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How openness to trade rescued the Irish economy

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In this paper we examine the performance of the Irish economy over the period 2008 to 2014. In particular we examine whether the recovery observed was due to the successful adoption of structural reforms in labour and product markets or whether the improved performance was due to a rebalancing of the Irish economy, post 2008, away from the disproportionate influence of the construction (non-tradable) sector and back to the more productive tradable sector? Prior to 2007 had seen the emergence of a significant, property-related credit boom which resulted in the Irish economy being increasingly influenced by the non-tradable sector. This was in sharp contrast to the earlier period of the Celtic tiger, which had mainly relied on export-orientated growth. We use a small open economy DSGE model with a tradable and a non-tradable sector to examine this issue. Our results suggest that the financial crisis acted as a rebalancing mechanism for the Irish economy, with the tradable sector contracting less and recovering quicker than the non-tradable sector. Our model-based simulations indicate that the Irish recovery is mostly export-driven with structural reforms playing a very minor role in stimulating growth in the immediate period after the crisis.

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1. Introduction

The remarkable recovery in the Irish economy since 2013 has surprised most observers. Having been particularly impacted by the international financial crisis of 2007/08, Irish economic activity has, since 2013, grown significantly, outpacing the rest of the Euro Area. Indeed the recent performance of the Irish economy is reminiscent of the earlier "Celtic Tiger" era; between 1995 and 2007, the Irish economy, on average, grew by 7.3 % per annum – over three times the Euro area average for the period. Unemployment, which had been stubbornly high in the Irish economy through the 1980s and early 1990s averaged just over 4.5 per cent between 2000 and 2007. However, given the emergence of a property related, credit bubble by 2007, the economy was particularly susceptible to the international financial crisis of 2007 and 2008. The Irish real estate boom saw the construction sector, both residential and commercial, assume a disproportionate influence on domestic economic activity by 2007. As a result, with the emergence of a toxic negative feedback loop between the sovereign and the Irish banking sector, formalised by the Irish Government guaranteeing the liabilities and assets of the banking sector in September 2008, the economy experienced one of the sharpest contractions amongst Euro Area countries. Unemployment went from over 4 per cent to 14.5 per cent in just 3 years, while Irish output fell by 8 per cent between 2007 and 2009.

The underlying difficulties in the financial sector, given the property bubble, and the resulting fiscal burden on the State, saw Ireland enter a programme of support in October 2010 with the European Union, the European Central Bank and the International Monetary Fund (commonly referred to as the "the troika"). As with most programmes of support, the Irish State were committed to fulfil certain "objectives" in order to satisfy the terms and conditions for the subsequent financing provided (see European Economy (2011)). These objectives centred on restoring financial stability, fiscal policy reform and structural reforms. While most of the attention concerning the performance of the Irish programme has centred on the first two objectives (see Schoenmaker (2015) for a review of financial sector measures and McCarthy (2015) for an overview of the role played by fiscal consolidation), very little attention has been devoted to the role played by structural reforms in the Irish recovery.

However, structural reforms have long been heralded by international institutions such as the IMF, the European Commission and particularly the OECD, amongst others, as a means of improving the growth potential of individual economies. Consequently, the obligation to

undertake such reforms is frequently an important condition of support programmes extended to individual countries. Given the subsequent substantial performance of the Irish economy, it is now appropriate to assess whether the structural reforms proposed in the original adjustment programme were a contributing factor to this recovery? Clearly, if the adoption of certain structural reforms were influential in influencing the recovery, the programme of support given to the Irish State could serve as a successful template for other struggling European countries?

In this paper, using a DSGE modelling framework, we critically appraise the performance of the Irish economy over the period 2008 to 2014. Using a model with a tradable and non-tradable sector, we examine whether the reason for the Irish recovery was due to a rebalancing of the Irish economy, post 2008, away from the disproportionate influence of the construction (non-tradable) sector and back to the more productive tradable sector. Using the same framework, we contrast this with the role that structural reforms played in the Irish recovery. Our results suggest that the financial crisis acted as a rebalancing mechanism for the Irish economy, with the tradable sector contracting less and recovering quicker than the non-tradable sector. Our model-based simulations indicate that the Irish recovery is mostly export-driven with structural reforms playing a very minor role in stimulating growth in the immediate period after the crisis.

Our paper contributes to the literatures on the Irish crisis and recovery and on structural reforms in the context of Dynamic Stochastic General Equilibrium (DSGE) models. On the one hand, a strand of the literature empirically assesses the Irish crisis and recovery[3] see e.g. Whelan (2014) and Barry and Bergin (2018). Here by contrast, we examine the empirical facts through the lenses of a general equilibrium model. To the best of our knowledge, this is the first paper that provides a unified narrative of the Irish crisis and recovery using this framework. On the other hand, there is a vast literature which studies structural reforms[4] under various DSGE setups see e.g. Forni et al. (2010), Eggersson et al. (2014), Cacciatore et al. (2012), Gomes et al. (2013), Gerali et al. (2014) and (2015), Papageorgiou and Vourvachaki (2016), Sajedi (2016) and Koliousi et al. (2017). In our paper, we focus on the Irish economy and examine the potential role of structural reforms over the 2008-2014 recovery.

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[3] For a detailed report on the various aspects of Irish crisis and recovery also see also CESifo 2014.
[4] Several theoretical and econometric studies have been conducted for structural reforms selective references include Babecký and Campos (2011), Fatas (2016), De Grawe and Ji (2017), Whelan and McQuinn (2018). For an exhaustive and critical overview of the literature on structural reforms see Campos et al. (2017) and references therein.

The rest of the paper is laid out as follows; in the next section we review the performance of the Irish economy over the period 1990 – 2014, focussing on three sub-periods. In section 3 we present our theoretical model in an informal setup. Section 4 solves the model and describes the various simulated scenarios while section 5 discusses the results of the modelling simulations. A final section offers some concluding comments.

2. The Irish Economy: 1990 - 2014

In reviewing Irish economic performance over the period 1990 – 2014, we examine three particular sub-periods; initially, between 1990 and 2001 we examine the role of openness to trade in Irish income levels converging with those of the EU richest countries; then, we discuss the Irish credit and housing bubble that lead to the emergence of imbalances in the Irish economy between 2001 and 2007. Finally, post 2008, we examine the role the international, financial crisis played in rebalancing Irish economy with exports, in particular, being a key driver of post-crisis Irish macroeconomic dynamics.

2.1. Convergence through trade openness

The remarkable economic performance of the Irish economy since late 80's/early 90's is well documented. Ireland real cumulative GDP growth summed to 128% from 1988 to 2007 implying an annual average growth of 6.4%. The reasons for the exceptional growth have been examined in length in Fitzgerald (2000), Honohan and Walsh (2002), Whelan (2014) and more recently Klein and Ventura (2018). Here, we focus on the role played by international trade and trade openness in influencing Irish growth during this period.

