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Highlights

- Structural reforms have positive short-run effects

- In some cases can drive the euro area out of the lower bound

- Services reform may reduce the lower bound period

- Reforms have significant different effects across different types of households

- Unilateral reforms in a large bloc have positive spillovers in the euro area

Euro area structural reforms in times of a global crisis[*]

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Abstract

The global financial crisis and the sovereign debt crisis brought back to the policy debate the issue of the lower bound (LB) on interest rates and the policy options when this is a binding constraint. The paper looks at structural reforms as a way to provide economic stimulus for an economy at the lower bound. We focus in the euro area and carry out a comprehensive analysis within a multi-country structural model of the euro area within the world. Main results show structural reforms have positive short-run effects that reduce the size of a recession and in some cases can drive the euro area out of the LB. The labour reform accentuates deflation which implies that interest rates remain at the LB for the same number of periods, while the services reform pushes the euro area out of the LB if implemented in

the largest part of the union. The latter result hinges on the assumption of a gradual implementation of reforms. Reforms have significantly different effects across different types of households and thus the share of these households is important in the transmission. Unilateral reforms in a large bloc have positive spillover effects within the euro area. Unilateral reforms in a small bloc are deflationary but the small size of the bloc leads to very limited impact of national developments on monetary policy.

JEL codes: E52, F42, F47.

Keywords: Lower Bound; Structural reforms; Monetary Policy; Dynamic general equilibrium models.

1 Introduction

The issue of the lower bound on nominal interest rates has been extensively discussed in the literature and policy debates. The interest in this topic was renewed by the impact of the global financial crisis . In fact, in response to the crisis central banks around the world reduced rapidly policy rates, in some cases even with the introduction of negative policy rates, and have stayed at exceptionally low levels for several years (see Figure 1).[1] The economic performance of the euro area has been further dampened by the sovereign crisis that started in 2010. Almost a decade after the global financial crisis, the pace of recovery in the euro area remains disappointing. Thus alternative strategies to revive economic growth have been in the forefront of the macroeconomic debate, in particular structural

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[1]The recovery has been much more convincing in the US, leading in December 2016 to the second second increase of the policy rate in around ten years.

reforms.[2]

This paper looks at structural reforms in the euro area economy that has struggled to revive economic growth. The crisis implied persistent and severe output losses in the short-run and most likely also resulted in output losses in the long-run, i.e. in a fall in potential output. Arguably, the euro area was faced with a low potential growth even before the crisis (see Gros, Durrer, Jimeno, Monticelli, and Perotti (2002) and European Commission (2014a)). In fact, since the beginning of the 2000s the euro area has shown steadily decreasing potential output growth. According to European Commissions estimates, the euro area potential output growth went down from over 1.5 per cent before the crisis to below 0.5 per cent and recovered slightly over the last few years to levels close to 1 per cent (see Figure 2).

While the need for reforms was not new, the financial and sovereign crisis made it more urgent. Several countries implemented structural reforms to boost economic activity and competitiveness. However European Commission (2014b) documents that for countries like Portugal, Greece, Spain or Italy, the distance with other Member States with the most flexible regulatory framework is still significant and Organisation for Economic Co-operation and Development (2016) documents that the reforms effort since the crisis has been larger in Southern

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[2]Another large strand of the literature analyses the use of fiscal policy (see for example Christiano, Eichenbaum, and Rebelo (2011), Erceg and Liné (2014), Eggertsson (2011), Coenen, Erceg, Freedman, Furceri, Kumhof, Lalonde, Laxton, Lindé, Mourougane, Muir, Mursula, de Resende, Roberts, Roeger, Snudden, Trabandt, and in't Veld (2012) and Gomes, Jacquinot, Mestre, and Sousa (2015)).

European countries but that there has been a slowdown in the pace of structural reform over the period 2013 to 2015. Also, as referred by Draghi (2015), the need for structural reforms in the euro area is often mentioned not because there has not been any progress but because a lasting return to prosperity cannot merely rely on cyclical policies, including monetary policy, but also structural policies and both are strongly interdependent.

The long-run macroeconomic impact of structural reforms are extensively documented in the literature (for the case of the euro area, see, among others, Bayoumi, Faruqee, Laxton, Karam, Rebucci, Lee, Hunt, and Tchakarov (2004), Jonsson (2006), Everaert and Schule (2008), Forni, Gerali, and Pisani (2010) and Gomes, Jacquinot, Mohr, and Pisani (2013)). A well established result is that the long-run impact of an increase in competition in the labour and services markets is positive on several macroeconomic variables. However, the extent to which these type of structural reforms can stimulate an economy in the short run is not settled in the literature, depending on the specific type of reform and on the monetary policy response. Structural reforms lead to a positive wealth effect associated with an increase in the potential capacity of an economy but if the nominal interest rate is constrained by the lower bound they may also lead to an increase in the real interest rate, thus dampening economic activity. The short run impact depends on which effect is stronger.

Eggertsson, Ferrero, and Raffo (2014) argue that structural reforms that reduce product and labour market markups can be contractionary if implemented

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in a crisis when the lower bound on interest rates binds. The results are based on a DSGE model with two equally-sized countries and no investment. The paper focus on an immediate and unexpected reduction in markups, a setup that raises some questions due to the time these reforms take to be implemented fully. The contractionary impact they show is short-lived and not very large. On the contrary, Fernández-Villaverde, Guerrón-Quintana, and Rubio-Ramírez (2014) use a simple 2-period model to show how supply-side policies, including an increase in price competitiveness, may help to push an economy out of the lower bound. By reducing markups in the future (instead of an immediate an unexpected decrease in markups), these policies generate a wealth effect that increases the desire to consume today and decreases the desire to save, and this effect is not offset by monetary policy as would be the case in normal times, i.e. outside the lower bound. Thus reforms address the low demand problem at the core of the lower bound situation by having positive impact even in the short run. Vogel (2016) also looks at impact of competition-friendly structural reforms when the lower bound binds but in a richer model, including liquidity constrained agents, investment in physical capital and extra euro area trade. This paper finds that in this richer model the short-term output response to reforms can be negative at the lower bound but if so this impact is small and short-lived. Gerali, Notarpietro, and Pisani (2015) also use a multi-country model but focus on reforms in the services sector in Italy when the lower bound binds and shows that in their model reforms have expansionary effects because their positive wealth effect but if investment

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cannot immediately react to the reforms due, for example, to the presence of liquidity or financial constraints, then the reforms are not successful in reducing the duration of the lower bound episode.[3] In a related contribution, Andrés, Óscar Arce, and Thomas (2017), in a model with a richer formalization of financial constraints, analyse the impact of structural reforms in product and labour markets in a model with credit restrictions and long-term debt. In this paper the resulting negative short-run effects of reforms are generally dominated by the positive effects and thus reforms stimulate output in the short run and may also bring forward the end of deleveraging and the exit from recession. This paper however looks at the case of a small open economy inside a monetary union, and therefore do not study the interaction between supply-side policy measures and the degree of monetary policy accommodation.

We analyse the short-run impact of structural reforms in a large-scale multi-country model called EAGLE (Euro Area and Global Economy) model (see Gomes, Jacquinot, and Pisani (2012)), focusing on the euro area and within the monetary union on the Spanish economy *vis--vis* the rest of the euro area. As in some previous contributions we analyse the impact of euro-area wide reforms and unilateral reforms in a euro area bloc. Unlike previous papers, we (i) explore the differences of reforming in a large versus a small bloc and most importantly on the spillovers of reforms across euro area blocs and (2) explore the fact that reforms may affect agents differently within a country (bloc). As in Vogel (2016), our model features

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[3]The paper however does not formalized in the model these financial constraints, but instead assume that investment is kept constant exogenously.

liquidity (financially) constrained agents but unlike that paper we explore the differentiated impact that competition-enhancing reforms may have on the different type of consumers. Also, by relying in a rich model we are able to explore the robustness of our results regarding the design of the reforms.

We proceed as follows. First, we induce a recession that drives the model into the lower bound constraint, by hitting the world economy with a sequence of unexpected demand shocks.[4] This implies a deep recession in the euro area and the policy rates remain trapped at zero for around 1 and a half years. So the fact that the lower bound restriction is binding is an endogenous result of the response of the model to these demand shocks. Then we simulate an increase in competition in the labour and in the services markets. We assess their short run effectiveness in alleviating the economic recession and in countering the lower bound both when reforms are coordinated across countries or implemented unilaterally in the monetary union. We explore the spillovers of reforms across euro area blocs and the differentiated impact between different types of consumers. We also perform robustness analysis by looking at the importance of some design characteristics of reforms and of some key parameters.

Our main results are as follows. Both the labour market and services sector reforms have short-run positive effects on GDP but it takes longer for the services market impact on GDP to materialize. Looking at the coordinated case, a similar reduction of markups in the labour and the services markup, the reform in the

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[4]Other papers have done the same, see e.g. Gomes, Jacquinot, Mestre, and Sousa (2015) and Gerali, Notarpietro, and Pisani (2015).

labour market markup is more successful in stimulating euro area GDP in the short run than the services reform. However, the reduction in the wage markup accentuated deflation in the euro area which implies that interest rates remain at the lower bound for the same number of periods, while the services market reform pushes the euro area out of the lower bound. The latter result hinges crucially on the fact that we assume a gradual implementation of reforms, as opposed to a quick implementation. We also show that reforms have significant different effects across different types of households and thus the share of these households is also important in the transmission.

The remainder of the paper is organised as follows. Section 2 presents the main features of the EAGLE model, the calibration and a few details of the solution procedure. Section 3 describes the induced recession and show the results of the simulated reforms, both in the coordinated and unilateral cases. In Section 4 we perform robustness exercises. Section 5 concludes.

