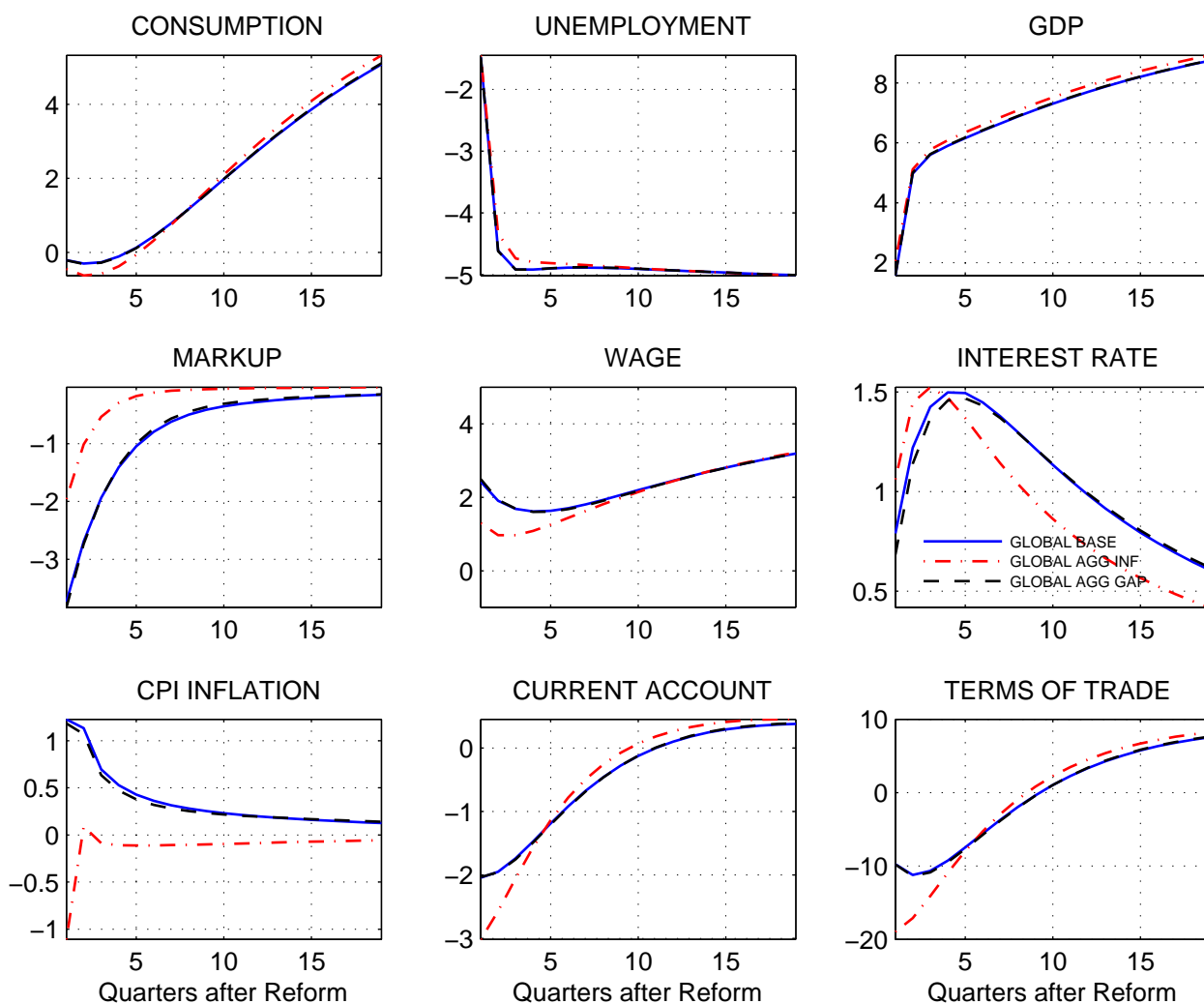
13. ALMPs reforms are excluded from these simulations because of the more arbitrary choice of parameter changes (cut in home production and improvement in job matching efficiency) they entail. Results are qualitatively unaffected by this exclusion. In particular, results are qualitatively similar if the definition of a “flexible” labour market also includes higher matching efficiency and lower home production than in the baseline.

14. This point remains empirically debated. Fiori *et al.* (2011) find support for this theoretical prediction. Bassanini and Duval (2009) instead found evidence of complementarity across a broad range of product and labour market reforms.

Figure 5. Dynamic impact of a decline in barriers to entry in a “flexible” vs. “rigid” labour market (under the benchmark monetary policy rule)



**Figure 6. Dynamic impact of a reform package combining a decline in entry barriers, a reduction in the unemployment benefit replacement rate and a relaxation of job protection (under three alternative monetary policy rules)**



## 5. The role of macroeconomic policy settings

18. Despite some transitional costs in some cases, none of the reforms considered here has large deflationary effects that would call for major cuts in policy rates. Therefore the model suggests that the “zero bound” constraint may not be an obstacle to the implementation of structural reforms in practice.<sup>15</sup>

19. Monetary policy, conducted by means of simple, empirically relevant monetary policy rules, does not appear to play a major role for the dynamic adjustment to labour market reforms (Figures 1, 2 and 3). This is essentially because transitional dynamics is largely driven by firms and consumers’ expectations of the long-run effects of reforms, which do not depend on the conduct of monetary policy.<sup>16</sup> Differences across monetary policy rules are especially small for labour market reforms. Compared with the benchmark rule, a rule that assigns greater weight to inflation achieves slightly quicker stabilisation of price mark-ups (for job protection, unemployment benefit and activation reforms) at the cost of marginally more persistent unemployment (in the case of job protection reform). Differences across rules are somewhat larger in the case of product market reforms, because these -- as already discussed -- are found to have larger effects on marginal costs, price mark-ups and domestic producer prices (Section 3.2, Figure 3, and Figure 4 for similar findings when a broad package of product and labour market reforms is implemented). A central bank that responds more aggressively to inflation dampens somewhat the decline in price mark-ups at the cost of higher and more persistent unemployment, with a small estimated consumer utility gain overall *vis-à-vis* the benchmark rule. Indeed fluctuations in price mark-ups and unemployment (relative to their natural levels) both entail consumer utility losses in the model -- the former *via* inefficient resource allocation across firms --, but (unreported) welfare calculations suggest that putting greater weight on inflation rather than on the output gap enables the central bank to achieve a slightly smaller loss overall.<sup>17</sup>