As can be seen in Figure 1, trade as a share of GDP in Ireland had already been among the highest in the European Union since the late 1980's early 1990's. However, from the early 1990's onwards external trade[5] accelerated sharply rendering Ireland one of the most open to trade economies globally. In 2001, international trade[6] was 1.7 times Irish GDP, while the analogous figures in select core and periphery EU countries were below 0.8 with the exception of Netherlands.

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[5] Much of Ireland's trade is in electronics, pharmaceuticals, other chemicals and medical instrumentation – see Barry and Bergin (2012) for more details.
[6] As indicator of trade openness we employ the sum of imports and exports as a share of GDP which is widely used see e.g. OECD (2011).

The trajectory of GDP per capita closely follows the path of international trade as illustrated in the left panel of Figure 1. It is the exceptional degree of trade openness, among other factors, which underpins Ireland's economic convergence with the richest EU countries in the late 90's and, as we argue below, it is this openness which appears to be a key driver of the Irish recovery after the Global financial crisis.

Figure 1: Trade openness and GDP per capita of the Irish Economy since 90's
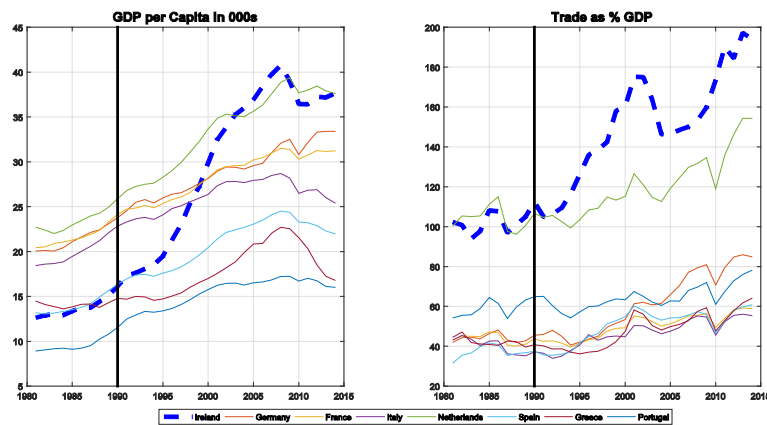
Source: Eurostat; Notes: Trade is defined as the sum of exports and imports.

In general, the change in Irelands trading performance over the period 1990-2001 is quite remarkable. In Figure 2 we plot some key international variables, showing exports (imports) to GDP ratio increases from 40% (40%) in 1990 to 92% (80%), while the FDI to GDP ratio goes from 1.26 in 1990 to 25.8 in 2001. Finally, over the same period, the Irish trade balance went from 0% to 12%. As a result, over this period the tradable sector, mostly dominated by foreign affiliated firms, expanded significantly vis-a-vis the non-tradable sector.

Figure 2: Other Irish international macro variables (as % of GDP)
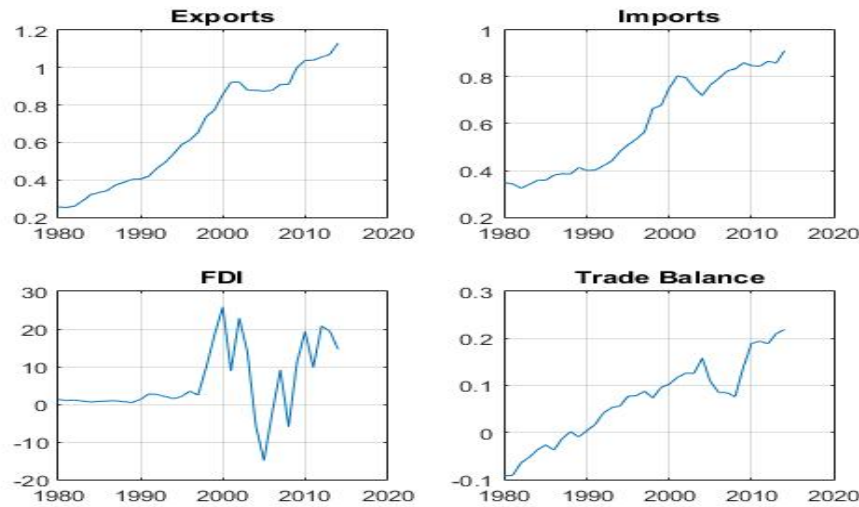
Sources: UNCTAD and OECD. Notes: Exports/Imports of goods and services; FDI is measured as inward inflow.

2.2. Emergence of the Irish Property Bubble: 2004 – 2007

The emergence of the Celtic Tiger in the mid-1990s resulted in a significant increase in Irish living standards with real incomes growing considerably. With declining interest rates due to accommodative monetary policy at the same time, the domestic property market experienced a substantial increase in affordability and consequently demand. Additionally, the housing stock per capita in Ireland was by the mid-1990s one of the lowest in Europe.[7] Real Irish house prices grew by nearly 9 per cent per annum between 1995 and 2007.

While the initial phase of increased activity in the housing market 1995 – 2003 is typically attributed to developments in underlying fundamentals in the market, the period 2004 – 2007 is characterised by the emergence of a credit based property bubble (see McCarthy and McQuinn (2017) for more on this). The increased ability of Irish financial institutions to borrow from credit institutions abroad, coupled with the easing of credit conditions in the domestic market, saw a significant increase in mortgage and construction credit issued. The dramatic increase in credit vis-à-vis GDP in the Irish economy can be observed from Figure 3.

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[7] In 2000, in an OECD cross-country sample of dwellings per 1000 inhabitants, the Irish housing market had the 5th lowest number of dwellings per population out of a sample of 31 countries.

As a result, house construction levels soared with annual house completions averaging 84,000 units between 2004 and 2006. This resulted in the investment to GDP ratio in Ireland rising to 29.1 per cent in 2006 (relative to 22.0 per cent in the EU). Between 2003 and 2007, investment in housing in Ireland averaged 12 per cent of GDP, more than double the European average. Employment levels in construction increased by 75 per cent between 2000 and 2007. As a result, by early 2008, approximately 1 in 8 workers were employed in the construction sector in Ireland, relative to 1 in 12 in the EU. Consequently, the significant increase in construction related activity resulted in productive resources in the domestic economy being reallocated towards the non-tradable sector (see also section 2.3).

The international financial crisis of 2007 and 2008 lead to a swift decline in investor confidence in Irelands' property sector given concerns about a price bubble and significant oversupply. The housing market collapse began in 2008, with prices declining on average by 10 per cent in nominal terms in each of the years to 2013. Annual house completions dropped by 91 per cent (from a peak of 93,000 units in 2006) to a low of 8,300 units in 2013. Finally, the number of persons employed in the construction sector dropped by two thirds.