2   The model setup, calibration and solution procedure

The model   The EAGLE (Euro Area and the Global Economy) model is dynamic general equilibrium model of the euro area within the world economy (see Gomes, Jacquinot, and Pisani (2012) and Gomes, Jacquinot, and Pisani (2010)). In the model, the euro area is a monetary union with two different blocs: the

Home bloc and the rest of the euro area (REA) bloc. The model has two other blocs: the United States (US) and the Rest of the World (RW).[5]

Each bloc comprises a continuum of households, firms and a monetary and fiscal authority. Households are infinitely lived, and gain utility from consuming a final good (assuming external habit persistence in consumption) and disutility from working. There are two types of households, I and J. I-type households (whose share in domestic population is $(1 - \omega)$) have access to financial markets, where they buy and sell domestic government bonds and internationally traded bonds, accumulate physical capital and rent its services to firms, hold money for transaction purposes. J-type households (ω share of domestic population) cannot trade in financial and physical assets but they can intertemporally smooth consumption by adjusting their holdings of money. Both types of households supply differentiated labor services and act as wage setters in monopolistically competitive markets, thus exerting limited bargaining power and charging markups over the marginal rate of substitution between labour and consumption. So they supply a lower amount of labour than under perfect competition. We assume wages are sticky *à la* Calvo (1983) with indexation. Households of type I own the domestic capital stock, which they rent to domestic firms that they also own. The market for capital is competitive, and capital accumulation is subject to standard investment adjustment costs. Labour and physical capital are immobile internationally.

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[5]The existence of two blocs outside the euro area allows us to better characterize the euro area trade matrix. For the purpose of this analysis it is important that we consider a global model but the split between the two countries is not crucial, as we focus on euro area reforms.

Households buy and sell two bonds, one issued domestically in domestic currency and the other is an international bond issued in zero net supply worldwide. Following Benigno (2009), when I-type households sell or purchase the international bond they pay a premium to financial intermediaries. The size of this premium is a function of the aggregate net asset position of the country and therefore can be seen as reflecting the cost of intermediation. This intermediation cost guarantees that the net foreign assets are stationary. In the case of the monetary union, we assume there is a bond denominated in the common currency which is traded across the countries member of the union. Again this bond incorporates an intermediation cost with the purpose of guaranteeing the stationarity of the model.[6]

In what regards the production side, there are firms producing final goods and a continuum of differentiated intermediate goods. In each bloc there are three final goods produced in a perfectly competitive market: a consumption good, an investment good and a public good. Consumption and investment final goods are produced using all available intermediate goods as inputs to a Constant Elasticity of Substitution (CES) technology and allowing for home bias, whereas the public good is a composite of only non-tradable intermediate goods. In each bloc, there are many varieties of intermediate goods, each produced by a single firm under monopolistic competition. The market power implies that firms set nominal prices by charging a markup over marginal costs and produce an amount of

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[6]Note that there is no sovereign default risk in the model and so the debt of all countries is (and is perceived by the markets) as default free.

goods which is lower than in the case of perfect competition. Each intermediate good is produced by using domestic labour and domestic capital, combined with a Cobb-Douglas technology. Prices are sticky *à la* Calvo (1983), with indexation (following Christiano, Eichenbaum, and Evans (2005) and Smets and Wouters (2003)). Intermediate goods are either non-traded or traded internationally. Final goods are produced with non-traded intermediate goods, domestic traded goods and imported traded goods. Imports are subject to short-term adjustment costs that temporarily lower the response of demand to changes in relative prices. There is international price discrimination since firms set prices in the currency of the importing country.

In each bloc, the government purchases the public good and finances its expenditures with public debt, seignorage and taxes on the domestic private sector. There are *lump-sum* and distortionary taxes of several types (levied on the price of consumption, the rental rate of capital, wages and dividends). Lump-sum taxes (as a fraction of steady-state nominal output) are adjusted to make the public debt stable according to a fiscal rule. All distortionary tax rates are assumed to be exogenously set by the fiscal authority and constant. The monetary authority sets the national short-term nominal interest rate by means of a Taylor-type interest rate rule (Taylor (1993)). The nominal interest rate is set as a function of the year-on-year consumer price inflation deviation from its steady-state value as

well as the quarterly output growth, as follows:

$$\left(R_t^4 - \bar{R}^4\right) = \rho_R \left(R_{t-1}^4 - \bar{R}^4\right) + (1 - \rho_R) \rho_\pi \left(\pi_{4,t} - \bar{\pi}_4\right) + \rho_y \left(\frac{gdp_t}{gdp_{t-1}} - 1\right) \quad (1)$$

where R is the (quarterly) nominal interest rate, $\bar{R}$ its steady-state value, π_4 is the year-on-year consumer price inflation rate, $\bar{\pi}_4$ is the central bank inflation target (assumed to be constant), gdp is the gross domestic product. To capture inertia in the conduct of monetary policy, we assume that the current period policy rate reacts to its one period-lagged value. In the case of the euro area, the central bank sets the interest rate for the whole area on the basis of area-wide indicators, i.e. euro area-wide inflation and gross domestic product. We also impose that nominal interest rates are bounded from below at zero.

Degree of competition Given that the purpose of our analysis is the study of the macroeconomic impact of competition enhancing reforms in the labour and goods markets, the monopolistic competition framework is of crucial importance and as such we describe it in more detail in what follows, starting with the labour market setup. Each household offers a specific kind of labour services that is an imperfect substitute for services offered by other households and set its wage to maximize its lifetime utility. In the steady state, the first order condition for labour supply, N, is:

$$\omega = \frac{\eta}{\eta - 1} \lambda^{-1} N^\zeta, \eta > 1 \quad (2)$$

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where ω is the real wage (expressed in units of domestic consumption), λ is the marginal utility of consumption and η is the elasticity of substitution between labour varieties. The markup is $\eta/(\eta-1)$. Thus, the higher the elasticity of substitution between labour varieties the lower the markup and the higher employment in terms of hours, for a given wage. As such, the markup reflects imperfect competition in the labour market.

In the intermediate goods market, imperfect competition is introduced in a similar way. There is a large number of firms offering a continuum of different products that are imperfect substitutes. Each product is made by one monopolistic firm, which sets prices to maximize profits. The elasticity of substitution between products of different firms determines the market power of each firm. In steady state, in each sector (tradables and services sectors) the first order condition for price setting is:

$$p^Y = \frac{\theta}{\theta-1}\frac{MC}{P^C}, \theta > 1 \qquad (3)$$

where p^Y is the relative price of the generic intermediate good Y (in terms of the consumption good) and MC/P^C is the real marginal cost of producing Y. The markup is $\theta/(\theta-1)$. The higher the elasticity of substitution θ, the lower the implied markup and the higher the production level, for a given price. Thus, the markup reflects imperfect competition.

Summing up, in EAGLE markups are modeled by a single parameter in each national market (labour, tradable intermediate good, nontradable intermediate

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good), as in other similar models based on the monopolistic competition framework. We thus simulate the impact of structural reforms by permanently modifying the elasticity parameters, and consequently the degree of competition in the considered market. The higher the elasticity of substitution between varieties, the lower the markup and the closer the market is to perfect competition.

Competition-friendly structural reforms will eventually lead to a supply expansion of the reforming economy, generating a wealth effect that fosters demand for consumption and investment. On the other hand, structural reforms in the product and labour market will put downward pressure on prices, either directly or indirectly via a drop on production costs. In normal times, monetary policy will be able to offset this downward pressure on prices with a reduction in interest rates. Real interest rates will drop, stimulating demand even in the short run. When monetary policy is constrained by the lower bound, it will not be able to accommodate the effect of the reforms. The decrease in prices will push upwards the real interest rate, dampening the interest-rate sensitive components of demand. Thus the impact of reforms in the shorter run may not be positive, and depend on the relative strength of the two effects. Note that in the case of our model, the wealth effect will be relatively more important for the constrained agents than for the unconstrained ones, while the opposite happens with respect to the real interest rate effect. This will be explored in the simulations below.

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Calibration The model is calibrated at a quarterly frequency. The euro area is split in a small and a large bloc. The small euro area bloc broadly represents a small country or group of countries of the Southern euro area. We took Spain as a representative economy, weighting close to 10% of euro area GDP (the Home bloc). As mentioned before, the model has two other blocs, the US and the RW. [7] The steady-state ratios were set to match national accounts data and the key behavioural parameters were chosen using information in the literature, some of which are invariant across countries while others have been modified to match country-specific information, such as the steady-state ratios of nominal domestic demand components to GDP. See Tables 1 and 2. The bias towards domestic tradable goods and the weight of non-traded goods in the consumption and investment baskets were set to match the shares of imported and services goods in the considered economy, given the values of the intratemporal and intertemporal elasticities of substitution. Nominal and real rigidities allow to produce realistic dynamic adjustment patterns. See Table 3. Regarding monetary policy, an identical calibration of the Taylor rules in all the blocs is assumed, and for all blocs, the inflation target is set at 2 per cent. See Table 4. Given the severity of the recession that hits the global economy, we assume a fast response of policy to the developments in the economy. This means that, following Gomes, Jacquinot, Mestre, and Sousa (2015), we set the lagged interest rate parameter in the Taylor rules to zero.

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[7]The usefulness of having the two blocs outside the euro area for the paper is merely for allowing the use of additional information on the calibration of the euro area economy international environment, namely in what regards the trade matrix. The distinction is not explored in the exercises in this paper. The distinction does not impact the reforms.

This leads to a faster reduction in interest rates and an earlier onset of the lower bound period.[8] The steady-state real interest rate was set at 1% (annualised), in line with the average real rate over the period 1999 to 2009. Regarding the calibration of the fiscal policy rule, the parameter measuring the reaction of taxes to public debt is set to achieve debt sustainability and hence model stability.

As for the calibration of (initial) steady-state markups, we assume that in the euro area, markups in the services (non-tradable) sector are larger than those in the manufacturing (tradable) sector. This dichotomy is larger in the euro area than in the US. In the euro-area markups in the services sector are higher than the corresponding values in the US (and the RW) but we assume that the tradable sector is as competitive in the euro area as in the US. Our calibration of the price markups is broadly in line with estimates by Høj, Jimenez, Maher, Nicoletti, and Wise (2007), Christopoulou and Vermeulen (2012) and Bouis and Klein (2008). Given the lack of information on the wage markup, we assume that the wage markup is equal to the price markup in the non-tradable (services) sector. See Table 5.

