EUROPEAN CENTRAL BANK

EUROSYSTEM

Working Paper Series

Filippos Petroulakis

Internal devaluation in currency unions: the role of trade costs and taxes

No 2049 / April 2017

Abstract

This paper studies export adjustment to negative shocks in currency unions. I consider the hitherto ignored role of trade costs and taxes in internal devaluations, which have been brought to the fore of international policy during the recent euro periphery crisis. Trade costs can limit the pass-through of internal devaluation on export prices. Using data on export prices ”on the dock”, I document that higher trade costs are associated with a lower reduction of export prices relative to domestic prices in the euro periphery. Furthermore, VAT (in theory trade neutral, but in practice much higher on tradables) hikes prevent the required shift of resources towards tradables. I show that the real exchange rate (RER) adjustment was heavily affected by indirect tax hikes, by comparing headline RER and tax-adjusted RER. I then build a standard New Keynesian small open economy model with sticky wages and prices, incorporating trade costs and indirect taxes (allowing for VAT imperfections), and show that both these frictions, but especially trade costs, can be quantitatively crucial in affecting export growth, more so than either product markups or wage rigidity. I apply the model to data for Greece, the least successful of the euro periphery fiscal devaluation programs, and show that it can account for the most salient features of the data; trade costs explain the failure to substantially raise exports, and taxes the initial small fall in exports.

Keywords: Euro Crisis; Current Account Adjustment; Trade Costs; Internal Devaluation
JEL codes: F32, F33, F41, F45

Non-technical Summary

The recent euro peripheral crisis has resurrected the old idea of internal (or fiscal) devaluation as a way for countries within a currency union, who cannot engage in nominal currency devaluations, to improve competitiveness and export their way out of the crisis. The idea was that persistent current account imbalances, largely mirroring a loss of competitiveness relative to the euro core, could be corrected by wage reductions in the peripheral countries, as a means of restoring competitiveness. Through successive reforms, wage adjustments relative to Germany fell substantially in all the countries in question, and the current account deficits were sharply curtailed. This presents a puzzle: even with highly sticky prices and imperfect pass-through of the lower labour costs to export prices, standard models can still not explain the divergent results among the peripheral countries.

In this paper, I argue that trade costs can account for the disparate results seen in the euro peripheral adjustment. By trade costs, I refer to any and all costs and frictions associated with the trade of goods and services across borders. Inside a monetary union, furthermore, any such costs and frictions exclude any role for official tariffs, quotas, or other official restrictions imposed on trade by sovereign governments, because trade within the union is unrestricted. I document how higher trade costs (such as an inefficient distribution and customs sector) implied a lower relative reduction of export price to domestic prices. I also show that real exchange rate adjustment was heavily affected by VAT and energy tax hikes, by comparing headline Real Exchange Rate (RER) and RER with tax adjustment. VAT is in theory trade neutral, but in practice it is not, as it is effectively applied at a higher rate on tradable goods. As such, the desired shift of production towards the tradable sector is moderated. At the same time, substantial energy hikes, which fell proportionately more on the tradable sector as well, made a large fraction of Greek exports more expensive despite the large reduction in labour costs.

I then build a standard New Keynesian small open economy model with sticky wages and prices, incorporating VAT imperfections, energy taxes, and trade costs, and illustrate these issues. I find that trade costs can have a very significant negative effect on exports. This result is novel and its implications are crucial. Wage cost reductions are an incomplete instrument to achieve current account adjustments if trade cost reduction policies are not part of the policy mix. An important corollary is that producer price adjustments alone, including a competitive devaluation equal in relative magnitude to the labor cost reduction, would not have been sufficient in boosting exports without addressing trade

costs.