Figure 3: Credit to Gross National Income (%): 1990 - 2017
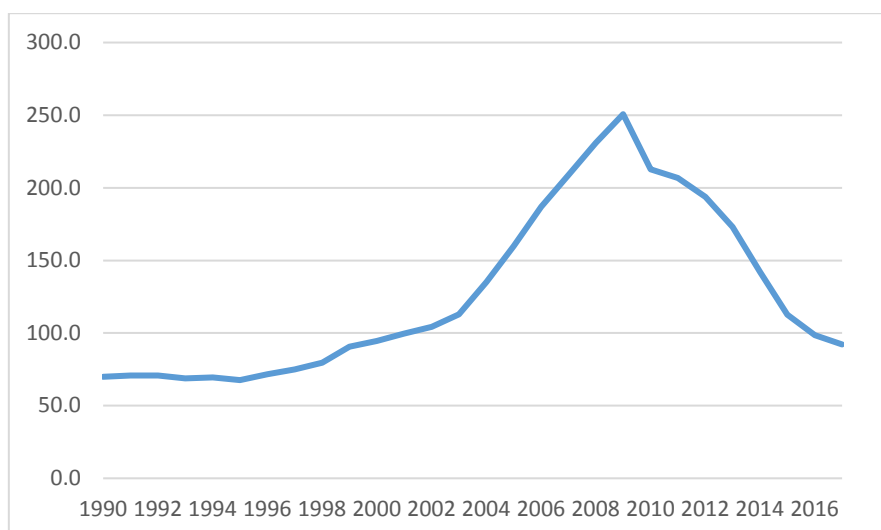
Source: CSO and Central Bank of Ireland; Notes: Own calculations.

2.3. Post 2008: The international financial crisis as a rebalancing mechanism?

In this section, we examine the effect of the international financial crisis of 2007/08 on the structure of the Irish economy at that time and on its subsequent economic performance. The evidence suggests that post 2008 the Irish economy rebalances away from the disproportionate impact of the non-tradable sector back to the tradable sector. This happens due to the combination of the collapse of the construction sector, which reduces the size of the non-tradable sector and the increase in exports which sees a sizeable increase in the tradable sector.

To examine the effect of the crisis on the structure of Irish economy we decompose GDP growth into two main components: domestic demand and net exports. As can be seen in Figure 4, from 2001 to 2007 the main driver of real GDP growth is domestic demand mainly fuelled by the credit and construction boom. In particular, domestic demand (represented by the blue bars) contributes more than 80 per cent to annual real GDP growth. However after 2008-09, domestic demand falls significantly due to the collapse of the housing bubble and does not recover until 2014. On the other hand, pre-2008 net exports contribution to real GDP growth is either small or negative, but it increases in the first years after the crisis compensating for the collapse of domestic demand.

Using this decomposition, 2008 emerges as a turning point not only for real GDP growth but also for its constituent components. Before 2007 it is evident real GDP growth is primarily domestic demand driven whereas from 2008 onwards net exports substitute domestic demand as the main determinant of growth.[8] From 2001-2007 the contribution of domestic demand averages 5.1%, whereas for 2008-2014 the equivalent figure is -0.02%. In contrast, net exports contribution averages -1% between 2001 and 2007 and then 2.04% between 2008 and 2014.

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[8] Notice that in 2014 domestic demand seems to contribute relatively more to GDP growth, this can be mostly attributed to the partial recovery of domestic investment that collapsed in 2008. Thus, any pick up observed is from a very low base.

Figure 4: Contribution of domestic demand and net exports to real GDP growth (2001-2014)
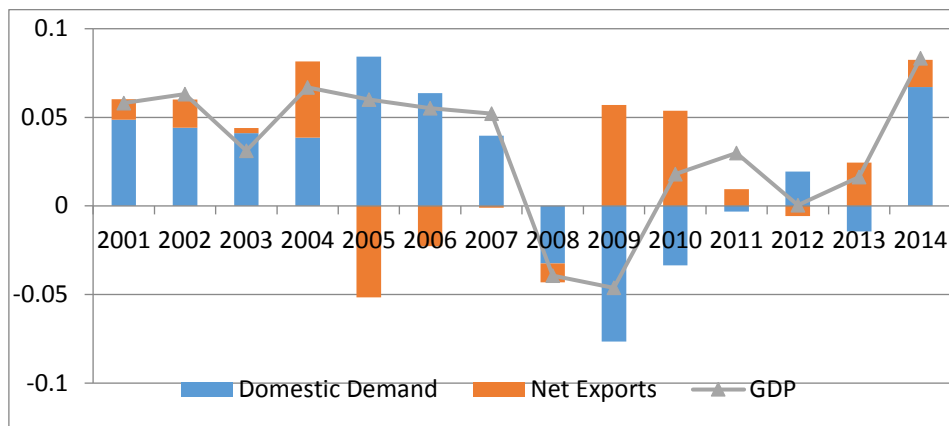
Source: Eurostat; GDP and main components, chained linked volumes (2010); Notes: y-o-y growth rates

Similar evidence can be inferred from decomposing total output (measured in GVA terms) into two sectors: tradable and non-tradable. We choose this categorization for two reasons: first, it is of particular relevance for our study of the Irish crisis and recovery; Ireland is a small open economy that relies on international trade, thus decomposing output into tradable and non-tradable sectors enables us to disentangle the effect of exports which operates through the tradable sector from any other effects (for e.g. fiscal policy and structural reforms). Second it allows us to establish a link between the empirical part of the paper and the theoretical DSGE model which we develop in the second part.

Figure 5 plots GVA in the tradable and non-tradable sectors[9] from 2001-2014. The tradable sector was less impaired by the crisis than the non-tradable sector. In particular, it declines temporarily and recovers sharply towards its pre-crisis trend. In contrast, the non-tradable sector enters a prolonged period of recession while it converges slowly towards a lower trajectory. Thus, sectoral outputs respond asymmetrically in the aftermath of the crisis. In the post-crisis period, the share of the tradable sector expands while the share of the non-tradable shrinks.

In Figure 6, we show that the increase in tradable output is accompanied by a resource reallocation of productive factors, like investment and employment, towards the expanding sector of the economy. Moreover, sectoral investment and employment shares indicate the

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[9] We allocate all NACE activities for Irish economy to two sectors, i.e. tradable and non-tradable following Bergin et al. (2017).

nature of the underlying imbalances in the Irish economy; namely, the misallocation of resources towards the overheated non-tradable sector and out of the tradable sector over 2001-2007 and the reversal of this trend after 2008 crisis (for example the employment and investment share increases in the tradable sector post 2008 – see orange square lines).