Solution procedure The model is non-linear, deterministic and solved under perfect foresight. In particular, the model is solved by stacking the equations for all periods of a given simulation. The system is solved using a modified Newton-type algorithm, a non-linear perfect foresight solver based on work by Boucekkine

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[8]This is a technical device to help activate more easily the lower bound constraint, not an actual policy recommendation.

(1995), Juillard (1996) and Laffargue (1990). The algorithm "stacks" the equations for all the periods into a (very) large system of equations and solves them simultaneously using Newton-Raphson algorithm.[9]

Given that the model is solved in a non-linear form, i.e. it is not linearised around a steady state, the lower bound condition was implemented in a rather straightforward way. The monetary authorities behaviour is described by a Taylor rule in normal times, i.e. when this rule delivers a nonnegative interest rate. Otherwise, the nominal interest rate is set to zero. Technically, this amounts to replacing the Taylor rule by a function that returns the maximum of the Taylor rule itself or zero. See equation (1).

3   The impact of structural reforms in crisis times

In this section we describe how we lead the world economy into the lower bound and then we analyze the impact of structural reforms in the labour and services (proxy for non-tradable goods) markets, by permanently modifying the elasticity parameters in the markets under consideration. We assume that the structural reforms are implemented gradually over a period of five years. The simulations are run under perfect foresight, thus eliminating any uncertainty about the credibility

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[9]Each iteration in Newton-Raphson algorithm requires solving a matrix equation involving the Jacobian matrix that can be very large for this stacked system. However, this large matrix has a repetitive structure of non-zero blocks along its diagonal that in turn are sparse. The algorithm takes advantage of this repetitive structure and of the sparcity within the blocks. For details see Hollinger (1996).

of the reforms.

3.1   The recession

As a first step, we induce a demand driven global recession that drives nominal interest rates to their lower bound endogenously. We do do by hitting the world economy with a sequence of unexpected demand shocks.[10] In particular, consumption and investment in all blocs of the model are shocked for 6 consecutive periods, through an intratemporal preference shock and a shock to the Tobin's Q equation in each period.[11] The shocks amount to 4% of consumption and 0.2% of Tobin's Q *ex-ante* (in each period). Note that the agents are unaware of future shocks, but once a shock hits the economy then agents correctly anticipate the results of each shock.[12] These shocks drive the policy rates in all the blocks to the lower bound, and they stay there for six quarters. The euro area undergoes a deep recession, with GDP showing a cumulated fall of close to 7 per cent two years after the first

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[10]For simplicity we assume that the lower bound on interest rates is zero, even though in reality it seems to be slightly negative as we have seen recently in several advanced economies where policy rates have been reduced below zero (see McCallum (2000) and Yates (2004)). Nevertheless, for the sake of our analysis what is crucial is that monetary policy is constrained by a lower bound and not so much the exact level of the bound.

[11]Thus we assume that the crisis is demand driven, a choice often made in the literature. However, it is possible that supply side factors have subsequently kicked in, which is not considered in our analysis.

[12]The way the simulations are set up is such that we first run the recessionary shocks for the first period of the simulations starting from the steady state. These shocks hit unexpectedly an economy that was at the steady state. Then we run a second simulation of recessionary shocks that starts from the result of the previous simulation one period on. In this simulation the recessionary shocks happen oin the first period and are thus not anticipated on impact. This is done for four periods. In the fifth period we take the same approach and simulate a reform shock, that thus is a simulation of an unanticipated shock that starts from the result of the sequence of shocks in the previous four periods. Given that it is the first period of this new simulation, it will be unanticipated on impact.

shock hits, while annualised inflation falls by more than 1.5 percentage points.

3.2   The structural reforms

In this section we first present the results of labour and services market reforms in the euro area that are implemented when the economy is in a recession and policy rates are constrained by the lower bound. In both cases, we simulate the impact of a reduction of markups of roughly 10 percentage points, gradually implemented over a period of five years starting from the fourth period of the crisis. This decrease will take markups close to the US levels. For the sake of facilitating the comparison of the two types of reforms we simulate similar sized reforms in both sectors. Given that, in a monetary union, monetary policy responds to the euro area wide variables, then it is of interest to analyse two scenarios: first the coordinated implementation of reforms in the whole euro area and the case when reforms are implemented only by part of the country members.

3.2.1   Euro area wide reforms

Figures 3 and 4 show the impact of the euro area wide labour and services markets reforms, respectively, on euro area variables.[13] According to our results, the two simulated reforms have a positive impact on euro area GDP in the short-to-medium run, but the impact is larger and materializes faster in the case of the labour market

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[13]We do not show the results for each of the two blocs since the impact is qualitatively rather similar (and in most cases also quantitatively) in the two blocs.

reform.[14] This is due to a larger income effect in the case of the wage reform as well as to the different behaviour of the real interest rate. Next we look at the results in more detail.

Anticipating the increase in the supply capacity of the economy, investment is stimulated in order to build up the necessary stock of capital. Labour demand also increases. In both cases, consumers benefit from an income effect associated with the reform but this is larger in the case of the wage reform, as employment is considerably stimulated by the reform, because the reform makes the labour input cheaper.[15] The services sector reform favours a postponement of consumption because households anticipate that services will be cheaper in the future (and services are a large fraction of the consumption basket) so consumption is lower in the case of the services market reform. At the same time, while the real interest rate increases from impact in the case of the wage reform it stays only slightly above the no-reform scenario so the negative impact steaming from the real interest rate behaviour does not completely offset the favourable income effect and both consumption and investment perform better in the reform scenario compared to the no-reform case. On the opposite, in the case of the services reform the real interest rate falls on the first period of implementation but then increases for some periods and stays considerable above the non-reform scenario, exerting a negative

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[14]Even though the focus of our analysis is the short run, we have computed a measure of the change in welfare between the two steady states and confirmed that reforms have a long-run positive impact in terms of Consumption Equivalents (on this measure see Bayoumi, Faruqee, Laxton, Karam, Rebucci, Lee, Hunt, and Tchakarov (2004) and Gomes, Jacquinot, Mohr, and Pisani (2013)).

[15]This more than compensates the fall in real wages fall.

effect on domestic demand.

It is worth noting that the reforms have a differentiated impact on the two different types of consumers (Figure 5). In the case of the wage reform, the increase in consumption associated with the reform is much more significant in the case of the constrained households, who benefit from the wealth effect associated with the reform but are not affected by the negative impact via the real interest rate, as these households don't have access to financial markets and don't invest in physical capital. On the contrary, unconstrained agents also benefit from the favourable income effect but are penalized by the real interest rate behaviour. On balance consumption it is still above the non-reform scenario. On the opposite, the real interest rate behaviour dominated in the case of the services reform and the reform has a further dampening effect on consumption, penalizing unconstrained (thus interest rate sensitive) consumers. These results may however hinge on the fact that constrained households are only one forth of the population. One may even conjecture that a global recessionary period may lead to an increase in the share of constrained households. If the share of constrained households was considerably larger, say twice as large, then the short run expansionary effect of reforms would actually be lower. The results of a similar reforms but with an increased share of constrained households (50% instead of 25%) is summarized in Figures 6 and 7. The different short run impact is due to a great extent to the response of investment which is decided by unconstrained households. In the case of a large share of constrained agents, the build up of capital, through investment, to reach

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the new (long run) supply capacity of the economy takes longer to materialize as do the reforms positive effects on demand. Constrained households consumption still performs better than the unconstrained consumers consumption but not by as much.

Focusing now on the impact of reforms on the length of the period when the lower bound bonds, while it remains unaffected in the labour market reform, the services sector reform allows the economy to escape the lower bound, given the upward impact on inflation from this reform in the short run. In fact, a major difference between these two types of reforms is the impact on inflation. While the wage reform leads to a greater fall of inflation that, with policy rates stuck at the zero lower bound, push upwards the real interest rate, the non-tradable sector reform has an inflationary impact (that pressures the real interest rate down) that ends up being sufficiently strong to drive the policy rates out of the zero bound.[16] In the case of the labour market reform, the reduction of wage markups pressures down labour costs in production of both in tradable and non-tradable goods and ultimately aggravates de fall in euro area consumer prices (as well as of the related components of the consumption bundle, in particular of those produced domestically). Differently, the services market reform is inflationary because, even though it eventually pushes downwards non-tradable price inflation in both euro area blocs, it impacts upwards price inflation of tradable-goods produced in the

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[16]Gerali, Notarpietro, and Pisani (2015) only analyse the case of the services market reform and focus on the case of Italy, but reach a similar conclusion regarding the impact of the reform on inflation.

two euro area blocs and of import prices (of the two blocs) amid a large real effective exchange rate depreciation (see Figure 8 for the impact of the coordinated services sector reform on the inflation rate of the different types of goods related to consumer price inflation[17]). The permanent reduction in the service sector markup is perfectly anticipated by the agents and as such there is an increased demand, namely for investment purposes, that leads to an increase in the demand for domestic and imported goods implying higher inflation also in these sectors. The implied increase in tradable goods (both domestic and imported) inflation ends up more than offsetting the decrease in services inflation. This explains that inflation falls by less than in the no-reform scenario and as such in this scenario the reforms actually drives the euro area economy out of the lower bound given the monetary policy response to these developments.

3.2.2 Unilateral reforms

In this section we explore the impact of reforms that are not carried out by all euro area countries and analyse the spillovers across euro area blocs. First we briefly comment the case where the large euro area bloc reforms but the small one does not. Then, we analyse the unilateral implementation of the reforms by the small euro area bloc.