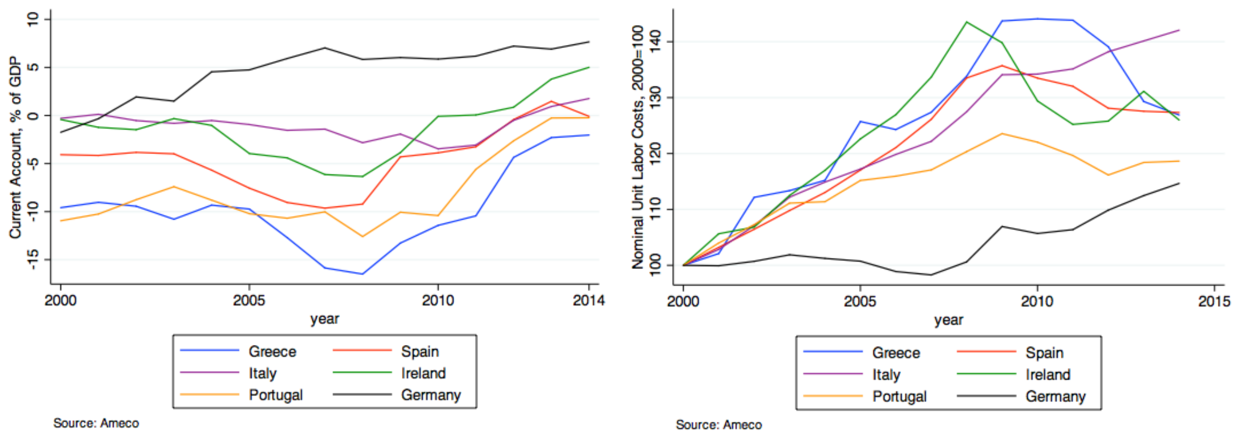
Indirect taxes can also be an important inhibitor, precisely when they disproportionately affect the reallocation of resources to the tradable sector, but their effects are lower for exports than that of trade costs. In addition, I examine the effect of markups in the product sector and find that while markups (capturing production inefficiencies) are more important than trade costs in explaining the lackluster growth of aggregate output, they are less crucial in explaining export behavior. Intuitively, the benefits of lower markups are evenly distributed across the two sectors, while lower trade costs only benefit the tradable sector.

The policy implications of this paper are clear: current account adjustment policies have to take into account the efficiency of the logistics and transportation sector of the adjusting economy. This is not only true in the case of fixed exchange rate regimes, but also apply to flexible regimes. In fact, a key corollary of the results of this paper is that the adjustment benefits of a flexible currency can be severely hampered by failure to reduce trade costs.

1 Introduction

The recent euro peripheral crisis has resurrected the old idea of internal (or fiscal) devaluation as a way for countries within a currency union, who cannot engage in nominal currency devaluations, to improve competitiveness and export their way out of the crisis. The idea was that persistent current account imbalances (figure 1a), largely mirroring a loss of competitiveness relative to the euro core (figure 1b), could be corrected by wage reductions in the peripheral countries, as a means of restoring competitiveness. Through successive reforms, wage adjustments relative to Germany fell substantially in all the countries in question, and the current account deficits were sharply curtailed.

Figure 1: Euro area, 2000-2014



(a) Current Account

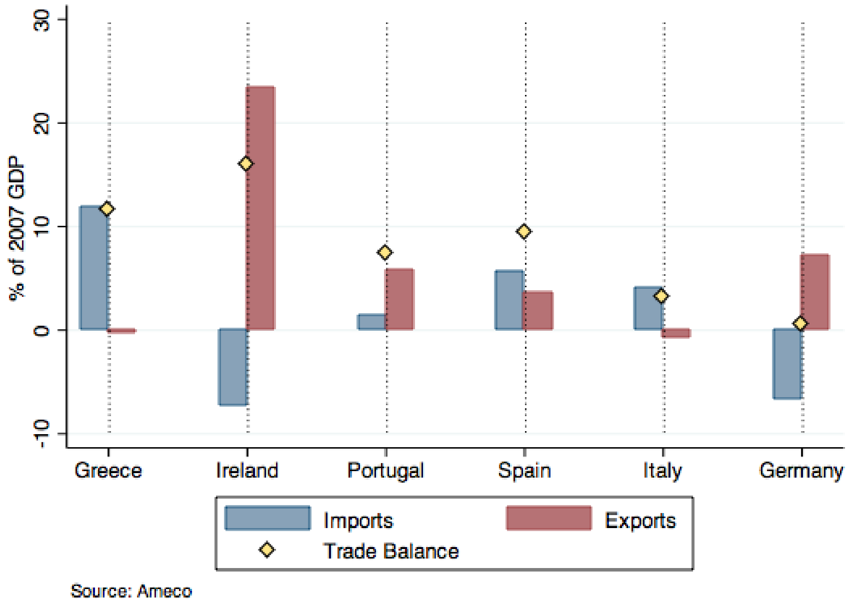
(b) Nominal labor Costs

And yet the means through which the adjustment was achieved were highly disparate. Figure 2 shows the cumulative contribution of exports and imports in the consolidation of the trade balance from 2007 to 2014, as a percentage of 2007 GDP.[1] Falling imports have a positive contribution to the trade balance, and are recorded as positive. Ireland has had a remarkable export performance, raising imports substantially, while Spain and Portugal both reduce imports and raise exports. Greece, on the other hand, has achieved its large adjustment exclusively through a steep fall in imports, accompanied by a slight *fall* in exports.[2]