20. Finally, the short-run gains for labour market reforms are found to be only marginally smaller if the reforming country belongs to a large monetary union than if it has a flexible exchange rate regime (results not reported). Labour market reforms slightly reduce marginal costs and domestic producer prices. As a result, the real interest rate tends to be somewhat higher than in a flexible monetary policy regime if -- as in a large monetary union -- the central bank cannot respond. Aggregate demand and the short-run gains in employment and GDP are then slightly smaller, and it also takes a bit more time for the full benefits of labour market reforms to materialise. For product market, by contrast, because a decline in barriers to firm entry raises domestic producer costs and prices in the model, a fixed exchange rate regime implies a lower real interest rate in the short run. This results in large immediate gains in GDP and employment.

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15. This would no longer be the case if reforms instead turned out to have deflationary effects, as e.g. in Eggertsson (2010) where supply-side policies are assumed to boost only *current* supply.

16. Cacciatore, Fiori and Ghironi (2011) study the optimal, Ramsey monetary policy following market deregulation. They show that the transitional adjustment implied by the Ramsey allocation differs from the one implied by the simple monetary policy rules studied here. The reason is that Ramsey optimal policy implies an endogenous inflation target that changes following market deregulation, unlike the (exogenous) target featured in simple rules, with consequences for the dynamic adjustment to reforms.

17. Consistent with this finding, Cacciatore, Fiori and Ghironi (2011) show that in response to market reforms a policy of zero producer price inflation is suboptimal. In general, the optimal monetary policy needs to strike a balance between minimising price mark-up and unemployment fluctuations relative to their (efficient) equilibrium levels.

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**ANNEX 1. THE MODEL**

## 1 The Model

### 1.1 Household Preferences

A small open economy is considered, which is populated by an infinitely lived, unit mass of atomistic households. Each household is thought of as a large extended family containing a continuum of members along a unit interval. In equilibrium some members will be unemployed while some others will be producing. Unemployed workers receive a fixed amount  $w^u$  of household production units. Members in each family perfectly ensure each other against variation in labour income due to employment or unemployment. There is no ex-post heterogeneity across individuals. The representative household maximises the following utility function:

$$u(C) = E_t \left\{ \sum_{s=t}^{\infty} \beta^{s-t} \frac{[\tilde{C}_s - h\tilde{C}_{s-1}]^{1-\gamma}}{1-\gamma} \right\}, \quad (1)$$

where the discount factor  $\beta$  and the habit parameter  $h$  both lie between zero and one. Aggregate consumption  $\tilde{C}_t$  is defined as

$$\tilde{C}_t = C_t + w^u(1 - L_t)$$

where  $C_t$  is a basket of markets goods,  $L_t$  is the number of employed workers.

### 1.2 Production

Household members are employed by perfectly competitive firms to produce a non tradable intermediate input that is sold to monopolistically competitive wholesale producers. These producers use the intermediate input to produce differentiated varieties. Importantly, the number of producers in the wholesale sector is endogenous and it varies in response to aggregate shocks. In the final stage of production, perfectly competitive retailers combine domestic differentiated goods together with imported varieties to produce a final homogeneous good,  $Y_t$ .

### 1.3 Retail Sector

Firms in the retail sector are perfectly competitive and demand both domestic ( $Y_{d,t}$ ) and imported varieties ( $Y_{x,t}^*$ ) to produce  $Y_t$ :

$$Y_t = [(1 - \alpha)^{\frac{1}{\phi}} Y_{d,t}^{\frac{\phi-1}{\phi}} + \alpha^{\frac{1}{\phi}} Y_{x,t}^{*\frac{\phi-1}{\phi}}]^{\frac{\phi}{\phi-1}}$$

where  $(1 - \alpha)$  capture the degree of home bias and  $\phi$  is the elasticity of substitution across domestic

and foreign output bundles. The corresponding aggregate price index is given by

$$P_t = [(1 - \alpha)P_{d,t}^{1-\phi} + \alpha P_{x,t}^{*1-\phi}]^{\frac{1}{\phi-1}}$$

The baskets  $Y_{d,t}$  and  $Y_{x,t}^*$  are aggregates of varieties produced by Home and Foreign wholesale producers, respectively defined over a continuum  $\Omega$  and  $\Omega^*$ :

$$Y_{d,t} = \left[ \int_{\omega \in \Omega} y_{d,t}^{\frac{\theta-1}{\theta}}(\omega) \right]^{\frac{\theta}{\theta-1}}, \quad Y_{x,t}^* = \left[ \int_{\omega \in \Omega^*} y_{x,t}^{*\frac{\theta-1}{\theta}}(\omega) \right]^{\frac{\theta}{\theta-1}}$$

where  $\theta$  is the elasticity of substitution across goods.

The corresponding price indexes are given by:

$$P_{d,t} = \left[ \int_{\omega \in \Omega} p_{d,t}^{\frac{\theta-1}{\theta}}(\omega) \right]^{\frac{\theta}{\theta-1}} \quad (2)$$

$$P_{x,t}^* = \left[ \int_{\omega \in \Omega^*} p_{x,t}^{*\frac{\theta-1}{\theta}}(\omega) \right]^{\frac{\theta}{\theta-1}} \quad (3)$$

where  $p_{d,t}(\omega)$  is the price of a variety produced and sold at Home and  $p_{x,t}^*(\omega)$  is the price of a variety produced at Foreign and exported to Home, both expressed in units of Home currency.