Focusing on the case when the reforms are carried out by the large euro area bloc, as expected due to the very large size of the reforming bloc (more than 90%

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[17]To make the chart easier to read in the left panel of this figure we report the impact of the reform only on rest of the euro area variables . The impact on the small bloc is similar.

of the euro area) the responses of the main macroeconomic variables of the REA are both qualitatively and quantitatively similar to the coordinated case. Given the similarity of the responses of most variables we do not include figures in this case.

Despite the similarity of the REA responses compared to the coordinated reforms, two results are worth stressing: (i) the spillovers to the other euro area bloc are positive, i.e. the Home (small) bloc benefits from the reforms implemented elsewhere in the euro area, and (ii) the spillovers are larger in the case of the services sector reform and this is related to the fact that interest rates are at the lower bound.[18] In the case of the wage reform the Home bloc benefits from the increased demand for Home goods from the REA (REA consumption and investment are stimulated by the reform) while in the case of the services Home exports to the REA actually drop by more but the Home bloc benefits from a larger drop in the real interest rate. Note that, in the latter case, the fact that nominal interest rates do not rise by as much as in normal times, because they are constrained by the lower bound, amplifies the spillovers in crises times because real rates are lower in the Home bloc stimulating domestic demand. Finally, the performance of the main macroeconomic variables of the Home bloc are always better when the reforms are implemented simultaneously so the fact that spillovers are positive cannot be seen as an argument for inaction, as it comes with a cost.[19]

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[18]For an analysis of the spillovers of this type of reforms in the euro area in normal times see Gomes, Jacquinot, Mohr, and Pisani (2013).

[19]We abstract from the financing implications of reforms.

Focusing now on the case when the reforms are carried out only by the small euro area bloc, Figure 9 and 10 report the results. Given the small size of the reforming bloc, the spillovers to the REA are limited. This, together with the fact that monetary policy in the euro area responds to euro area wide variables, implies that when the reforms are implemented in a small bloc the policy rate remains virtually unchanged compared to the case of the global recession (i.e. without reforms). Thus, the period when the zero lower bound binds remains unchanged in the two types of reforms scenarios. In fact, since developments in a small euro area bloc have very limited (i.e. proportional to the size) impact on the response of monetary policy, the fact that reforms are carried out at the lower bound ends up not being significantly relevant, namely for the length of the lower bound period. Still, a few interesting results, namely compared to the coordinated/large bloc cases are worth stressing. In the Home bloc, similarly to the coordinated case (and the case of a large bloc reforming), the services sector reform accentuates the fall of domestic consumption (given that non-tradables produced in the small bloc will be cheaper in the future) but since firms anticipate the future increase in production, they start building up capital and investment falls less in the short run compared to the global recession scenario. However, in the case of reforms in the small bloc, the services reform pressures inflation downwards, leading to an increase in the real interest rate, contributing to depress domestic demand, in particular consumption. The deflationary impact of the non-tradable sector reform (which has been emphasized elsewhere in the literature on structural reforms and

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the lower bound, see Eggertsson, Ferrero, and Raffo (2014)) is rather different from the case of the coordinated reform (or the large bloc unilateral reform), where the reform is inflationary. The future permanent decrease in the services sector price markup leads to a very large fall in non-tradables goods inflation in the short run that is not offset by an increase in domestic tradables and import prices, see Figure 8. This is so because the increased demand for euro area goods is much smaller given that it is limited to those produced in the small bloc.

4 Robustness

In this section we provide a short of exercises carried out to asses how our results hinge on some of the assumptions made. We investigate the impact of changing the design of reforms and how they hinge on some crucial parameters.[20]

4.1 Gradual versus immediate implementation of reforms

In the benchmark simulations we assumed that the reforms are implemented gradually over a period of roughly five years.[21] So markups gradually converge to the new steady state level, to reflect the fact that implementation of reforms usually takes time. However, the period over which it is implemented until markups reach their new level is somewhat arbitrary and by being implemented gradually then

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[20]We have also checked if the impact of the reforms depends on the initial conditions of the simulations, i.e. starting from the steady state or from a deep recession (to isolate the desired effect, we do not impose the lower bound so that there is no impact from this non-linearity). We find that the impact of initial conditions is very small.

[21]After five years the markups have basically reached their new steady-state level.

results might only materialize with some lag. As such we compare the benchmark results with a situation in which the implementation is not gradual but instead that markups quickly (i.e. in one period) jump to their new long-run level. This means that each reform is fully implemented in the fourth period of the simulations (markups thus jump to their new steady-state levels) and this is unanticipated by the agents. Figures 11 and 12 report the results of this alternative scenario. The immediate implementation of reforms continues to have a positive short run impact on GDP, but some differences are worth mentioning. In the case of the labour market reform the results are very similar. The major differences are in the case of the services market reform. In fact, while in the gradual reforms there is a postponement of consumption to when services will be cheaper, this no longer happens. This, together with a somewhat more favourable response of investment leads to a more positive impact. On the other hand, inflation no longer increases as the reforms leads to a much milder depreciation of the exchange rate on impact. This implies that the services market reform is no longer successful in reducing the lower bound period.

4.2 Parameter sensitivity

Figures 13 and 14 report the effects on euro area GDP, CPI inflation and nominal interest rate of euro area-wide reforms in the labour and services sectors, respectively, for alternative values of key parameters. We investigate the impact of changing the Frisch labour elasticity (set to 0.33 instead of 0.5) and lower elas-

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ticities of substitution between tradables and non-tradables (set to 0.5 for both consumumption and investment goods, compared to 2.5 and 4.3 in the original calibration, respectively), domestic tradables and imports and imports from different origins (in both cases, set to 1.5 instead of 2.5 in the case of consumption bundle and to 3.0 instead of 4.3 in the case of the investment bundle).[22] The main takeaways from these exercises are that the qualitatively our main results are broadly robust to changes in the considered parameters, even though there are as expected some differences on the magnitudes of the effects. The short run impact of reforms continues to be positive and the binding lower bound period is generally not altered.

5   Concluding remarks

This paper analyses the impact of implementing structural reforms when an economy that is in a deep recession that led interest rates to the lower bound. We focus on the euro area. While the long-run impact of an increase in competition in the labour and services markets is positive, the short term impact depends on a number of characteristics of an economy, including the response of monetary policy. We use a large scale fully structural model of the euro area because: (i) by being multi-sectoral it allows for investigating reforms in the services market and in the labour market; (ii) by being multi-country, in particular by formalizing the euro

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[22]We have also run the exercises separately but as a summary in the figures we only present the scenario where we change all the trade elasticities simultaneously.

area as a two-bloc monetary union it allows us to analyse the issue of coordination and spillovers of reforms within the euro area; (iii) by including different types of agents it allows to explore the importance of having financially constrained agents for the reforms impact.

We find that structural reforms are short run positive impact, that the reforms have differentiated impact across different types of households, that unilateral reforms in a large bloc have positive spillover effects within the euro area, and that an increase in the share of constrained households reduces the short run macroeconomic benefits of reforms. A reform in the small bloc euro area bloc has very different results for inflation that in this case falls, as the large fall in non-tradable inflation is not offset by changes in inflation of tradable goods. However given the very small size its impact on euro area monetary policy is negligible, thus enacting the reforms at the lower bound is no longer relevant.

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Table 1: Steady-State National Accounts (percentage of GDP)

	Home	REA	US	RW
Private consumption	54.7	60.0	64.0	64.0
Private investment	24.0	20.0	20.0	20.0
Public expenditure	21.3	20.0	16.0	16.0
Imports	28.7	12.2	8.7	8.1
Public debt (% of yearly GDP)	60.0	60.0	60.0	60.0
Share of services sector	52.0	56.1.4	60.3	60.3
Share of world GDP	1.3	19.9	29.9	48.9

Notes: REA=Rest of euro area; US=United States; RW=Rest of the world.

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Table 2: Households and Firms Behavior

	Home	REA	US	RW
Households				
Subjective discount factor	$1.01^{-0.25}$	$1.01^{-0.25}$	$1.01^{-0.25}$	$1.01^{-0.25}$
Depreciation rate	0.025	0.025	0.025	0.025
Intertemporal elast. of substitution	1.0	1.0	1.0	1.0
Habit persistence	0.75	0.75	0.75	0.75
Inverse of the Frisch elast. of labour	2.00	2.00	2.00	2.00
Share of constrained agents	0.25	0.25	0.25	0.25
Tradable Intermediate Goods				
Cobb-Douglas bias toward capital	0.27	0.20	0.19	0.21
Nontradable Intermediate Goods				
Cobb-Douglas bias toward capital	0.32	0.35	0.30	0.30
Final consumption goods				
Substitution btw domestic and imp. goods	2.50	2.50	2.50	2.50
Bias toward domestic goods	0.20	0.79	0.82	0.82
Substitution btw tradables and nontrad.	0.50	0.50	0.50	0.50
Bias toward tradable goods	0.45	0.45	0.35	0.35
Final investment goods				
Substitution btw domestic and imp. goods	4.30	4.30	4.30	4.30
Bias toward domestic goods	0.07	0.76	0.82	0.63
Substitution btw tradables and nontrad.	0.50	0.50	0.50	0.50
Bias toward tradable goods	0.75	0.75	0.75	0.75
Imports				
Substitution between consumption imports	2.50	2.50	2.50	2.50
Substitution between investment imports	4.30	4.30	4.30	4.30

Notes: REA=Rest of euro area; US=United States; RW=Rest of the world.

Table 3: Real and Nominal Rigidities

	Home	REA	US	RW
Real Rigidities				
Investment adjustment	6.00	6.00	4.00	4.00
Variable cap. utilisation	0.007	0.007	0.007	0.007
Import adjustment (consumption)	2.00	2.00	2.00	2.00
Import adjustment (investment)	1.00	1.00	1.00	1.00
Nominal Rigidities				
Households				
Wage stickiness	0.75	0.75	0.75	0.75
Wage indexation	0.75	0.75	0.75	0.75
Manufacturing				
Price stickiness (domestically produced goods)	0.92	0.92	0.75	0.75
Price indexation (domestically produced goods)	0.50	0.50	0.50	0.50
Price stickiness (imported goods)	0.25	0.75	0.75	0.75
Price indexation (imported goods)	0.50	0.50	0.50	0.50
Services				
Price stickiness	0.92	0.92	0.75	0.75
Price indexation	0.50	0.50	0.50	0.50

Notes: REA=Rest of euro area; US=United States; RW=Rest of the world.