[1] This is an update of a graph from Arkolakis et al. (2014) to include 2014 data.

[2] One reason for this observed fall is that I take 2007 as the basis for this exercise, and so do not account for the Great Trade Collapse of 2009. I account for this in the quantitative exercises by starting my analysis for exports in 2010, in which case there is still a small fall in exports in the first stages of the adjustment.

Figure 2: Contribution to the Trade Balance Consolidation, 2007-2014



In this paper, I argue that trade costs can account for the disparate results seen in the euro peripheral adjustment. By trade costs, I refer to any and all costs and frictions associated with the trade of goods and services across borders. Inside a monetary union, furthermore, any such costs and frictions exclude any role for official tariffs, quotas, or other official restrictions imposed on trade by sovereign governments, because trade within the union is unrestricted. Trade costs can be the result of an inefficient or uncompetitive logistics and distribution sector, state bureaucracy, informational asymmetries, institutional constraints, or any other non-tariff barrier to trade.

The presence of trade costs implies that lower domestic producer prices (a result of internal devaluation) can only partially pass through to export prices. Using data on export prices ”on the dock”, I document that higher trade costs are associated with a lower reduction of export prices relative to domestic prices.

Trade costs have long been recognized as a potentially key explanation of standard models to account for several puzzles in international macroeconomics (Obstfeld & Rogoff 2000). Recently, (Eaton et al. 2016) showed in a rich multi-country setting with complete markets that trade costs can account for the Feldstein-Horioka, exchange rate disconnect, consumptions correlation, and relative PPP puzzles. Coeurdacier (2009) introduced financial friction together with trade costs to account for home bias in equity investments.

Trade costs have also been used to explain recent developments in international economics. Reyes-Heroles (2016) shows that two-thirds of the rise of global trade imbalances since the 1970s can be attributed to the reduction of trade frictions. Alessandria & Choi (2014) show that a model incorporating trade costs can explain the recent US export growth. Similarly, the same authors find that about half of the rise in the US trade deficit since 1980 can be accounted for by falling trade costs (Choi & Alessandria 2016).

In this context, I show that trade costs can be an important obstacle to external adjustments. To my knowledge, this is the first paper to consider this channel, whose policy implications are important and wide-ranging. Namely, acknowledging the presence of this friction as important in external adjustments leads to a refinement of the link between competitiveness-enhancing policies and wage adjustments.

In addition, I consider the role of indirect taxes as a secondary inhibitor to export growth. Indirect taxes are typically part and parcel of adjustment programs designed to counter fiscal, as well as current account imbalances. Hiking indirect taxes can be a revenue-neutral, export enhancing complement to labor tax reduction (Farhi et al. 2014), or can simply be used for generating revenue. VAT hikes, in particular, were used in all distressed peripheral countries and unavoidably led to higher than otherwise domestic prices, by up to a third (Arkolakis et al. 2014). As VAT is rebated on exports, it is, in theory, a trade-neutral tax. In practice, VAT has a negative trade-adjustment property, namely the fact that it is higher (both in incidence and statutorily) on tradable than non-tradable goods. Other indirect taxes used for revenue collection in fiscal devaluations, predominantly energy taxes, can have exactly the same effects, and so attention is not limited to VAT.

In a textbook model (Vegh 2013), a negative demand shock will reduce demand for both tradable and non-tradable goods, but since the latter can only be produced domestically, there will be a corresponding labor shift to the tradable sector. However, if taxes on tradables are higher, this shift will not take place. This distortion is magnified in the presence of tax compliance issues. I show that real exchange rate adjustment was heavily affected by tax hikes, by comparing headline Real Exchange Rate (RER) and tax-adjusted RER.