### 1.3.1 Incumbents

The number of firms operating in the small open economy is endogenous and it varies in response to aggregate shocks. Denote with  $N_t$  the mass of domestic producers on the market at period  $t$ . There are no fixed costs of production and all firms that enter the economy produce every period. Exit from the market is exogenous and it occurs when a firm is hit by a "death" shock, which occurs with probability  $\delta \in (0, 1)$  in every period.<sup>1</sup>

Each firm on the market serves both domestic and foreign retailers. Export is costly due to the presence of iceberg trade costs  $\tau_t$ , with  $\tau_t > 1$ . To deliver one unit of a good to the export market,  $\tau_t$  units need to be shipped abroad. Final producers use the intermediate input to produce with the following production

<sup>1</sup>In order to preserve model tractability, abstraction is made from the endogenous decision of firms to leave the market.

function:

$$y_t(\omega) = y_t^I(\omega)$$

where  $y_t^I(\omega)$  is the amount of intermediate input used by the producer  $\omega$ .

At Home, demand for a domestic variety  $\omega$  is given by

$$y_{d,t}(\omega) = (1 - \alpha) \left[ \frac{p_{d,t}(\omega)}{P_{d,t}} \right]^{-\theta} \left[ \frac{P_{d,t}}{P_t} \right]^{-\phi} Y_{d,t} \quad (4)$$

As in Gali and Monacelli (2002) we assume that the share of the small economy's goods consumed in the rest of the world is positive but negligible from the rest of the world's perspective. Export demand for the same producer is given by:

$$y_{x,t}(\omega) = \alpha \left[ \frac{p_{x,t}(\omega)}{P_{x,t}} \right]^{-\theta} \left[ \frac{P_{x,t}}{P_t^*} \right]^{-\phi} Y_{x,t}^* \quad (5)$$

where  $p_{x,t}(\omega)$  is the price of the exported variety in the Foreign currency and  $P_{x,t}$  and  $P_t^*$  are defined analogously to equation (2) and (3). Notice that (5) imply that domestic producer faces a downward sloping demand for its own product on the international markets. Hence in the aggregate the small open economy maintains the ability to affect its own terms of trade.

Define  $\rho_{d,t}(\omega) \equiv \frac{p_{d,t}(\omega)}{P_t}$  and  $\rho_{x,t}(\omega) \equiv \frac{p_{x,t}(\omega)}{P_t^*}$ . The expressions (4) and (5) can be rearranged as follows:

$$y_{d,t}(\omega) = (1 - \alpha) (\rho_{d,t}(\omega))^{-\theta} \left[ \frac{P_{d,t}}{P_t} \right]^{\theta - \phi} Y_{d,t}$$

$$y_{x,t}(\omega) = (1 - \alpha) (\rho_{x,t}(\omega))^{-\theta} \left[ \frac{P_{x,t}}{P_t^*} \right]^{\theta - \phi} Y_{x,t}^*$$

We assume producer currency pricing. The law of one price (adjusted for the presence of iceberg trade costs) requires

$$p_{x,t} = s_t \tau_t p_{d,t} \quad (6)$$

where  $s_t$  is the nominal exchange rate.

Prices are sticky since final producers have to pay a quadratic price adjustment cost  $\Gamma_t$  defined as

$$\Gamma_t(\omega) = \frac{\nu}{2} \pi_t^2(\omega) [\rho_{d,t}(\omega) y_{d,t}(\omega) + Q_t \rho_{x,t}(\omega) y_{x,t}(\omega)]$$

where  $\pi_t(\omega) = \left(\frac{p_{d,t}(\omega)}{p_{d,t-1}(\omega)} - 1\right)$ .<sup>2</sup> Using (6) we have:

$$\Gamma_t(\omega) = \frac{\nu}{2} \pi_t^2(\omega) \rho_{d,t}^{1-\theta}(\omega) \Omega_t$$

where

$$\Omega_t = (1 - \alpha) \left[\frac{P_{d,t}}{P_t}\right]^{\theta - \phi} Y_{d,t} + \alpha \tau_t^{1-\theta} Q_t^\theta \left[\frac{P_{x,t}}{P_t^*}\right]^{\theta - \phi} Y_{x,t}^*$$

Total revenue for the producer  $\omega$  is given by the following expression:

$$TR_t(\omega) = \rho_{d,t}(\omega) y_{d,t}(\omega) + Q_t \rho_{x,t}(\omega) y_{x,t}(\omega) = \rho_{d,t}^{1-\theta}(\omega) \Omega_t$$

Total cost is given by

$$TC_t(\omega) = \varphi_t(y_{d,t}(\omega) + \tau_t y_{x,t}(\omega)) + \Gamma_t(\omega) = \varphi_t \rho_{d,t}^{-\theta}(\omega) \Omega_t + \frac{\nu}{2} \pi_t^2(\omega) \rho_{d,t}^{1-\theta}(\omega) \Omega_t$$

Total profits in period  $t$  are then given by:

$$d_t = [\rho_{d,t}^{1-\theta}(\omega) - \varphi_t \rho_{d,t}^{-\theta}(\omega) - \frac{\nu}{2} \pi_t^2(\omega) \rho_{d,t}^{1-\theta}(\omega)] \Omega_t$$

Firms maximise the present discounted value of the stream of current and future real profits:

$$E_t \sum_{s=t}^{\infty} \beta_{s,s+1} (1 - \delta)^{s-t} \frac{P_s}{P_{s+1}} d_s(\omega)$$

where  $\beta_{s,s+1} = \beta \left(\frac{u_{c,t+1}}{u_{c,t}}\right)^{-\gamma}$  is the stochastic discount factor.