Table 4: Monetary Policy

	EA	US	RW
Inflation target	1.02	1.02	1.02
Interest rate inertia	0.0	0.0	0.0
Inflation gap parameter	2.0	2.0	2.0
Output growth parameter	0.75	0.75	0.75

Notes: EA=Euro area; US=United States; RW=Rest of the world.

Table 5: Price and Wage Markups

	Home	REA	US	RW
Manufacturing (tradables) price markup	1.15	1.15	1.15	1.15
Services (nontradables) price markup	1.35	1.35	1.25	1.25
Wage markup	1.35	1.35	1.25	1.25

Notes: REA=Rest of euro area; US=United States; RW=Rest of the world.
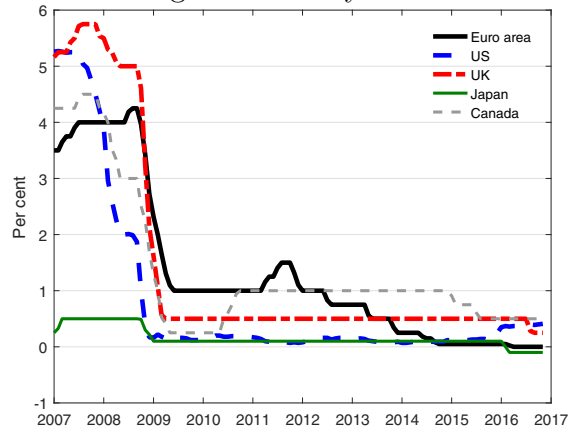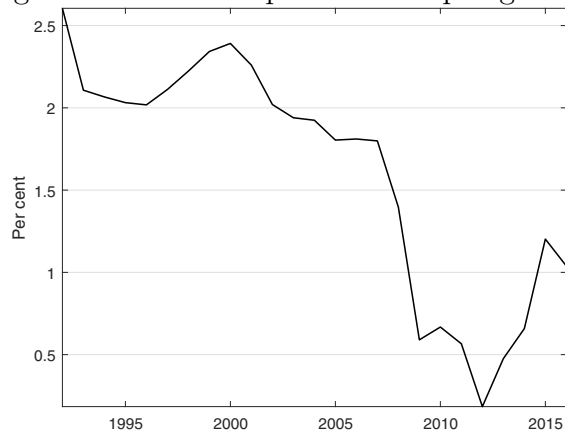
Figure 1: Policy rates

Figure 2: Euro area potential output growth

Source: European Commission AMECO database and author's calculations.
Note: Euro area with 19 countries. Before 1998, backdated with data for the euro area with 12 countries.

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Figure 3: Euro area wide labour market reform
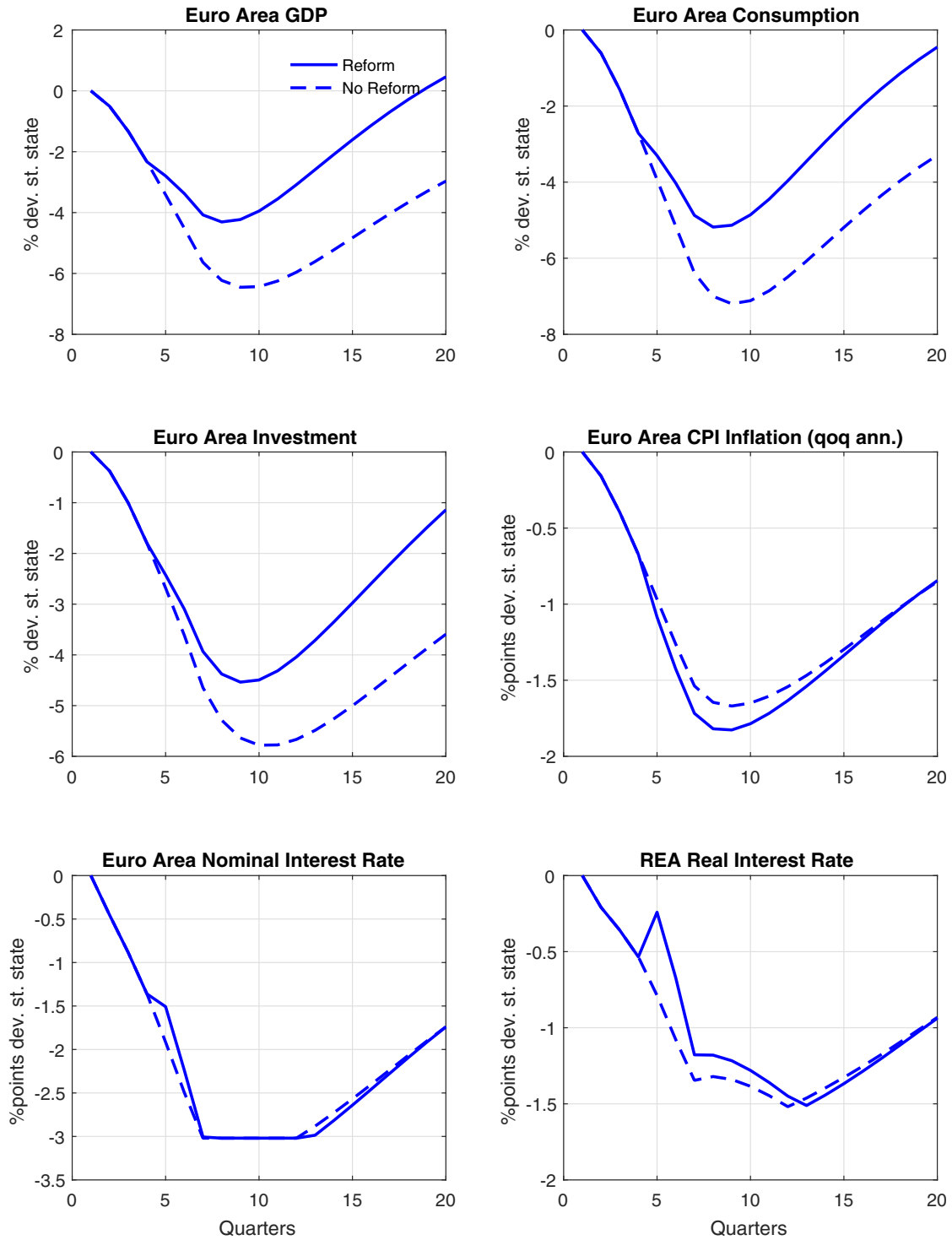
Figure 4: Euro area wide services market reform
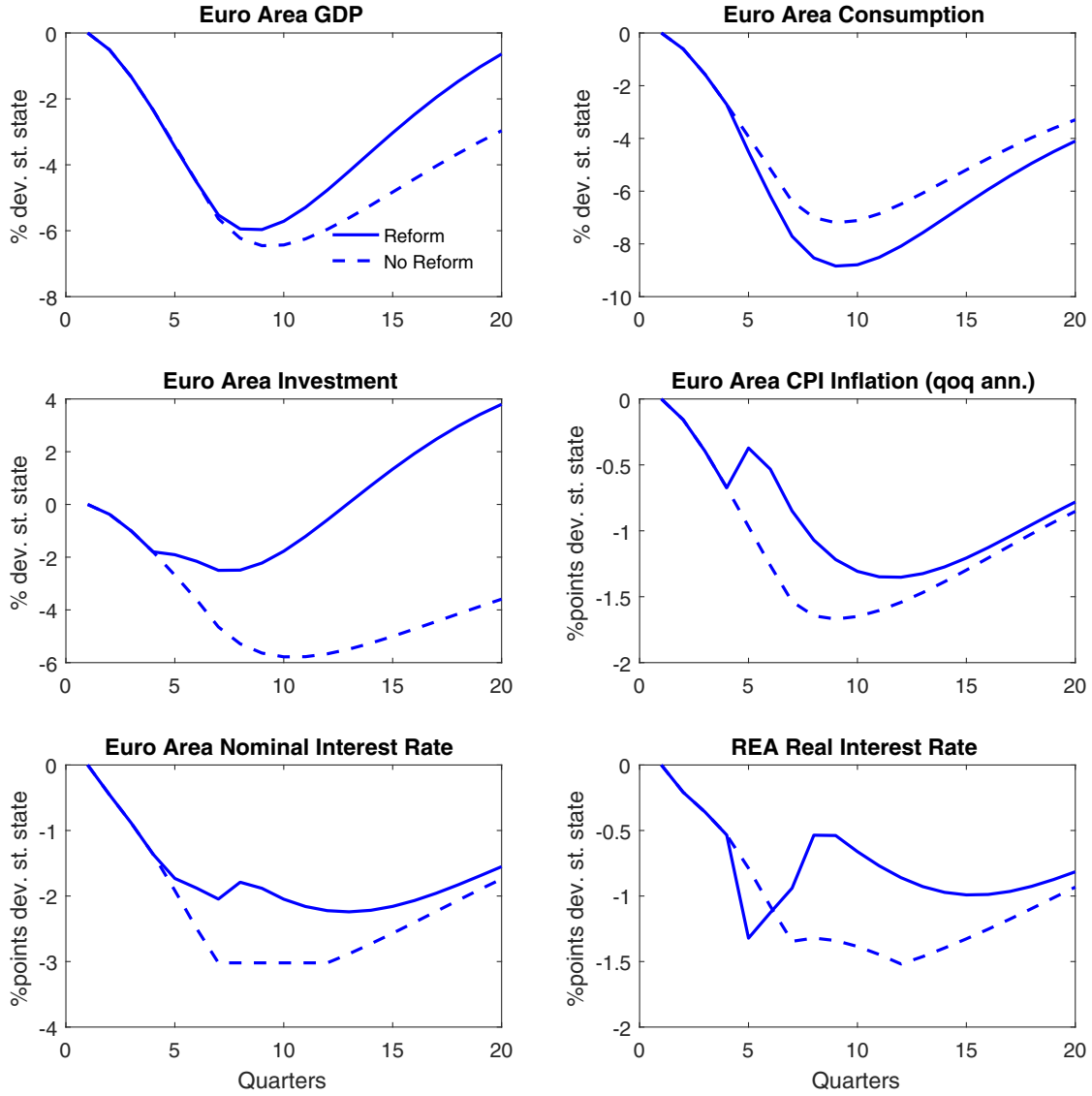
Figure 5: Euro area wide reforms - consumption on different types of households
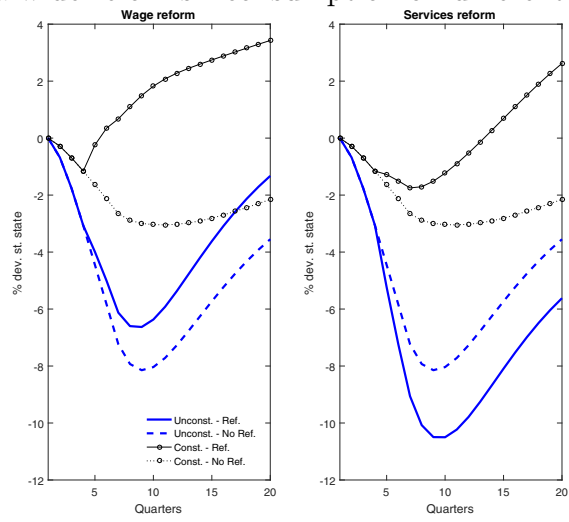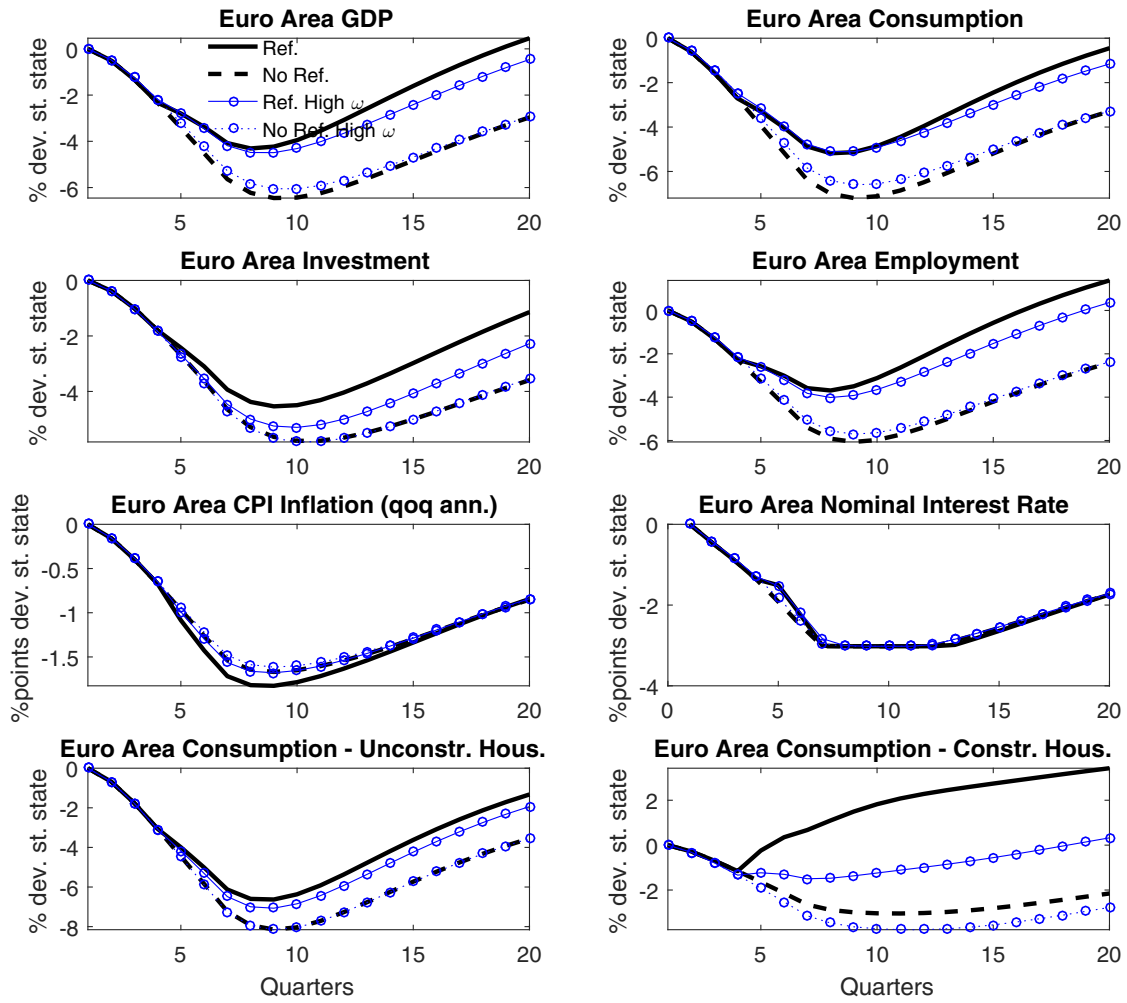
Figure 6: Euro area wide labour market reform - High omega