Figure 5: Tradable and non-Tradable GVA 2001-2014
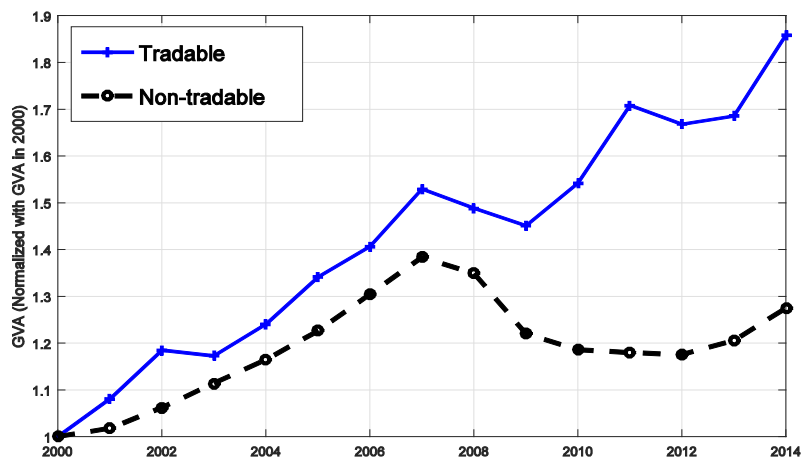
Source: Eurostat; Gross Value Added-chain linked volumes (2010), Total -all NACE activities.

Figure 6: Share of productive factors in the tradable and non-tradable sector

Source: CSO and ESRI database. Notes: Shares are computed divided by total employment in private tradable and non-tradable sectors, while we exclude public employment.

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### 2.4. The role of structural reforms over 2008-2014

So far our analysis focuses on the export-driven narrative of Irish recovery. Given the importance attached to structural reforms in driving the recovery of economies, in this section we examine the performance of the Irish economy in adopting structural reforms post 2008 as measured by OECD product and labour market deregulation indicators.

In particular, in the left panel of Figure 7 we present the broad product market regulation (PMR) indicator for Ireland, comparing it with OECD and EU averages. PMR indicator measures liberalization in product markets in a scale ranging from 0 to 6, where 0 stands for perfect competition and 6 for fully regulated product market. PMR averages scores from three sub-indicators, i.e. state control, barriers to entrepreneurship and barriers to trade and investment. Similarly, in the right panel we present an employment protection legislation (EPL) indicator for Ireland and averages for the OECD and EU. EPL measures flexibility in labour markets in a scale from 0 to 6, where 0 implies a flexible labour market and 6 a rigid labour market. As can be seen in Figure 7, Ireland ranks higher in product and labour market flexibility than OECD and EU averages for all years of the OECD sample[10]. Thus, according to the classification, Ireland had already been a relatively flexible economy when the 2008 crisis occurred. Focusing on the period of interest and comparing PMR and EPL values in 2008 with their values in 2013, it is evident no further liberalization in product and labour markets can be observed. Actually, these indices slightly increase between this period suggesting a slight deterioration in product and labour market flexibility. Thus, we can infer that there are no clear signs of major structural reforms occurring in the Irish economy during this period. Later in the paper using our modelling framework we perform simulations to examine the impact of potential structural reforms on the performance of the Irish economy post 2008.

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[10] In 2013 Ireland ranks below EU average in PMR indicator. This can be attributed mostly to the increase in the sub-indicator "state control" which was influenced by state ownership of Irish banks after the bailout programme was launched in 2011.

Figure 7: Product and Labour Market OECD Indicators
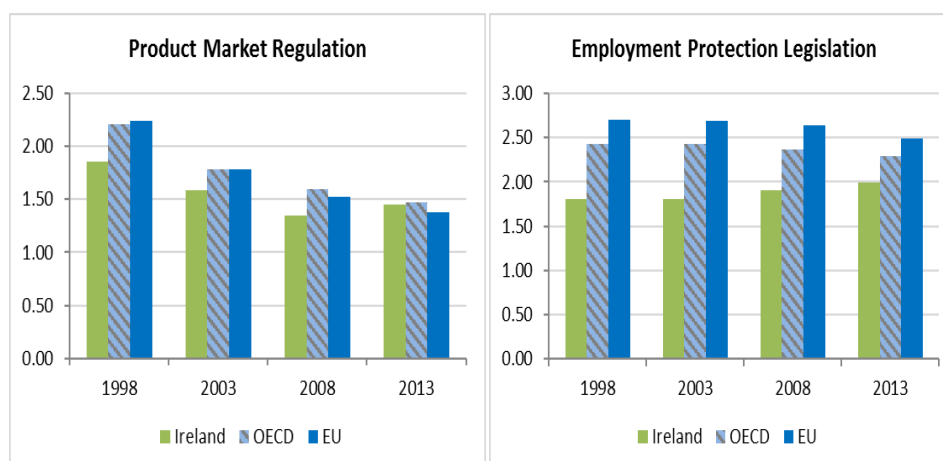
Source: OECD; Left panel economy-wide product market regulation index (PMR); Right panel, employment protection legislation indicator (individual and collective dismissals-regular contract.

3. Theoretical analysis

In this section we outline the small open economy (SOE) DSGE model used to simulate the alternative scenarios which could serve as possible explanations for Irish economic performance post-2008. Then, we compare the model-based simulations of each scenario to assess quantitatively, which of those scenarios can replicate most closely the actual empirical outcomes highlighted in Section 2.

Therefore, initially we present the SOE-DSGE model in an informal setup. The model is then solved numerically for a data-mimicking steady-state solution and the alternative simulated scenarios are presented. Finally, we assess the different scenarios quantitatively using model-based simulations of the main Irish macroeconomic variables.

3.1.A DSGE model for Ireland

Full details of the model in a formal setup are discussed in McQuinn and Varthalitis (2019). The model is a standard small open economy DSGE model with a tradable and non-tradable sector calibrated for the Irish economy[11] (see for example Schmitt-Grohe and Uribe (2017)); since Ireland is member of the Eurozone we assume a monetary regime of fixed exchange rates

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[11]General Equilibrium models calibrated for Ireland include Klein and Ventura (2018), Lozej et al. (2017) and Clancy and Merola (2014) and (2016).

while monetary policy is conducted by the ECB as in Philippopoulos et al. (2017). The small open economy consists of three building blocks: households, firms and government. Each block of the model is now discussed.

3.1.1. Households

The economy is populated by N number of households. Each household aims to maximize a welfare function, i.e. their expected lifetime utility, by choosing their consumption and investment plans as well as their working schedule given fiscal policy. Their expected lifetime utility depends positively on the composite final consumption good and the public good and negatively on hours worked (or positively on leisure). The final composite good that enters the utility function of each household is assumed to be a composite good made up of the domestic composite good and imported goods from the rest-of-the-world; similarly the domestic composite good is made up of tradable and non-tradable goods produced domestically. Regarding their income and assets, households rent physical capital and supply differentiated labour services to firms of the tradable and non-tradable sector. Also, they enjoy market power for their own labour supply meaning that they can set wages with a mark-up over their marginal rate of substitution between consumption and hours worked. In addition, they can borrow/lend government bonds and internationally traded financial assets. Finally, Irish households are subject to consumption, labour and capital taxes while they receive lump-sum public transfers.