The first-order condition with respect to  $\rho_{d,t}$  yields

$$\rho_{d,t}(\omega) = \mu_t(\omega) \varphi_t^*$$

where  $\mu_t(\omega)$  is the time varying endogenous markup for producer  $\omega$  is given by:

$$\mu_t(\omega) = \frac{\theta}{(1 - \theta) \left[1 - \frac{\nu}{2} \pi_t^2(\omega)\right] + \nu \{[\pi_t(\omega) + 1] \pi_t(\omega) - E \beta_{t,t+1} (1 - \delta) [\pi_{t+1}(\omega) + 1] [\pi_{t+1}(\omega)] \frac{\rho_{d,t+1}}{\rho_{d,t}} \frac{y_{d,t+1}(\omega) + y_{x,t+1}(\omega)}{y_{d,t}(\omega) + y_{x,t}(\omega)}}}$$

<sup>2</sup>Notice that  $\nu$  is denominated in units of consumption and the total cost is proportional to the firm's total revenue.

The export price is

$$\rho_{x,t}(\omega) = \frac{\tau_t}{Q_t} \mu_t(\omega) \varphi_t$$

where  $Q_t$  is the real exchange rate.

In the foreign economy:

$$\rho_{d,t}^*(\omega) = \mu_t^*(\omega) \varphi_t^*$$

$$\rho_{x,t}^*(\omega) = Q_t \tau_t \mu_t^*(\omega) \varphi_t^*$$

### 1.3.2 Entry Decision

Perspective entrants are forward looking and correctly anticipate their future profits  $d_s(\omega)$  in any period  $s > t$  as well as the exogenous probability  $\delta$  of incurring in the exit-inducing shock. Entrants at time  $t$  will start producing only from  $t + 1$ . Perspective entrants compute their expected post-entry value  $e_t(\omega)$  given by the presented discounted value of the expected stream of per period profits  $d_s$ :

$$e_t(\omega) = E_t \sum_{s=t}^{\infty} \beta_{s,s+1} d_s(\omega). \quad (7)$$

Prior to entry, firms face a sunk entry cost  $f_{E,t}$  in units of intermediate input. It is interpreted as the cost associated with regulation and barriers to entry. It is exogenous and subject to shocks. Entry occurs until firm value is equalised to the entry cost, leading to the free entry condition  $e_t(\omega) = \varphi_t f_{E,t}$ .<sup>3</sup> Given the time to build assumption, the law of motion of firms is given by  $N_t = (1 - \delta)(N_{t-1} + N_{E,t-1})$ . The number of producing firms represents the stock of capital of the economy. It behaves much like physical capital in a standard real business cycle model, but it has an endogenously fluctuating price given by (7).

### 1.4 Intermediate Input Producers

Perfectly-competitive firms produce a non-traded intermediate input using labor. Each firm employs a continuum of workers. The stock of labour varies because of the endogenous variation in hiring (job creation) and firing (job destruction) rates. To hire a new worker firms have to post a vacancy, incurring in a fixed cost  $\kappa$  - denominated in units of final output  $Y_t$ . The probability of finding a worker depends

<sup>3</sup>This condition holds as long as the mass of new entrants  $N_{E,t}$  is positive. It is assumed that macroeconomic shocks are small enough for this condition to hold in each period.

on a constant-returns-to-scale matching technology, which converts aggregate unemployed workers  $U_t$  and aggregate vacancies  $V_t$  into aggregate matches  $M_t$ :

$$M(U_t, V_t) = \chi U_t^\varepsilon V_t^{1-\varepsilon}, 0 < \varepsilon < 1.$$

Labour market tightness is defined as  $\vartheta \equiv \frac{V_t}{U_t}$ . Each firm meets unemployed workers at a rate  $q_t = \frac{M(U_t, V_t)}{V_t}$ . As in Krause and Lubik (2007), we assume that newly created matches become productive only in the next period. For an individual firm, the inflow of new hires in  $t + 1$  is therefore  $q_t v_t$ , where  $v_t$  is the number of posted vacancies.

Firms and workers can separate for exogenous and endogenous motives. When the firm finds a match to be no longer profitable, it can dismiss the worker but it has to incur a real cost  $F$  denominated in units of final output  $Y_t$ . This cost is constant and proportional to the steady state (aggregate) wage:  $F = \psi_F \bar{w}^{SS}$ .<sup>4</sup>

Production is subject to both aggregate and idiosyncratic shocks. Specifically, each filled job produces  $Z_t z_{it}$  units of output, where  $i$  indexes a particular job. Aggregate productivity  $Z_t$  is common to all firms, while the specific job's productivity  $z_{it}$  is idiosyncratic. Job-specific productivity is an *i.i.d.* draw from a time invariant distribution with *cdf*  $G(z)$ , positive support and density  $g(z)$ .<sup>5</sup>

For a generic intermediate input producer, total output is determined by the measure  $l_t$  of jobs, aggregate productivity  $Z_t$  and the average of idiosyncratic job-specific shocks,  $\bar{z}_t$ .

$$y_t^I = Z_t \int_{z_t^c}^{\infty} z \frac{dG(z)}{1 - G(z^c)} l_t \equiv Z_t \bar{z}_t l_t, \quad (8)$$

where  $z^c$  is the (endogenous) critical threshold below which firms destroy non profitable jobs with  $z_{it} < z^c$ . Denote with  $\lambda^x$  is the fraction of jobs that are exogenously separated at the beginning of each period. Total separation is then given by  $\lambda_t = \lambda^x + \lambda_t^e$  where  $\lambda_t^e = (1 - \lambda^x)G(z_t^c)$  is the fraction of jobs endogenously destroyed.