Figure 7: Euro area wide services market reform - High omega
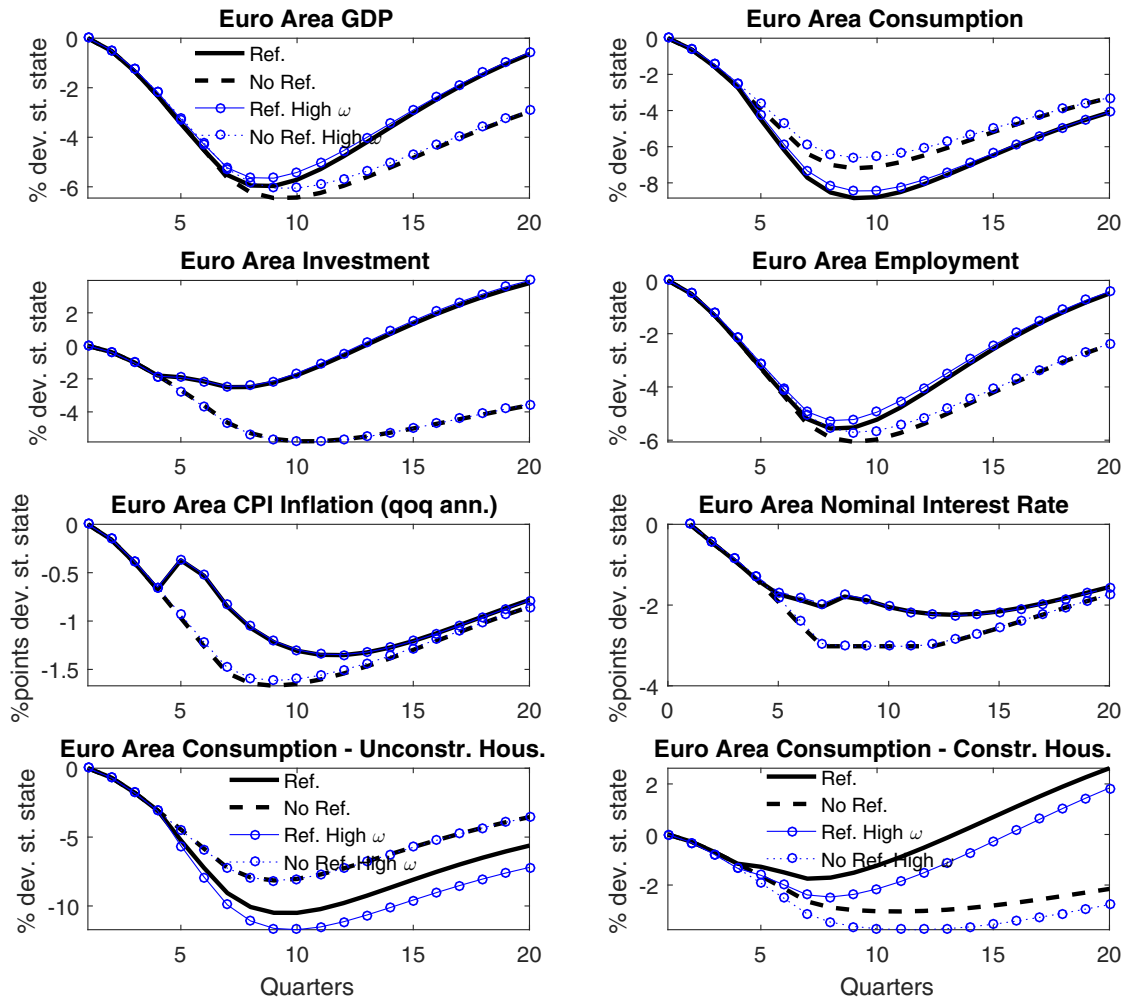
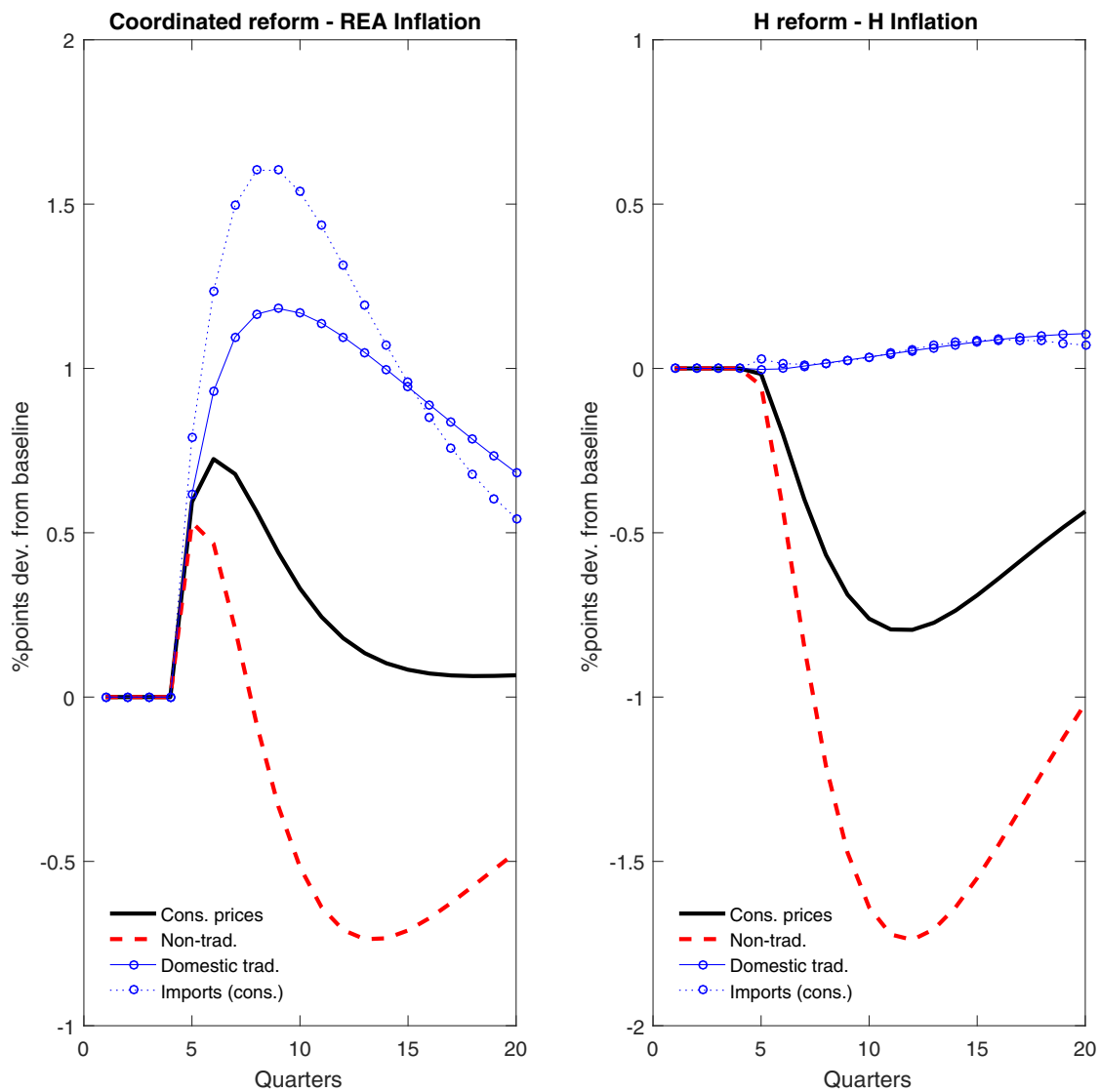Figure 8: Coordinated and unilateral services markets reforms - Consumer price inflation response