3.1.2. Production

There are two sectors of production, the tradable and the non-tradable sector. Both sectors have a similar structure. In each sector there are two types of firms: the final good distributors and the intermediate good producers. The intermediate good producers enjoy market power for their own goods, meaning that they can set prices with a mark-up over their marginal cost. To produce intermediate goods they rent physical capital and labour services from households. Final good distributors combine the different varieties of intermediate goods to produce a single good that can be used by households either for consumption or investment purposes. This holds for each sector; thus the SOE produces tradable and non-tradable composite goods.

3.1.3. Government

The Government levies consumption, labour, capital taxes from domestic households and borrows from domestic households and foreign investors to finance government purchases of private goods and public transfers to households. The national fiscal authority follows simple feedback rules, meaning that its independently set policy instruments react to a small number of easily observable macroeconomic indicators. The fiscal instruments used include the ratios of government spending and public transfers to GDP, the tax rates on consumption, capital and labour income. These fiscal instruments react to deviations in the public debt to GDP ratio from its target value and the output gap (see Schmitt-Grohe and Uribe 2007 for similar rules).

3.1.4. Modelling exports

A small open economy setup means that a country is small in world product and financial markets. Thus, it cannot influence variables such as world interest rates and prices. As noted by Schmitt-Grohe and Uribe (2003) in order to achieve a dynamically stable solution and a well defined steady state we must endogenize the world interest rate at which the small open economy borrows from the international financial markets. We do this by assuming that the interest rate a country borrows from international capital markets with is an increasing function of the country's net foreign liabilities.[12] Regarding world prices, typically it is assumed that the terms of trade defined as the relative price of exports in terms of imports are exogenous and follow an autoregressive process while exports are an endogenous variable (see Schmitt-Grohe and Uribe 2017). In our case, we aim to mimic the increase in exports observed in Irish data; thus, it is more convenient to assume that exports are exogenous and in particular follow a law of motion while we allow the terms of trade to become an endogenous variable. That is exports are a function of three components, exports in the previous period, an exogenous innovation and of deviations in the terms of trade from its steady state value. The exogenous innovation can capture changes in the world economy which are exogenous to the Irish economy (for more details on the shock and its rationale see subsection 4.2.2.) while the latter term ensures dynamic stability and allows exports to have an endogenous feedback from changes in relative prices (as in e.g. Philippopoulos et al. (2017)). That is, ceteris paribus, a decrease in the relative

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[12] Alternatively, we can assume that interest rate is an increasing function of debt-to-GDP when this ratio exceeds a specific threshold. Both are common assumptions in the related literature see e.g. Stephanie Schmitt-Grohe and Uribe (2003), Garcia-Cicco et al. (2010), Bi (2010), Philippopoulos et al. (2017) and Economides et al. (2017) and is supported by a number of empirical studies see e.g. European Commission (2012).

price of Irish exports with respect to prices in the rest-of-the-world results in an increase in Irish exports.

3.1.5. Structural reforms in DSGE setup

Finally in order to model the potential implications of structural reforms being implemented, we assume that structural reforms refer to policies that make product and labour market more flexible and competitive. Thus, in order to study structural reforms in a DSGE model we depart from the assumption of fully competitive markets and introduce product and labour market imperfections.

In particular, we introduce the standard Dixit-Stiglitz type monopolistic competition in both product and labour markets. As a result, prices are set with a mark-up over marginal cost and wages are set with a mark-up over the marginal rate of substitution between consumption and hours worked. Prices and wages in Ireland are generally acknowledged as being relatively flexible see e.g. OECD (2009) for price and wage flexibility and Babecky et al. (2010) for a comparison of wage rigidities within Europe. The structural reforms proposed are mainly concerned with competition policy and activation measures in the labour market.[13] Thus, mark-ups in our model can be interpreted as capturing a lack of competition and other structural rigidities in product and labour markets such as barriers to entrepreneurship and investment, the degree of regulation in labour markets and the general lack of labour market mobility. In this setup structural reforms can take the form of reductions in price and wage mark-ups[14]. The size, pace, timing and reversal or not of this reduction depends on the implementation of the reforms.

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[13]For a discussion on proposed selected structural reforms in Ireland see OECD (2009) and Irish Government Economic and Evaluation Service (2014).

[14]For a similar approach to modelling structural reforms see e.g. Gomes et al. (2013), Papageorgiou and Vourvachaki (2017), Andrés et al. (2017) and Sajedi (2018). However, there are different modelling approaches see for example Cacciatore et al. (2016) who model structural reforms as reductions in the size of sunk entry costs in product markets and as a reduction in unemployment benefits and workers' bargaining power in labour market while De Grawe and Ji (2017) study structural reforms that increase flexibility in price and wage setting in the context of a New Keynesian behavioural model.

4. Numerical solution of the model

For the purposes of examining our alternative scenarios, we initially obtain a numerical steady solution. Then to examine the impact of alternative simulated scenarios, we observe the deviation from this solution of each particular scenario.

4.1. Steady state solution

As we wish to examine the performance of the Irish economy post 2008, the model is calibrated using relevant Irish data over the period 1995-2008. In particular, most of the structural parameters of the model are calibrated so that the numerical solution mimics key macro and international macro ratios in the Irish data while fiscal policy instruments are set as per the actual data. The steady solution of the model is presented in Table 1. The model replicates some key data ratios and as such will be used as the reference point to evaluate the various scenarios subsequently performed.

Table 1: Steady state solution

Variable	Model	Data
Consumption as a share of output	0.45	0.47
Total public debt as a share of output	0.42	0.42
Trade balance as a share of output	0.1	0.1
Exports to Imports ratio	1.4	1.2
Tradable to Non-Tradable wage ratio	1.5	1.5

4.2. Simulated scenarios

We now subject the economy to certain exogenous shocks so as to mimic the Irish crisis of 2008-09 while at the same time simulating alternative scenarios to assess different possible explanations of the Irish recovery. In order to replicate the Irish crisis and capture the decline of around 9 per cent in Irish GDP over 2008-09 we implement a negative TFP shock[15] on the

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[15]McQuinn and Whelan (2018), in examining the growth performance of EU countries, generate estimates of TFP for 12 member countries. In the Irish case, McQuinn and Whelan (2018) find that TFP fell during the crisis. Although the 2007-08 world financial crisis affected Ireland in many different ways our aim is to start from the

tradable and non-tradable sector.[16] To replicate the increase in the Irish debt-to-GDP ratio which soared from 42% in 2008 to 110% in 2010 we also assume an initial debt shock.