<sup>4</sup>Firing costs are not a transfer to the worker here. Severance transfers from the firm to the worker would have no allocative effects with Nash wage bargaining, see e.g. Mortensen and Pissarides (1994).

<sup>5</sup>As common in the literature, the *i.i.d.* assumption is for analytical tractability. A more realistic assumption would be to allow the idiosyncratic shocks to display persistence. It can be conjectured that by departing from this assumption the results would not be significantly affected (see den Haan, Ramey, and Watson (2000)).

The law of motion of employment is given by :

$$l_t = (1 - \lambda_t)(l_{t-1} + q_{t-1}v_{t-1}) \quad (9)$$

Intermediate input producers choose  $v_t, l_t$  and  $z_t^c$  to maximize the present discounted value of current and future profits. Specifically

$$\text{Max } E_t \sum_{t=0}^{\infty} \beta_{t,t+1} \frac{P_t}{P_{t+1}} \{ \varphi_t Z_t \bar{z}_t l_t - \bar{w}_{tt} l_t - \kappa v_t - \lambda_t^e [l_{t-1} + q_{t-1} v_{t-1}] F \}$$

s.t.

$$l_t = (1 - \lambda_t)(l_{t-1} + q_{t-1} v_{t-1})$$

The first term represents the real value of output -  $\varphi_t = \frac{p_t^I}{P_t}$  is the real price of the intermediate input. The term  $\bar{w}_t$  is an aggregate of the individual wages. The last two terms reflect hiring and firing costs.

First-order necessary conditions are:

$$l_t : \phi_t = \bar{w}_t - \varphi_t Z_t \bar{z}_t + E_t \beta_{t,t+1} (1 - \lambda_{t+1}) \phi_{t+1} \quad (10)$$

$$v_t : \frac{\kappa}{q_t} = E_t \beta_{t,t+1} (\phi_{t+1} (1 - \lambda_{t+1}) - \lambda_{t+1}^e F) \quad (11)$$

$$z_t^c : \varphi_t Z_t z_t^c = w_t^c - \frac{\kappa}{q_t} - F, \quad (12)$$

where  $\phi_t$  is the Lagrange multipliers attached to the employment constraint. The multiplier  $\phi_t$  represents the current period (average) value of an extra worker for the producers.

#### 1.4.1 Wage Determination

The wage schedule is obtained through the solution of an individual Nash bargaining process. Without loss of generality, a worker with idiosyncratic productivity  $z$  is considered. The bargaining solution then splits the surplus of their match in shares determined by an exogenous bargaining weight  $\eta$ . The sharing



rule is such that:

$$\eta J_t = (1 - \eta)(W_t(z) - U_t).$$

where  $J_t$  is the value of the matched worker for the firm,  $W_t(z)$  represents the worker's asset value of being matched to a job and  $U_t$  is the value of unemployment. We have:

$$J_t(z) = \varphi_t Z_t z - w(z) - \frac{\lambda_t^e}{1 - \lambda_t} F + E_t \beta_{t,t+1} (1 - \lambda_{t+1}) \bar{J}_{t+1}, \quad (13)$$

where  $\bar{J}_{t+1} = \int_{z_{t+1}^c}^{\infty} J_{t+1}(z) \frac{dG(z)}{1 - G(z_t^c)} - \frac{\lambda_{t+1}^e}{1 - \lambda_{t+1}} F$ .

The surplus for a worker with productivity  $z$  is given by

$$W_t(z) - U_t = (1 - \iota)w_t(z) - \tilde{b} + (1 - p_t)E_t \beta_{t,t+1} (1 - \lambda_{t+1})(\bar{W}_{t+1} - U), \quad (14)$$

where  $\bar{W}_{t+1} = \int_{z_{t+1}^c}^{\infty} W_{t+1}(z) \frac{dG(z)}{1 - G(z_t^c)}$  and  $\iota$  is the labour income tax rate. The outside option for any worker is given by  $\tilde{b} = w^u + \psi_b \bar{w}$ . The first term is home production while the second is a transfer from the government interpreted as unemployment benefits.

Using equation (11), equation (13) can be rewritten as:

$$J_t(z) = \varphi_t Z_t z - w(z) - \frac{\lambda_t^e}{1 - \lambda_t} F + \frac{\kappa}{q_t}$$

The sharing rule implies

$$(\bar{W}_{t+1} - U) = \frac{\eta}{1 - \eta} \bar{J}_{t+1}$$

Equation (14) can then be written as:

$$W_t(z) - U_t = (1 - \iota)w_t(z) - \tilde{b} + (1 - p_t)E_t \beta_{t,t+1} (1 - \lambda_{t+1}) \frac{\eta}{1 - \eta} \bar{J}_{t+1}$$

to get

$$W_t(z) - U_t = (1 - \iota)w_t(z) - \tilde{b} + \frac{\eta}{1 - \eta} (1 - p_t) \frac{\kappa}{q_t}$$

Inserting the value functions in the bargaining rule yields the following equation for the individual real

wage:

$$w_t(z) = \frac{1}{\eta + (1 - \eta)(1 - \iota)} \left\{ \eta[\varphi_t Z_t z + \kappa \vartheta_t - \frac{\lambda_t^e}{1 - \lambda_t} F] + [1 - \eta] \tilde{b} \right\} \quad (15)$$