I then build a standard New Keynesian small open economy model with sticky wages and prices, incorporating VAT imperfections, energy taxes, and trade costs, and illustrate these issues. I find that trade costs can have a very significant negative effect on exports.

This result is novel and its implications are crucial. Wage cost reductions are an incomplete instrument to achieve current account adjustments if trade cost reduction policies are not part of the policy mix. An important corollary is that producer price adjustments alone, including a competitive devaluation equal in relative magnitude to the labor cost reduction, would not have been sufficient in boosting exports without addressing trade costs.

Indirect taxes can also be an important inhibitor, precisely when they disproportionately affect the reallocation of resources to the tradable sector, but their effects are lower for exports than that of trade costs. In addition, I examine the effect of markups in the product sector and find that while markups (capturing production inefficiencies) are more important than trade costs in explaining the lackluster growth of aggregate output, they are less crucial in explaining export behavior. Intuitively, the benefits of lower markups are evenly distributed across the two sectors, while lower trade costs only benefit the tradable sector.

I then evaluate the role of wage flexibility in the context of current account adjustment. In a recent paper, Gali & Monacelli (2016) show that the welfare gains from wage flexibility are questionable in countries with an exchange rate-focused monetary policies, including currency unions. This insight is complementary to the results of this paper, and it is interesting to consider how wage flexibility interacts with trade costs. I examine how different levels of trade costs affect export adjustment under alternative regimes of wage flexibility and find that, for realistic values of the wage rigidity parameter, gains are very modest, and much lower than gains from trade cost reduction.

Finally, I apply the model to the euro periphery crisis, and focusing on Greece, I find that lowering trade costs by 30%, to the level of Portugal, within ten quarters, would result in 20% higher exports, and 1.9% higher output. Due to the protracted nature of the shock, in that case, taxes only have a small effect on exports, but they can account for an initial decline in exports (as opposed to the lack of growth).

This discussion is as follows. Section 2 briefly discusses the relevant literature and identifies the role of trade costs and taxes in the data. Section 3 presents a sketch of the model, full details of which, along with a complete solution, are given in the appendix. Section 4 describes the calibration process. Section 5 is the core of the paper, presenting results from several static and dynamic exercises, and illustrates the findings of the model. Then section 6 applies the model to Greece as a case study, using the actual path of interest rates in a stochastic environment, compares the model to the data, and discusses the outcome of counterfactual policies. Section 7 concludes.

Related Literature The idea of internal devaluation was theoretically addressed by Farhi et al. (2014), who provided conditions under which a combination of taxes and subsidies could mimic the real effects of a nominal devaluation under fixed exchange rates, in the context of a standard New Keynesian small open economy model with sticky prices. They also show the equivalence of this new approach of fiscal devaluation with the older Keynesian idea of tariff-cum-subsidy.

Feldstein & Krugman (1990) first formally pointed out that the theoretically trade-neutral nature of the VAT rests on uniform rates on all goods, and a properly functioning rebate system, making the specific distinction between tradable and non-tradable goods, as it is well known that non-tradables are typically taxed at a lower rate. This is partly due to administrative complexity in taxing certain non-traded activities, such as household production and, importantly, the informal sector. This is especially crucial for Greece, which has one of the largest informal sectors relative to GDP among OECD countries (Schneider & Buehn 2012). To the extent that informal activity is predominantly non-traded, there exists a natural tax-advantage to non-tradable production. Furthermore, modern welfare states typically tax-discriminate in favor of certain non-tradable services, such as healthcare and education, for equity reasons, magnifying the relative tax distortion between the two types of production. Empirical evidence of the effects of VAT on trade is decidedly mixed, with several prominent papers (Keen & Syed 2006, Desai & Hines 2005, Nicholson 2013) reaching contradictory conclusions. A substantial obstacle is reliance on aggregate data, and the proliferation of administrative datasets in recent years is likely to yield more conclusive results.