Given these external shocks we simulate three different scenarios to assess quantitatively possible explanations for the significant Irish recovery over the period 2008-2014. Below, we consider three main scenarios namely the baseline, the export-driven recovery and the structural reforms scenario.

4.2.1. The baseline scenario (fiscal adjustment)

This scenario is used as the reference scenario for comparison purposes. We refer to the scenario as the baseline one because it consists of commonly accepted facts of the Irish crisis, i.e. the exogenous shocks that resulted in the Irish crisis and the fiscal consolidation policies subsequently implemented. This baseline scenario quantifies the impact of exogenous shocks mimicking the impact of the 2008 crisis on the Irish economy if only fiscal consolidation policies were implemented while other structural or exogenous shocks are "switched off" or not implemented.

We simulate this scenario as follows, the economy departs from the steady-state solution reported in Table 1 in 2008. On impact the economy is subjected to exogenous shocks that mimic the key features of the Irish crisis. In particular, negative TFP shocks are implemented on the tradable and non-tradable sectors reflecting a contraction in total and sectoral outputs. In addition we assume an initial debt shock mimicking the substantial increase in the debt-to-GDP ratio. Then, we assume that a fiscal policy is implemented consisting of an expenditure-based fiscal consolidation programme similar to the one actually implemented by the Irish government over the period 2009-2014 (for more details see Larch et al. 2016).

This is implemented through the feedback policy coefficients in the associated fiscal feedbacks rules so that the main Irish tax-spending instruments resembles their observed path in the data[17]. Thus, transition dynamics are driven by data-mimicking exogenous shocks while fiscal

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crisis and focus on its aftermath thus we assume that these different adverse effects are reflected in adverse TFP shocks (see e.g. Chari et al. (2007) for a methodological treatment of this issue).

[16]Notice that although the negative TFP shocks that hit the tradable and non-tradable sectors are ex-ante symmetric our model endogenously generates asymmetric output responses in the two sectors which resembles their actual responses in Irish data, meaning a relatively higher contraction in the non-tradable sector vis-à-vis the tradable sector.

[17] This implies spending cuts of 4% percentage points on impact, temporary increases in consumption and labour taxes of around 0.8% and 2% respectively while capital tax rate is set constant to its relatively low with respect to the rest of Eurozone data average

policy reacts to debt imbalances so as to reduce the level of public debt.[18] It should be noted that the model is dynamically unstable when fiscal policy does not react to debt levels. Thus, some fiscal action was necessary to ensure fiscal sustainability. Section 5 computes simulated paths of key endogenous variables of the model under this scenario. The other scenarios are in addition to this baseline scenario.

4.2.2. Export-based recovery

In this scenario we aim to examine the impact of an increase in Irish exports given the exogenous shocks that lead to the contraction in output, the increase in debt and the fiscal consolidation programme implemented by the Irish government. Comparing this scenario with the baseline we can disentangle the role played by the increase in exports.

We simulate this scenario as follows, starting from the baseline scenario we assume an exogenous increase in exports in line with the increase observed in Irish data over the period 2008 to 2010. This exogenous increase can be attributed to changes in the world economic environment at that time, e.g. the recovery of the main trading partners of the Irish economy and the related favourable movements (for Irish exporters) of the Euro with respect to the US dollar and British sterling. As with the baseline scenario, the economy departs from the 2008 data-mimicking steady-state solution. Then, when the economy is subjected to the exogenous, negative TFP shock and a debt shock, the Irish government is assumed to initiate a fiscal consolidation package as in the baseline scenario. However, now Irish exports recover in line with the Irish data. Exports increase on impact mimicking the increase in the observed Irish data and then return gradually to their pre-crisis value following an autoregressive process. The parameter influencing the persistence of exports is calibrated so as to replicate the average increase in exports from 2008 to 2014[19]. Therefore, in this scenario the transition dynamics are driven by the exogenous shocks also assumed in the baseline scenario plus the increase in exports over the period 2008-2014. As before, the Government adopts fiscal consolidation policies resembling the actual fiscal policy undertaken over 2008-2014.

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[18]Five exogenously set fiscal instruments is assumed to follow feedback rules, namely government consumption and transfers to GDP ratio, consumption, labour and capital tax while debt adjusts residually to satisfy the government budget constraint.

[19] We have experimented with various values for the autoregressive parameter which governs exports' persistence and we report that our main qualitative results hold.

4.2.3. Structural reforms-based recovery

We then simulate a scenario to quantify the impact of structural reforms on the Irish recovery. As above, structural reforms are modelled in addition to the baseline scenario while we now switch off the impact due to exports. Comparing this scenario with the baseline we can quantify, separately, the effect of the structural reforms. To assess the effect of product and labour market reforms separately we simulate reforms in one market at a time.[20]

We now assume that product market reforms are implemented when the exogenous TFP and debt shocks impact the economy and when the Government implements its fiscal consolidation package. That is price mark-ups in tradable and non-tradable sectors decrease by 3 p.p. and 5 p.p. respectively and then return gradually to their pre-crisis value following an autoregressive process. The parameter influencing the persistence of structural reforms is set at a very high value[21]; thus reforms in our model are fully implemented on impact and are almost permanent in their impact. We limit our analysis to the first few years (2008-2014) after the crisis as we are interested in the short run effects of structural reforms on the Irish recovery. Given that our modelling implies that reforms are fully implemented on impact, our results set an upper limit for the potential short run positive effects of structural reforms.[22]

5. Quantitative assessment of the various simulated scenarios

In this section we present model-based simulations for the alternative scenarios described above. In order to disentangle the effects and mechanisms of each different explanation we simulate one scenario at a time. We start by computing the effect of total and sectoral outputs for each scenario because this facilitates comparisons with the empirical analysis in section 2. Then, we employ model-based simulations of several endogenous variables of our model to shed light on the propagation mechanism of each alternative scenario. In doing so, we provide

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[20] We have also performed simulations with structural reforms in both product and labour markets and we report that our main qualitatively results do not change but as expected we observe some quantitatively differences.
[21] Since we don't find clear cut empirical evidence of extensive structural reforms over 2008-2014 (see section 2.5) we consider this scenario as counterfactual. To this end, the size of the mark-ups reduction, persistence and timing follows the related literature.

[22] We report that we have experimented with the pace and timing of reform implementation and the qualitative results do not change. Similarly we model labour market reforms (LMR) as a decrease in wage mark-ups of the tradable and non-tradable sector.

a unified framework to develop an economic narrative of the Irish recovery establishing links with the empirical facts when necessary.