As shown in Shimer (2005), Hall (2005) and Krause and Lubik (2005), introducing real wage rigidity improves the performance of the matching model in terms of the dynamics of labour market variables. Borrowing from Hall (2005), a simple form of wage rigidity which serves well the purposes of this paper is assumed. In particular, the individual real wage is assumed to be a weighted average of the one obtained through the Nash bargaining process and the one obtained as solution to the steady state:

$$w_t^R(z) = \rho w_t(z) + (1 - \rho) w^{SS}(z)$$

The aggregate real wage is the average of individual wages, weighted according to the distribution of idiosyncratic productivity:

$$\bar{w}_t = \int_{z_t^c}^{\infty} w_t^R(z) \frac{dG(z)}{1 - G(z^c)} = \rho \bar{w}_t^R + (1 - \rho) \bar{w}^{SS} \quad (16)$$

The labour market structure of the economy can be summarised by a job creation equation, a job destruction equation and the expression for the aggregate wage rate provided by (16). Combining (10) and (11) one gets the following aggregate job creation:

$$\frac{\kappa}{q(\theta_t)} = E_t \beta_{t,t+1} (1 - \lambda_{t+1}) [\varphi_{t+1} Z_{t+1} \bar{z}_{t+1} - \bar{w}_{t+1} + \frac{\kappa}{q_t}], \quad (17)$$

stating that the expected cost of posting a vacancy today -  $\frac{\kappa}{q_t}$  - has to be equal to the expected marginal benefit. The aggregate job destruction can be restated as:

$$(1 - \eta)(\varphi_t Z_t z_t^c - \tilde{b} - F) - \eta \kappa \vartheta_t + \frac{\kappa}{q_t} = 0. \quad (18)$$

This equation defines the cutoff productivity  $z_t^c$ , a sufficient statistics for the behavior of job destruction. At the margin, the producer has to be indifferent between maintaining the match and firing the worker.

### 1.5 Household Budget Constraint and First Stage Budgeting

International financial markets are assumed to be incomplete. The representative household in the small open economy can invest in three types of assets: shares in a mutual fund of firms<sup>6</sup> and domestic and foreign bonds. Let  $x_t$  be the share in the mutual fund of firms held by the representative household entering period  $t$ . The representative household buys  $x_{t+1}$  shares in a mutual fund of all the firms existing at time  $t - N_t + N_{E,t}$  - even though only a fraction  $(1-\delta)$  of those will be producing in  $t+1$ . The real price of one share at time  $t$  is equal to the price of claims to future firms real profits  $e_t$ . Let  $B_{t+1}$  denote nominal holdings of Home bonds (in Home currency) and  $B_{*,t+1}$  nominal holdings of foreign bonds (in Foreign currency). As in Ghironi (2006), quadratic costs of adjusting international bond holdings are assumed. Let  $\frac{\xi}{2}(\frac{B_{*,t+1}}{P_t^*})^2$  be the cost of adjusting Foreign bonds (in units of foreign consumption). There is no cost of adjusting domestic bonds and equity holdings.<sup>7</sup> The per period household's budget constraint can be written as:

$$\begin{aligned} B_{t+1} + s_t B_{*,t+1} + \frac{\xi}{2} \left( \frac{B_{*,t+1}}{P_t^*} \right)^2 s_t + P_t C_t + N_{E,t} x_{t+1} e_t = \\ = (1 + r_t) B_t + P_t s_t (1 + r_t^*) B_{*,t} + P_t (d_t + e_t) N_t x_t + P_t b (1 - L_t) + T_t \end{aligned}$$

where  $s_t$  is the nominal exchange rate and  $T_t$  is a lump sum transfer from the government.

Let  $b_{*,t} = \frac{B_{*,t+1}}{P_t^*}$  be the real holding of foreign bonds. The Euler equations for domestic and foreign bonds are respectively:

$$\begin{aligned} 1 &= \beta(1 + r_{t+1}) E_t \left[ \frac{u_{c,t+1}}{u_{c,t}} \frac{1}{\pi_{t+1}^{CPI}} \right] \\ \tilde{C}_t^{-\gamma} (1 + \xi b_{*,t+1}) &= \beta(1 + r_{t+1}^*) E_t \left[ \frac{Q_{t+1}}{Q_t} \frac{u_{c,t+1}}{u_{c,t}} \frac{1}{\pi_{t+1}^{*CPI}} \right] \end{aligned}$$

The Euler equations for shares holding is:

$$e_t = (1 - \delta) E_t \beta \frac{u_{c,t+1}}{u_{c,t}} (d_{t+1} + e_{t+1})$$

where  $\tilde{C}_t = C_t + w^u(1 - L_t)$  and  $\pi_{t+1}^{CPI} = \frac{N_t}{N_{t-1}} \pi_t$ .

<sup>6</sup>New entrants finance entry on the stock market in this model.

<sup>7</sup>Bond-adjustment fees capture fees on international transactions.

## 1.6 Symmetric Equilibrium

To ensure symmetry among incumbents and preserve tractability, new entrants are assumed to pay the quadratic price adjustment cost when they set their first price. In the symmetric equilibrium we have

$$e_t(\omega) = e_t, \mu_t(\omega) = \mu_t, \rho_{d,t}(\omega) = \rho_{d,t}, \rho_{x,t}(\omega) = \rho_{x,t}.$$

In equilibrium, the aggregate price index can be written as

$$1 = (1 - \alpha) \left( \frac{P_{d,t}}{P_t} \right)^{1-\phi} + \alpha \left( \frac{P_{x,t}^*}{P_t} \right)^{1-\phi} \quad (19)$$

where

$$\frac{P_{d,t}}{P_t} = \rho_{d,t} N_t^{\frac{1}{1-\theta}}, \frac{P_{x,t}}{P_t} = \rho_{x,t} N_t^{\frac{1}{1-\theta}} \quad (20)$$

Combining equations (19) and (20) yields:

$$1 = \rho_{d,t}^{1-\phi} \left[ (1 - \alpha) N_t^{\frac{1-\phi}{1-\theta}} + \alpha (\tau_t Q_t)^{1-\phi} N_t^{*\frac{1-\phi}{1-\theta}} \right]$$