Some papers have looked at micro issues regarding the disparities in the euro peripheral adjustment, particularly the differences between Greece and the rest. Pelagidis & Mitsopoulos (2014) focus primarily on the cost of energy Greek exporters face, documenting a rise in costs by 60% since 2009, due to a steep increase in the prices charged by the public energy company, by far the largest provider of wholesale energy, as well as formal tax hikes.[3] Arkolakis et al. (2014) consider rigidities in the product sector, and, using a canonical Eaton-Kortum model, find that given past performance, Greek exports should have risen by 25% in 2007-2012, instead of falling by 5%. They attribute this primarily to

[3]See the appendix for more detailed information.

rigidities in the product markets, as secondarily to firm size distribution (characterized by few large exporting firms) and the lack of a conducive business environment.[4] [5]

Finally, though there is no, to my knowledge, any other study looking at the importance of trade costs in trade adjustments in currency areas, Lama & Rabanal (2014) consider the role of trade costs, in conjunction with financial linkages, in the decision to enter a monetary union. Their exercise is quite different in that they consider the benefits of joining a monetary union in the form of lower trade costs.

2 Trade Costs, Taxes, and Comparative Price Adjustment

In this section, I provide graphical evidence of the issues tackled in this paper. First, I consider the trade costs of each country and how they relate both to each other and the rest of the world. Second, I compare the evolution of domestic producer prices for the periphery to the prices domestic companies receive in non-domestic markets in the euro area. The latter measure can be thought of as the price of exports on the domestic border. Finally, I show how the real exchange rates have been affected by higher taxes, by exploiting tax-corrected data on consumer prices.

2.1 Trade Costs

Ever since the seminal contribution of Obstfeld & Rogoff (2000), it has been recognized that trade costs can account for part of the failure of standard models to account for several puzzles in international macroeconomics. In their formulation, trade costs encompass any type of friction, such transport and distribution costs, tariffs, and non-tariff barriers (corruption, red tape, poor law-enforcement, culture, language issues etc). Here the focus is on all these, except for tariffs.

A summary measure of trade costs is provided by gravity models of international trade. Here, I use a metric available from the World Bank Trade Cost Database, constructed according to the Inverse Gravity framework of Novy (2013). The gravity model relates

[4] A recent paper devoted to the Greek crisis is by Gourinchas et al. (2016), but they focus on the output collapse, not on exports.

[5] Pelagidis & Mitsopoulos (2014) also consider the role of the high cost of credit to firms, which is not separately addressed here, but accounted for by introducing a large aggregate borrowing shock.

bilateral trade to the incomes of two countries and the distance between them, and is the workhorse model of the international trade literature. Novy (2013) adopts the well-known multi-country general equilibrium model of trade of Anderson & Wincoop (2003), which features with differentiated goods and rewrites their gravity equation only in terms of only observable aggregate trade data, by exploiting the insight that changes in international trade must be mirrored in changes in intranational trade. For instance, if trade costs between two countries fall, it must be the case that some of the goods traded within the countries are now sold abroad, ceteris paribus.

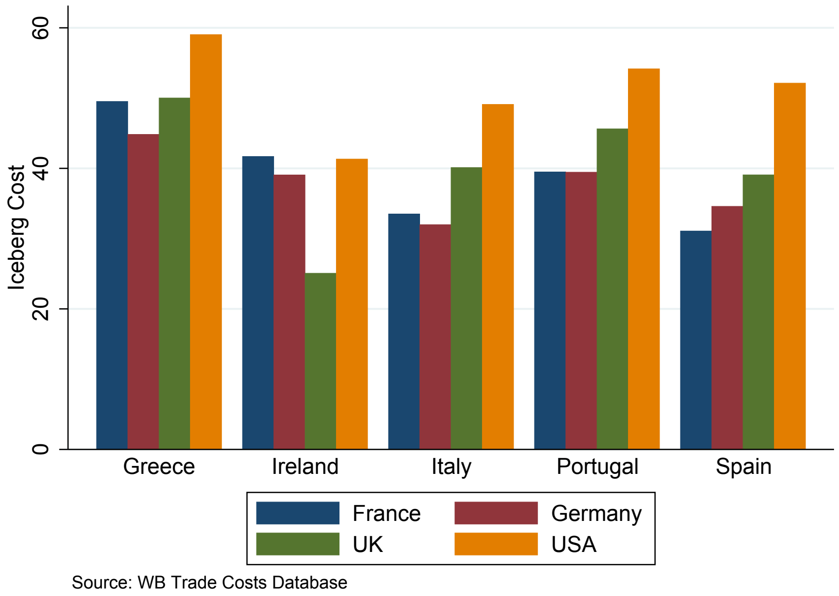
The fact that Novy (2013) can back-out the trade cost measure solely from readily available aggregate data is an important improvement over previous models that relied on restrictive functional forms. This is particularly useful in this paper since estimated gravity equations had a particular problem capturing non-tariff barriers, for which no good proxies exist, but are of fundamental importance for trade within currency areas. The framework is also appealing as it can be nested in a number of leading trade models, which Novy (2013) shows give an isomorphic trade cost. The cost measure is a tariff-equivalent, measuring the difference between actual trade flows and those predicted by a frictionless model. As such, a tariff-equivalent of $x\%$ would translate into the more familiar iceberg cost as $\frac{x\%}{1+x\%}$.