5.1. Effect on GDP and sectoral output

Figure 8 presents the simulated implied paths of total and sectoral outputs in the tradable and non-tradable sectors. The solid black line represents the point of departure, i.e. the solution reported in Table 1; while the blue solid lines represent the baseline scenario, the red dashed lines the export-based recovery scenario and the green cross and yellow square lines reflect the structural reforms in product and labour market respectively.

Comparing across alternative scenarios, we observe that, in the export-driven recovery scenario, the GDP recession is smaller on impact and the recovery is faster in the after-math of the crisis. On the other hand, the simulated response functions under the structural reforms in product markets or in labour markets suggest that these reforms are most unlikely to reflect the significant recovery observed in the Irish data. Comparison between product/labour market reforms scenarios with the baseline scenario implies that such reforms could not have substantially mitigated the recessionary effects of the exogenous shocks which impacted the Irish economy. This is more striking in the short run (over the first 3 years after the negative shocks) where structural reforms scenarios implied response functions do not deviate substantially from the baseline scenario. Thus, a key message from our model-based simulations is that only the export-driven recovery scenario can mimic the significant recovery in total output.

As discussed in section 2.3, a key feature of the Irish quick recovery is its sectoral decomposition between the tradable and non-tradable sectors. Our model-based simulations allow us to break down the GDP recession and recovery into its sectoral components, i.e. tradable and non-tradable output, under the different scenarios. This analysis provides further evidence that support the export-based recovery scenario; that is simulations generated by the latter mimic closely the actual path of sectoral outputs in the Irish data. In addition, the rapid recovery in Irish GDP can be attributed mostly to an analogous recovery of the tradable sector of the Irish economy due to an increase in exports while the non-tradable sector enters a relatively more prolonged recession and recovers on a slower basis (see Figure 5 in section 2.3). Both structural reform scenarios generate simulations for sectoral outputs which do not resemble their actual paths observed in the Irish data.

Figure 8: GDP and Sectoral output
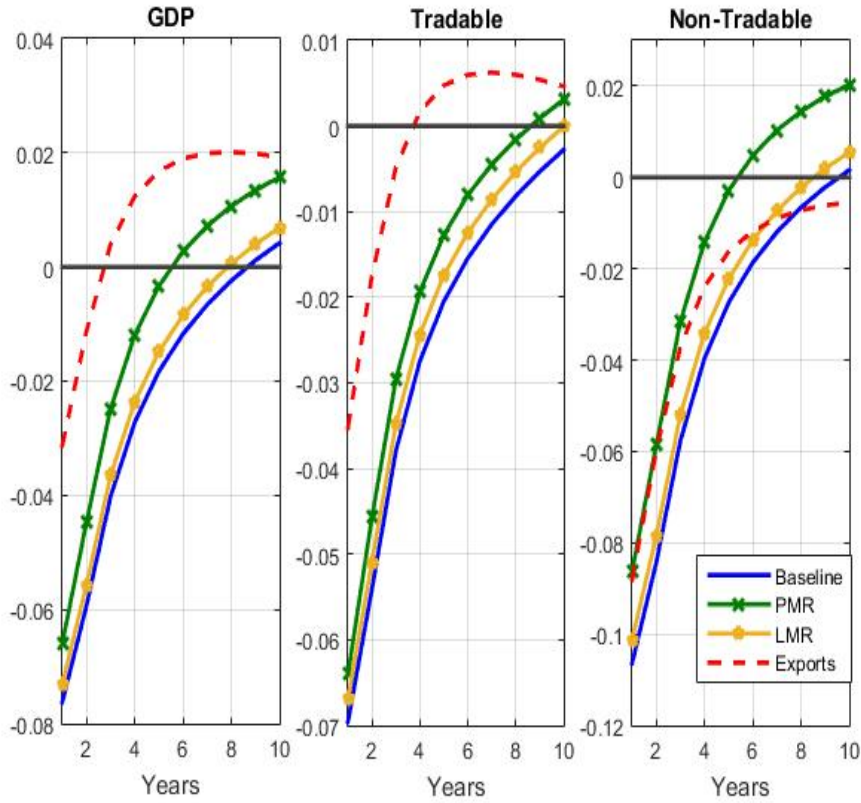
Notes: Variables are percentage deviations from their steady state value

5.2. Underlying mechanisms

To understand the key underlying mechanism of each scenario we now present the associated impulse response functions of other key endogenous variables. Figure 9 plots the associated simulated paths of the output share of tradable and non-tradable output, the real wage in the tradable and non-tradable sector, the relative price of tradable with respect to the price of non-tradable sector, the trade balance and the exports to GDP ratios under the various scenarios. Similar to Figure 8 above the baseline scenario is illustrated by the blue solid lines, the export-driven scenario by the red dashed lines while the structural reforms in product and labour markets are denoted by the green cross and yellow square lines respectively. Since the export-driven scenario moves in line with the actual post-crisis Irish data in what follows we develop

our economic narrative around this scenario while for reasons of comparison we refer to the other scenarios to illustrate any differences.

Under the export-driven scenario, the Irish crisis seems to act as a rebalancing mechanism for the Irish economy; the tradable sector contracts less and recovers much faster than the non-tradable sector. As a result, the share of the tradable sector increases vis-à-vis the share of the non-tradable sector as can be seen in the first row of Figure 9. The severe negative shock impacts the non-tradable sector of the economy disproportionately while the negative effect is mitigated in the tradable sector due to the exogenous increase in exports; the latter can be seen by the last subplot of Figure 9 where the exports to output ratio, under the export-driven recovery scenario, increases significantly more than in the structural reforms and baseline scenarios. In the baseline and structural reform scenarios, the significant loss in output and reductions in price and wage mark-ups do result in an increase in exports by reducing domestic prices vis-à-vis the rest of the world prices, and hence improving competitiveness. However, in magnitude terms, this is not significant enough to generate the implied response functions that reflect the actual path of Irish exports and of other endogenous variables during the recovery.

The increase in the exports to output ratio in the former scenario is calibrated to replicate the increase in exports observed in the data over the period 2008-14. In our model, due to the expansion of the tradable sector vis-à-vis the non-tradable sector, productive resources such as investment and employment reallocate towards the tradable sector of the economy and away from the non-tradable sector. This can be seen in Figure 10 where we plot shares of hours worked and investment in physical capital with respect to their aggregates in the tradable and non-tradable sectors. Shares of hours worked and investment in the tradable sector increase on impact, while the analogous shares in the non-tradable sector decrease. Thus, in our model, the 2008 crisis acts as a rebalancing mechanism in all scenarios studied, however, this is even more striking under the export-driven recovery where the increase in exports underpins the asymmetric sectoral response.

In summary, our model-based simulations show that the path of exports plays a qualitatively and quantitatively important role in explaining the post-2008 dynamics of the main Irish macroeconomic variables.