The law of motion of aggregate employment can be written as:

$$L_t = (1 - \lambda_t)(L_{t-1} + q_{t-1}V_{t-1}),$$

The government collects taxes on labour income and bond-adjustment fees and pays unemployment benefits. In equilibrium any difference between government revenue and expenses is financed by lump sum taxes  $T_t$ :

$$T_t = \nu \bar{w}_t L_t + \frac{\xi}{2} Q_t b_{*,t+1}^2 - \psi_b \bar{w}_t (1 - L_t)$$

The aggregate budget constraint implies:

$$Z_t \bar{z}_t L_t = N_t (y_{d,t} + \tau y_{x,t}) + N_{E,t} f_{E,t}$$

Finally, equilibrium of international payments requires

$$\underbrace{[Q_t N_t \rho_{X,t} y_{x,t} - N_{X,t}^* \rho_{X,t}^* y_{x,t}^*]}_{\text{Net Exports}} + \underbrace{r_t^* b_{*,t}}_{\text{Interests}} = \underbrace{Q_t (b_{*,t+1} - b_{*,t})}_{\text{Current Account}}$$

In order to close the model one needs to specify exogenous processes for  $\tau_t^*$ ,  $N_{X,t}^*$ ,  $\rho_{X,t}^*$  and  $y_{x,t}^*$  as well as a monetary policy rule for the small open economy. Since the focus is only on domestic shocks and the small open economy has a negligible impact on the rest of the world, foreign variables are simply assumed to be constant and normalised to the initial symmetric steady state as standard practice in the literature.

Terms of trade are defined as the price of imports relative to exports:

$$TOT_t = \frac{Q_t \rho_{x,t}^*}{\rho_{x,t}}$$

and the Gross Domestic Product (GDP) is

$$gdp_t = \rho_{d,t} [N_t (y_{d,t} + \tau y_{x,t}) + N_{E,t} f_{E,t}]$$

## 1.7 Monetary Policy

The model is closed by assuming a floating nominal exchange rate regime and by specifying a Taylor rule for Home economy. The benchmark formulation is the following:

$$r_t = \phi_r r_{t-1} + (1 - \phi_r) [\phi_\pi \tilde{\pi}_t^{CPI} + \phi_y \tilde{y}_t]$$

Notice that sans-serif variables denote deviations from the steady state, *i.e.*  $x_t = x_t - \bar{x}$ . Moreover  $\tilde{\pi}_t^{CPI}$  is the data-consistent CPI inflation and  $y_t$  is the data-consistent output gap (the difference between actual and potential output). Data-consistent variables are defined below.

In alternative we consider a currency union between the small open economy and the rest of the world. The Union wide monetary authority sets the nominal interest rate without responding to inflation and output dynamics of the small open economy since the latter has a negligible impact on the Union-wide macroeconomic aggregates.

## 1.8 The Price Index in the Model and its Data Counterpart

A well-established property of CES production functions, which is adopted here for the production of final goods, is that they exhibit "love for variety". This means that even if physical quantities of intermediate goods do not change, aggregate output increases if the range of available varieties expands. To understand

this point more clearly it is sufficient to consider the equilibrium expression for the Home price index

$$P_t^{1-\phi} = (1-\alpha)p_{d,t}^{1-\phi}N_t^{\frac{1-\phi}{1-\theta}} + \alpha p_{x,t}^{*1-\phi}N_t^{*\frac{1-\phi}{1-\theta}}$$

As the economy experiences entry into both domestic and foreign markets, aggregate prices  $P_t$  could fluctuate just for this reason, even if average prices remained constant.

In the data, however, aggregate prices are not measured taking into account variety effects.<sup>8</sup> As a result Central Banks decide monetary policy by using price indexes that only reflects changes in average prices.

In order to get around this issue, the procedure proposed by Ghironi and Melitz (2005) is followed and a data-consistent price index is constructed as:

$$\tilde{P}_t = \Psi_t^{\frac{1}{\phi-1}} P_t$$

where

$$\Psi_t = (1-\alpha)N_t^{\frac{1-\phi}{1-\theta}} + \alpha N_t^{*\frac{1-\phi}{1-\theta}}$$

As a result, data-consistent CPI inflation is given by

$$\tilde{\pi}_t^{CPI} = \frac{\tilde{P}_t}{\tilde{P}_{t-1}}$$

Real variables constructed using the data consistent CPI index  $\tilde{P}_t$  are given by

$$x_{R,t} = \frac{x_t}{\tilde{P}_t}$$

## 2 Calibration

Periods are quarters and the model is calibrated on the Euro Area as of the end of 2007. The discount factor is set at  $\beta = .99$  implying an annual real interest rate of 4%. The value of the risk aversion coefficient  $\gamma$  is equal to 2. The elasticity of substitution across domestic goods -  $\theta$  - is equal to 11, while the elasticity of substitution across Home and Foreign varieties,  $\phi$ , is equal to 1.5. The degree of home bias,  $(1-\alpha)$ , is

<sup>8</sup>There is empirical evidence that these gains from variety go mostly unmeasured in CPIs, as documented in Broda and Weinstein (2006).

set to .2. The quadratic cost of adjusting prices  $\nu$  is set to 80 as in Bilbiie, Ghironi, and Melitz (2007). The parameter governing habit persistence,  $h$ , is set to .75.

The regulation parameters are calibrated to reproduce an average of countries belonging to the Euro Area as of 2007. Pissarides (2003) compiles an index for entry delay as the number of business days that it takes (on average) to fulfill entry requirements, weighted by the number of procedures that must be performed. Following the procedure proposed by Ebell and Haefke (2009) this index is converted in months of lost output.  $f_R$  is set so that the costs required to fulfill entry requirements amount to 0.81 quarters of lost output (based on 230 business days in a year).