Figures 3 and 4 provide graphical evidence of the burden of trade costs on the external adjustment of the euro periphery. The graphs show trading costs by trading partner for the peripheral economies when trading with the three largest EU economies, Germany, France, and the UK, plus the United States. Figure 3 gives data for 2007 and 4 for 2013, the last year of data availability. Data are expressed in term of iceberg costs.

The figures clearly show that trade in Greece faces much larger trade costs compared to the other peripheral countries. Tellingly, even though there are no official trade barriers of any kind within the European Union, Greece has a higher cost of trading with the UK, an EU member, than Italy does in trading with the US, which is not an EU member (and thus does have some trade barriers when trading with the EU). On the other hand, Ireland had the lowest trade costs of all countries considered, and especially so with the UK, with which it shares a border.

By 2012, with structural adjustment well under way, all countries has achieved reductions in trade costs, but previous differences were even more pronounced. Greek tariff equivalent costs vis-a-vis France fell by 9.5% from 2007 to 2012, compared to a fall of 24% for

Figure 3: Trade Costs by Trading Partner: Euro Periphery, 2007



Italy, and around 19% for Portugal and Spain. Trade costs for Greece actually increased slightly, by 0.31%, when trading against Germany, compared to a fall of over 9% for Italy and Portugal and over 2% for Spain. The numbers are again similar in relation to the UK. Ireland also lagged the rest, but still showed a marked trade-weighted improvement as the bulk of its bilateral trade is with the UK and the US, against which it enjoyed comparatively very low trade costs to begin with.[6]

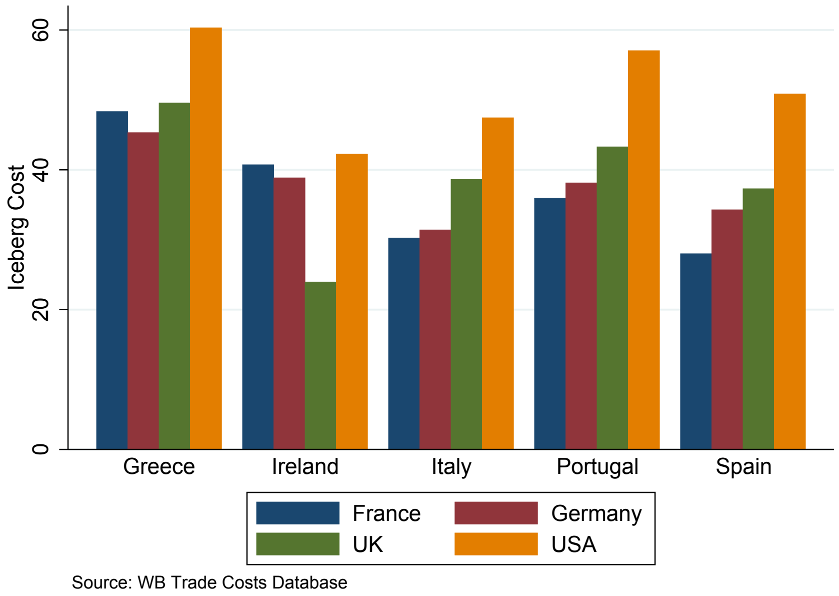
2.2 Trade Costs and Producer Prices

The presence of trade costs essentially implies that there is a wedge between domestic and foreign prices of domestic goods, and hence that lowering domestic prices may not necessarily lead to lower foreign prices. This implies that we should be able to see this phenomenon when comparing domestic and foreign prices for domestic producers for countries with high trade costs.

I use the Short Term Statistics of Eurostat, which gives a producer price index before VAT and similar taxes (hence allowing us to isolate the effect of trade costs), separately for

[6]A different comparison yielding almost identical results comes from the Logistics Performance Index (LPI), which tracks the opinion of logistics professionals on the performance of each country. See the appendix for details.