Figure 9: Implied response functions of other macroeconomic variables
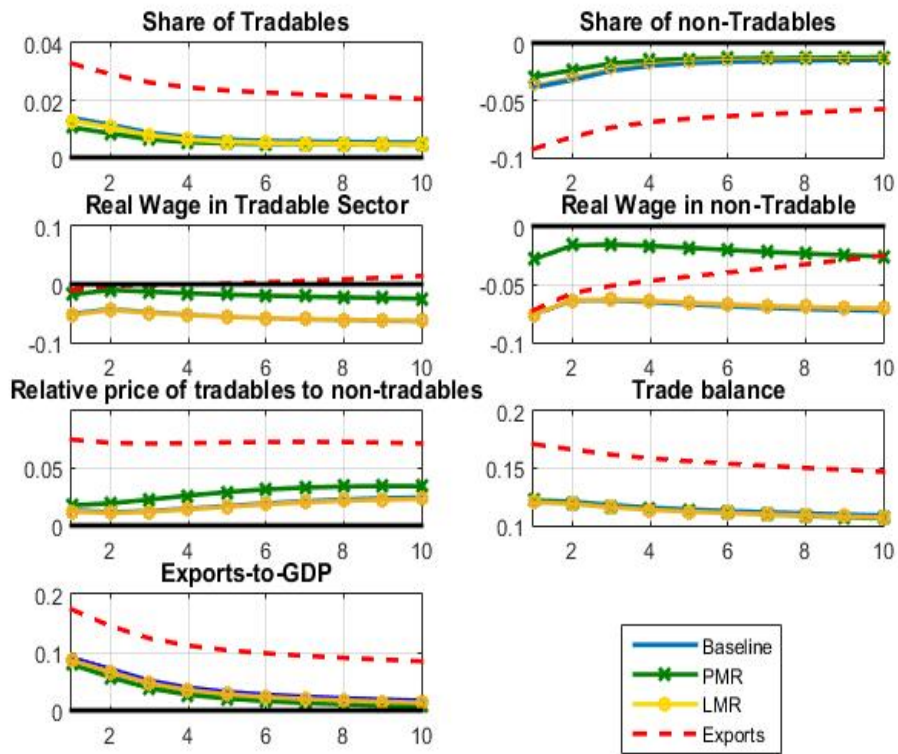
Notes: Variables are percentage deviations from their steady state value

Figure 10: Shares of production factor inputs in tradable and non-tradable sectors
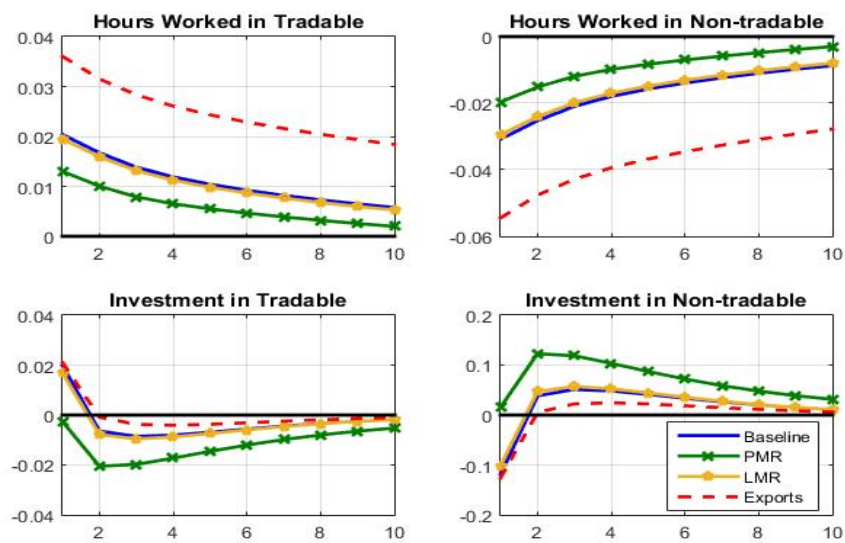
Notes: Variables are percentage deviations from their steady state value

Regarding competitiveness, under the export-driven scenario any increase in overall competitiveness arises due to the decline in real wages and prices in the non-tradable sector of the economy due to the large negative effect of the crisis in this sector. This is also reinforced by the reallocation of demand and resources towards the tradable sector. The associated simulated paths of real wages in the tradable and non-tradable sector as well as the relative price of tradables to non-tradables (see the red lines in the associated subplots in Figure 9) illustrate the underlying dynamics of the reallocation. The relative price of tradables to non-tradables increases indicating a fall in prices of the non-tradable sector. Real wages in the non-tradable sector experiences a sharp decrease at the outset of the shock in contrast to real wages in the tradable sector which slightly decrease when the shock occurs. Real wages then remain constant in the short run and subsequently grow higher than their pre-crisis levels. The latter trend is also evident in the actual data.[23]

6. **Conclusions**

In a well cited review of Irish economic performance, Honohan and Walsh (2002), argue that the surge in Irish economic activity witnessed from the early 1990s reflected the sizeable movement in the labour force away from traditional sectors of the economy such as agriculture towards the information technology and pharmaceutical sectors. The young Irish workforce being English speaking with a relatively high educational attainment levels were ideally suited for the rapidly growing information technology using sectors from the early 1990s. However, the resulting export lead growth, which characterised the initial phase of the Celtic Tiger, gave way to a credit-fuelled bubble driven by activity in the non-traded sector. By 2007, the construction sector exerted a disproportionately large influence on domestic economic activity.

Using a DSGE framework, our simulations indicate that the international, financial downturn of 2007/08 prompted a significant rebalancing within the Irish economy; capital and labour resources, which had been attracted to the bubble driven returns of the construction sector between 2001 and 2007, were subsequently redeployed towards the more productive export sector.

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[23]For example, the average real wage growth per employee in the tradable sector over 2001-2007 was 2% and remain positive to 2.1% over 2008-2014. On the other hand, the average real wage growth per employee in the non-tradable sector was 2.2% and -1.1% over 2001-2007 and 2008-2014 respectively.

The relatively modest contributions of structural reforms to the recovery experienced in the Irish economy raises interesting policy issues. Institutions such as the IMF, the OECD and the European Commission, place a significant emphasis on the capacity for structural reforms to improve the medium-term growth prospects of individual economies. While this is undoubtedly the case, policy-makers must be wary of issuing one size fits all series of policy recommendations to countries experiencing significant difficulties; the re-emergence of the Irish economy over the period 2008 – 2014 was for a particular set of circumstances not necessarily transferable to other countries such as Greece, Portugal or Spain. Countries like Spain experienced a similar boom in the residential sector preceding 2007, however, the much more open nature of the Irish economy meant it was significantly better placed to benefit from the subsequent rebalancing of resources from the non-traded to the traded sectors.

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