Coordinated reform - REA Inflation

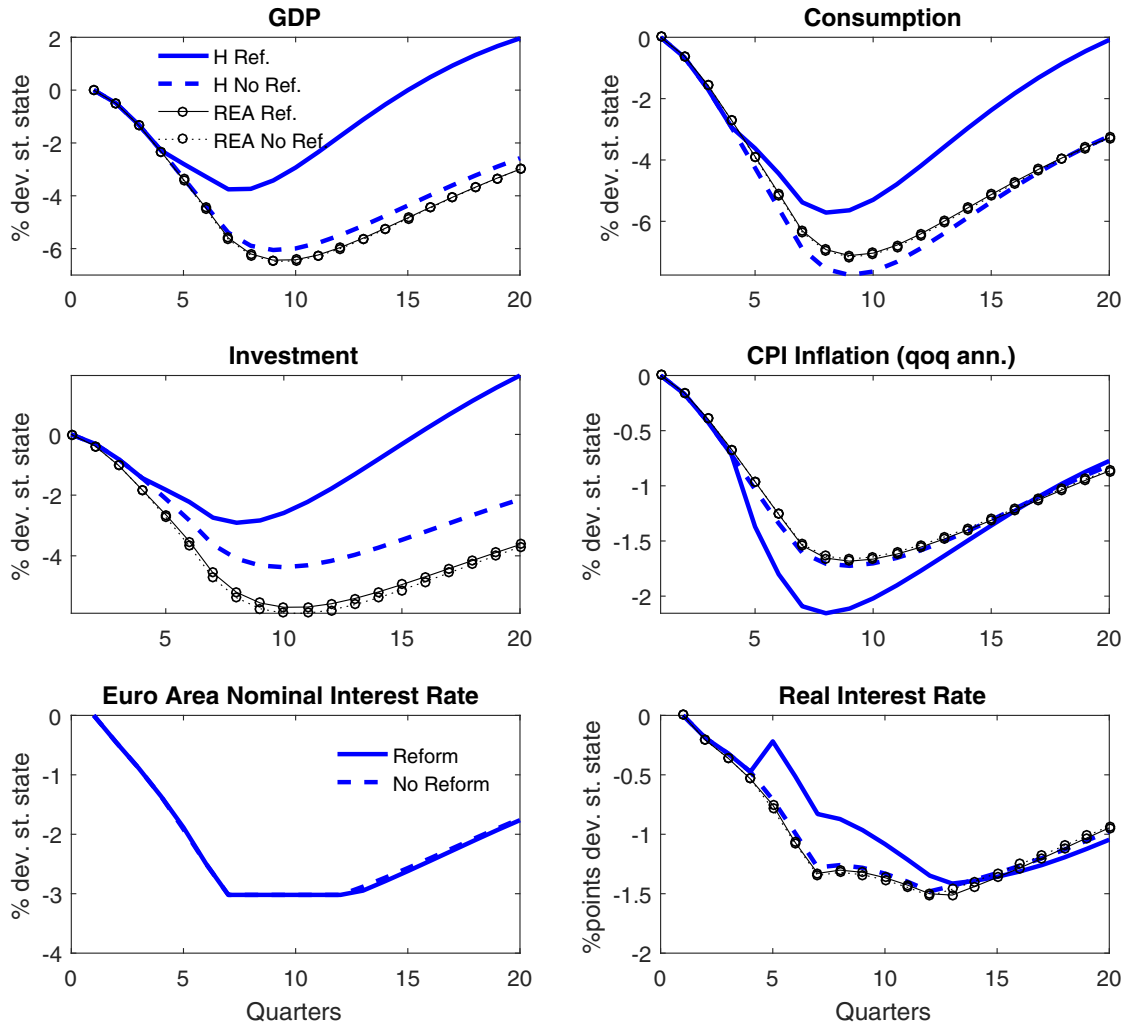**H reform - H Inflation**

Figure 9: Labour market reform in a small euro area bloc

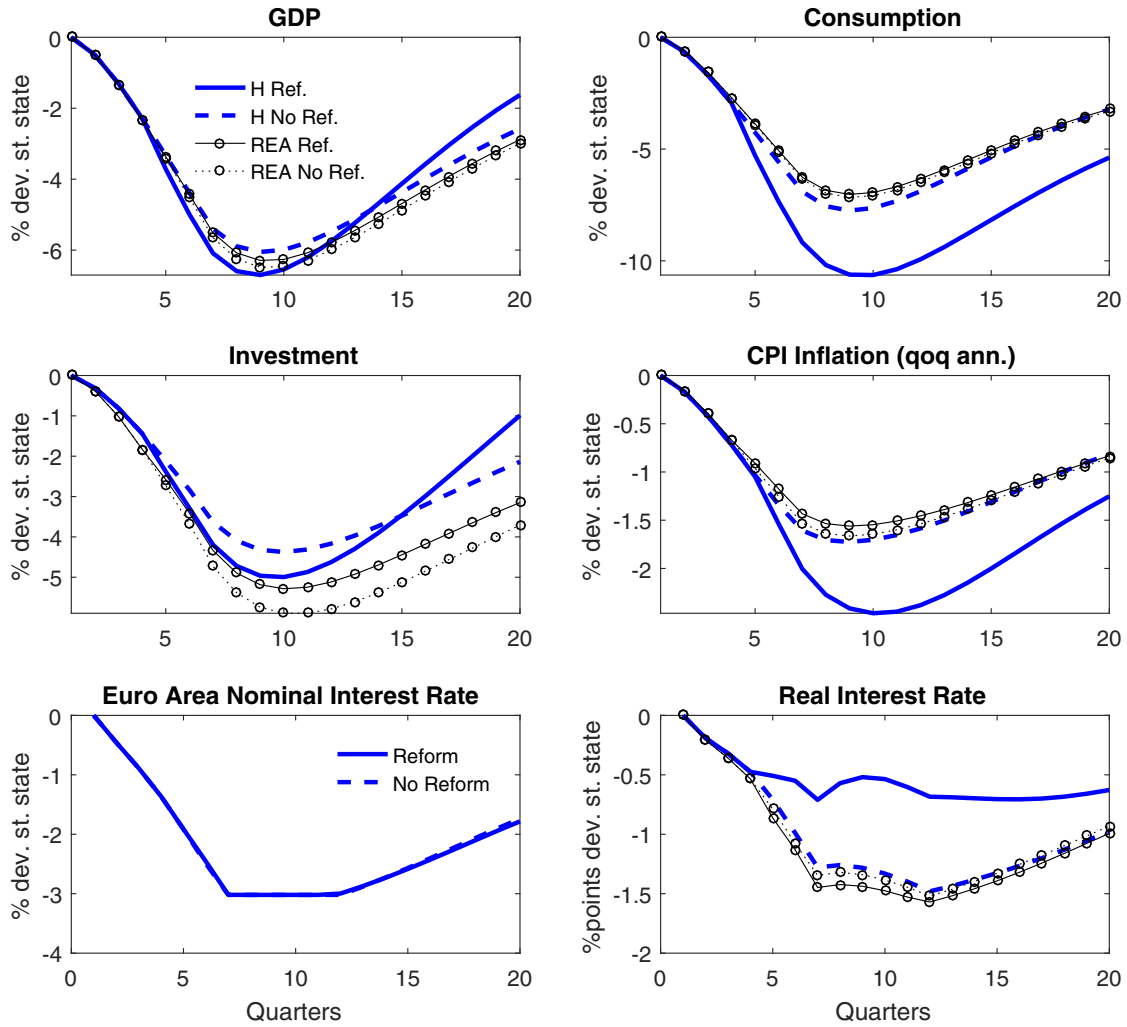Figure 10: Services market reform in a small euro area bloc