Figure 4: Trade Costs by Trading Partner: Euro Periphery, 2013



domestic (PPI) and non-domestic (NDPPI) data. For the latter, the index is calculated at the national border (free on border price, FOB). This has two crucial advantages for the purposes of this paper. First, NDPPI includes the cost of the domestic distribution network. Second, it is not affected by pricing decisions of the foreign retailer, and is hence not affected by pass-through issues. Note that data covers only trade in the EU.[7]

The relevant metric is

$$\Delta REL = \Delta PPI - \Delta NDPPI, \tag{1}$$

that is, the relative price change between domestic and foreign prices. In the absence of frictions, ΔREL should be zero. If it is negative, it indicates that FOB export prices are rising or falling at a lower rate relative to domestic prices. The figure below gives ΔREL for the peripheral countries, from 2009 to 2014.

It should be noted that this metric is very crude, and has a number of shortcomings, the most important of which is that it does not control for pricing to market behavior. Ideally, one would compare producer price data across foreign markets, to net out local demand effects. At the same time, the absolute magnitude of ΔREL is irrelevant, it is

[7]Trade with non-euro area EU countries is included.

the relative magnitude amongst the different countries that is of interest. Since only trade within the EU is considered for the numbers above, trade partner composition effects should be minimal, and hence export market demand shocks should be roughly equal for all countries. This means that ΔREL has a meaningful interpretation in comparing the pass-through of lower domestic producer prices to export prices.

Table I: Relative Domestic and Foreign Producer Price Change, 2009-2014 (%)

Category	Greece	Ireland	Spain	Italy
Intermediate	-3.13	.	-1.94	0.88
Capital	-0.73	.	-0.32	0.81
Consumer Durables	1.04	.	4.90	4.47
Consumer Non-Durables	-4.65	.	-0.60	1.70
Total ex Energy	-2.79	14.06	-0.83	1.23

Results are striking. Ireland exhibits a substantial positive ΔREL (14%), implying that external producer prices have fallen by more than domestic ones. This is intuitively surprising but it nevertheless underlines the competitiveness gains of Ireland. By contrast, Greece exhibits negative ΔREL for intermediate, capital, and non-durable domestic goods, which account for over 80% of its 2010 exports (and 96% of non-energy exports). In total, non-energy ΔREL falls by 2.8%. Spain presents a more mixed picture, with some sectors improving and others worsening, with non-energy ΔREL falling by 0.8%. Finally, Italy, despite modest wage reductions, achieves a ΔREL rise of 1.2%.[8]

Comparing the results above with figure 3 it is clear that the lower the trade costs, the higher is ΔREL. These results support the thesis that trade costs inhibit adjustment.

2.3 Taxes and the RER

The hikes in VAT and other taxes have a corresponding effect on consumer prices, counteracting to an extent the labor cost reductions for firms. In Greece, in particular, taxes on energy taxes rose so much that they resulted in a rise of up to 60% in the cost of energy for industrial use since 2009 (Mitsopoulos 2014), and disproportionately affected tradables. As far as VAT is concerned, this should only have an effect on the domestic market. Exported goods are subject to border adjustment, as they are sold without VAT to other

[8] Data for Portugal are not available. In addition, the category breakdown is not available for Ireland, meaning that the total does include energy, but which accounts for only 1% of exports.

countries. In that sense, VAT is trade neutral when it is destination-based (i.e. imposed at the point of final sale) and uniformly applied to all goods.

Table II: VAT Rates and VAT Gap

	VAT GAP (%)		VAT Rates	
	2000-2011	2011	Before	After
Greece	30	39	19	23(2010)
Ireland	8	10	21	23(2012)
Italy	26	27	20	21(2012), 22(2014)
Portugal	9	16	21 (2007), 20(2008)	21(2010), 23(2011)
Spain	12	21	16	18(2010), 21(2012)

This, however, masks potential problems with VAT, which penalizes tradable over non-tradable activities. First, there are several exemptions to VAT, more heavily targeted to non-tradable service activities, such as health and education. Even with border adjustment and a smoothly functioning rebate system, higher taxes with non-uniformity would skew domestic demand towards non-tradables, mitigating the shifting of resources to the tradable sector that would result from higher demand for exports. Second, tradable goods in general, and exports in particular, operate typically in a more formal tax environment. This is more serious in countries with problematic tax compliance. In Greece, in particular, it is well known that several non-tradable sectors, predominantly services benefiting from the relative lack of an audit trail, were not issuing receipts, managing to evade VAT altogether. Such informality contributes to divergence from trade-neutrality. One way to measure this divergence is the VAT gap, which measures the deviation of actual VAT revenues from statutory liabilities, shown in Table II[9], together with the path of top statutory rates. As expected, Greece has by far the largest gap, and Ireland the smallest.