Turning to the labour market the elasticity of the matching function is set to  $\varepsilon = 0.6$ , a midpoint of estimates reported in Petrongolo and Pissarides (2006). Total separation  $\lambda_t^T$  is set to 5% to reproduce the empirical evidence in Hobijn and Sahin (2007). The fraction of exogenous separation  $\lambda^X$  is set equal to 0.68, as in den Haan, Ramey, and Watson (2000). To pin down exogenous exit of plants -  $\delta$  -, the calibration targets the portion of job destruction due to the exit of plants. Empirical evidence suggests that job destruction induced by the exit of plants ranges between 25 to 55 per cent in OECD countries. A midpoint of those estimates is chosen and  $\delta$  is set so that the exit of plants accounts for 40% of overall job destruction. The replacement rate is  $\psi_R = 0.69$  taken from the OECD (2004) "Benefits and Wages" publication. Given  $F = \psi_F w^{SS}$ , the calibration follows Thomas and Zanetti (2009) and set  $\psi_F = 0.2$ . The workers' bargaining power  $\eta$  is set to 0.6 and the parameter  $\rho$  governing real wage rigidity is equal to .7 as in Campolmi and Faia (2008).

Three labour market parameters are left to calibration. The cost of posting a vacancy  $\kappa$ , the flow value of home production  $h_P$ , the efficiency of the matching function  $\chi$ . As is common practice in the literature,  $\kappa$ ,  $h_P$  and  $\chi$  are chosen so as to match the steady-state unemployment rate  $U^{SS}$ , the probability of filling a vacancy  $q^{SS}$  and the total separation rate  $\lambda_t^T$ . Furthermore the parametrisation sets  $U^{SS} = 9\%$  and  $q^{SS} = 0.7$ , in line with estimates reported by ECB (2002) and Weber (2000). The idiosyncratic productivity shock  $z$  is lognormally distributed with mean  $\xi$  and standard deviation  $\sigma_A$ . The parametrisation of the latter follows den Haan, Ramey, and Watson (2000):  $\xi$  is normalised to 0, calibrating  $\sigma_A$  to .4 a value in the range reported by Thomas and Zanetti (2009).

The degree of home bias is set to 0.2. The elasticity of substitution between domestic and foreign goods is equal to 1.5. The adjustment cost on foreign bond is set to 0.004.

### 3 Dynamic Adjustment to Deregulation

The dynamic effects of structural reforms are explored by studying the dynamic adjustment to the new long run equilibrium. First, the analysis studies how monetary policy can affect transition dynamics following product and labour market reforms by contrasting alternative monetary policy rules and studying the role of different exchange rate regimes for the transitory adjustment. Then the possible interdependence of reforms is addressed by considering how the impact of reforms in one area can depend on prevailing policy settings in the other.

#### The size of reforms

The focus is on a one-off, permanent change in the policy parameters. Product market deregulation is a permanent decrease of regulatory barriers,  $f_R$ . Labour market reforms include a permanent reduction in unemployment benefits, a permanent easing of employment protection legislation and - in a more stylised manner since no model parameter(s) readily capture(s) this dimension - a permanent strengthening of active labour market policies. The level of unemployment benefits is captured by  $\psi_R$ . Turning to employment protection, Blanchard and Giavazzi (2003) focus on reductions in workers' bargaining power. In the data, employment protection refers to all types of employment protection measures, whether grounded primarily in legislation, court rulings, collectively bargained conditions of employment or customary practice. In the model, those forms of protection are assumed to be jointly captured by firing costs and workers' bargaining power. Likewise, active labour market policies are assumed to be jointly captured by the efficiency of the matching function  $\chi$  and the home production term  $w^u$  in the outside option of the worker.

Policy parameters are assumed to be lowered to an average of "flexible" OECD countries, with the exception of activation policies for which an arbitrary 25% improvement in the efficiency of the job-matching process and a 25% decline in the value of home production are assumed.<sup>9</sup> The implied value of  $f_R$  is 0.40 quarters of lost output. The replacement rate is lowered to  $\psi_R = 0.58$ . Firing costs and workers' bargaining power are reduced by 25% in the employment protection legislation reform scenario.

A perfect foresight, fully anticipated, permanent change in policy settings is assumed. Given the large

<sup>9</sup>For each policy parameter, the initial value of the parameter is aligned on an average of a basket of benchmark countries. Due to data limitations, the composition of the basket is slightly different across policy parameters. In particular, the benchmark for  $f_R$  is constructed as an average of the following "flexible" countries: Australia, Japan, Denmark, Sweden, the United Kingdom and the United States. Likewise, the benchmark for the measures of unemployment benefits and EPL includes Australia, Canada, Japan, Korea, New Zealand, Turkey, the United Kingdom and the United States. To pin down the change in Employment Protection Legislation (proxied in the model by the size of firing costs and the workers' bargaining power  $\eta$ ), the ratio of OECD indexes (for 2008) of employment protection legislation (excluding the component relative to temporary workers) for the group of "flexible" countries and Europe is considered. In the data this ratio is equal to 0.75.



size of shocks, the model is solved using a Newton-type algorithm, first proposed by Laffargue (1990). The details of the algorithm can be found in Juillard (1996).

### Monetary policy

In the floating exchange rate regime, the dynamic adjustment of the economy to reforms is compared under three different simple Taylor rules:

- (i) Benchmark:  $\phi_r = .8$ ;  $\phi_\pi = 2$ ;  $\phi_y = .2$ .
- (ii) Aggressive Inflation:  $\phi_r = .8$ ;  $\phi_\pi = 9$ ;  $\phi_y = .2$
- (iii) Aggressive output gap:  $\phi_r = .8$ ;  $\phi_\pi = 2$ ;  $\phi_y = .8$

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