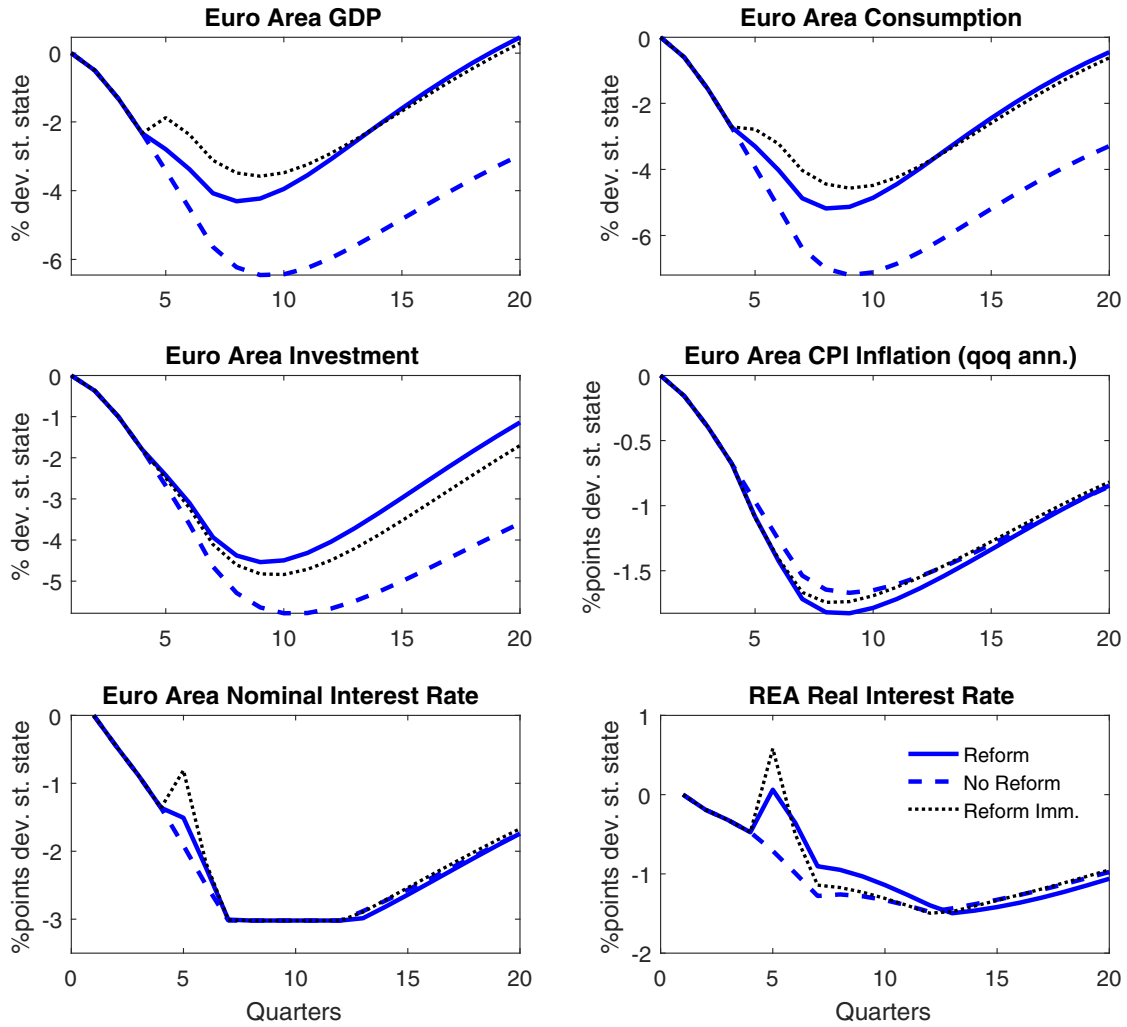Figure 11: Euro area labour market reform: immediate implementation

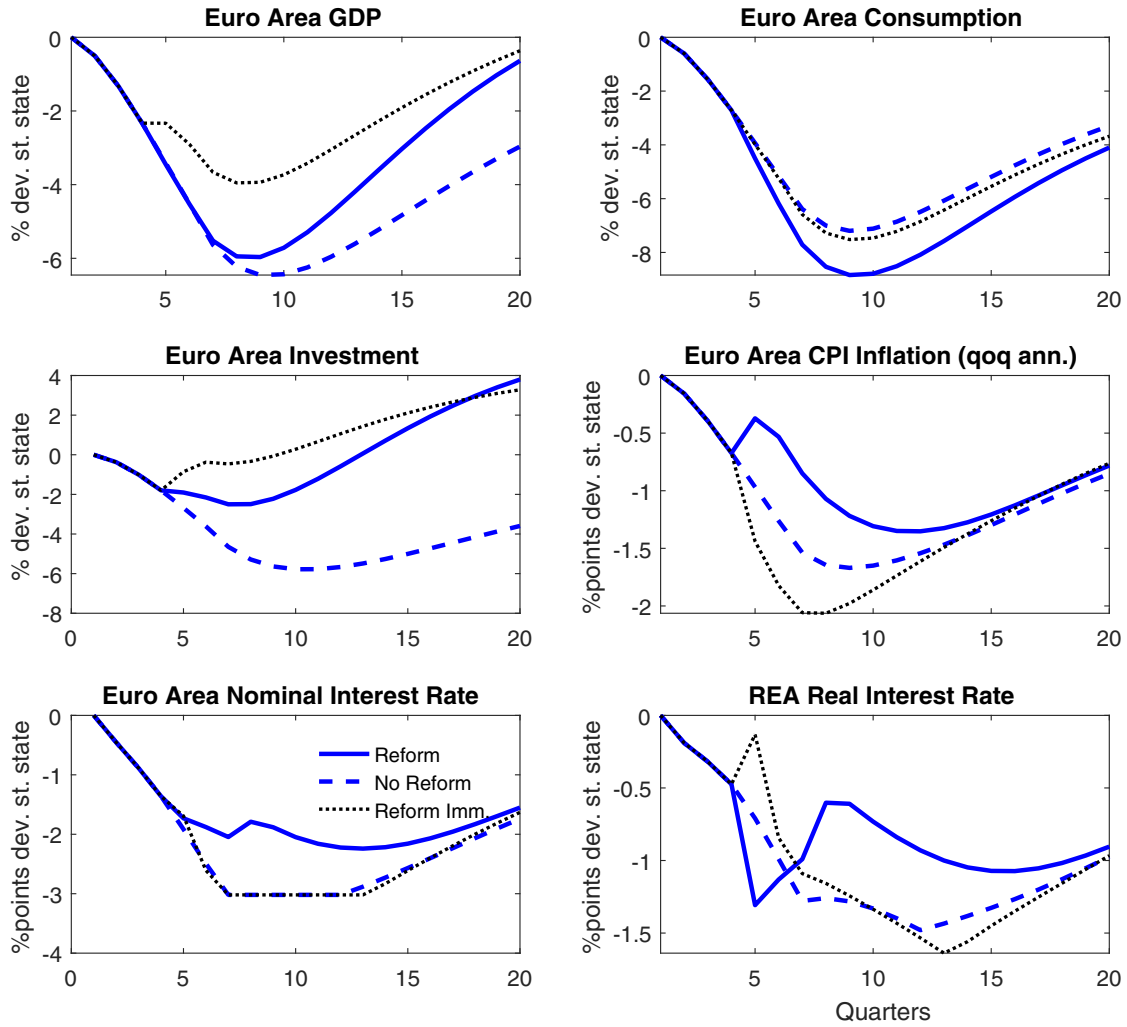Figure 12: Euro area services market reform: immediate implementation

Figure 13: Euro area labour market reform: sensitivity

Euro Area GDP — **Euro Area CPI Inf. (qoq ann.)** — **Euro Area Nom. Interest Rate**

Reform
No Reform
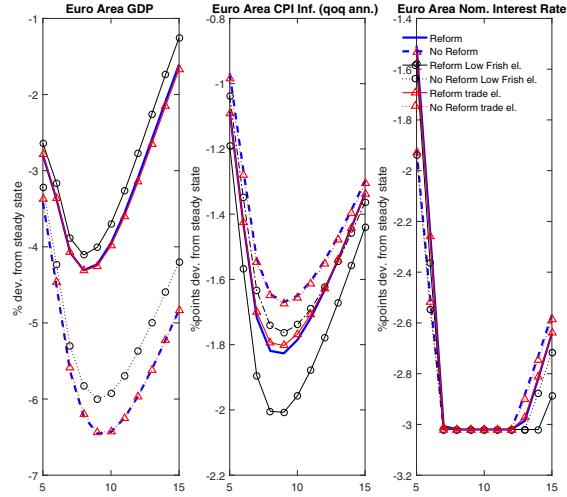Reform Low Frish el.
No Reform Low Frish el.
Reform trade el.
No Reform trade el.

Figure 14: Euro area services market reform: sensitivity

Euro Area GDP — **Euro Area CPI Inf. (qoq ann.)** — **Euro Area Nom. Interest Rate**

Reform
No Reform
Reform Low Frish el.
No Reform Low Frish el.
Reform trade el.
No Reform trade el.