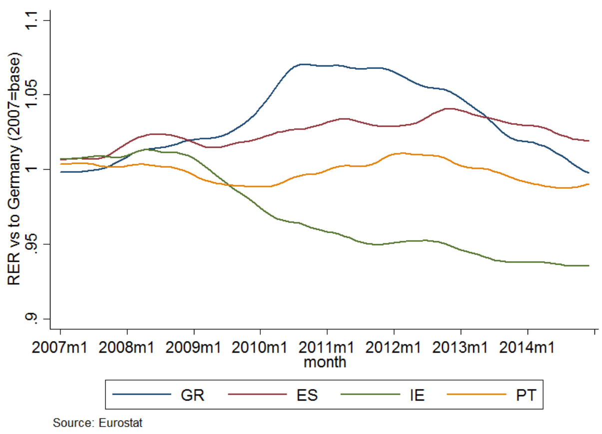
Higher VAT and energy taxes then can partially neutralize the required adjustment towards tradable production, and this distortion is rising in the magnitude of the tax informality (and hence the tax wedge between tradables and non-tradables).[10] It is then important to consider the effect of VAT and other taxes on the prices of each country relative to the core. The left panel in figure 5 shows the evolution of the RER for each country relative to Germany. The right panel shows the same but adjusted for changes in taxes, where I use tax-adjusted Harmonised Consumer Price Index (HICP) data, published by

[9]The data for the VAT gap come from http://ec.europa.eu/taxation_customs/resources/documents/common/publications/studies/vat-gap.pdf.

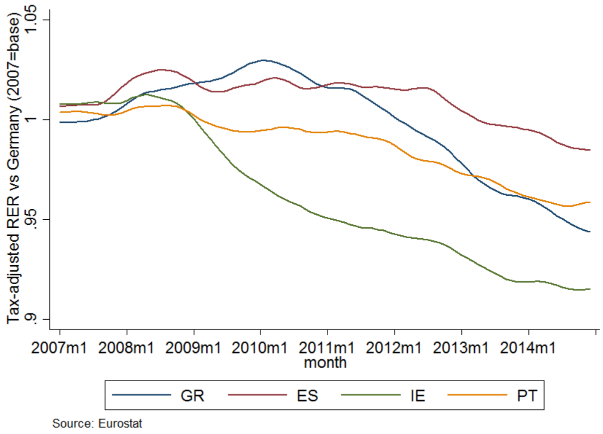
[10]Anecdotally, another issue specific to Greece was the rebate of VAT for extra-EU intermediate imports. For sales inside of Greece, the rebate was automatic, but for exports the government withheld the rebate.

Eurostat.

Figure 5: RER with respect to Germany



(a) RER



(b) Tax-adjusted RER

The graphs show that taxes did indeed distort the adjustment process, particularly for Greece, and secondarily for Spain and Portugal. With perfect border adjustment, VAT rebate, and a uniform VAT, the RER for exports would still be strictly higher than the tax-adjusted RER, due to the energy taxes hike. As such, the true RER for exports is in between the two measures. By the end of 2011, an approximate 7% difference had emerged between the headline RER and the tax-adjusted RER for Greece, persisting until the end of 2014. Put another way, an almost 5% real depreciation from early 2010 to early 2013, could have been reduced to as little as 1% due to taxes.

3 Model

In this section, I develop a model to incorporate all the issues analyzed in the previous section. The context is a standard New Keynesian small open economy framework, as in Gali & Monacelli (2005). A representative household consumes a composite consumption good, made up of tradable and non-tradable goods, and supplies labor. Preferences are logarithmic with respective to consumption, and of the constant relative risk aversion variety for labor. The consumption preferences are also characterized by habit formation, a common feature of such models, in order to induce smooth adjustments to shocks.

The economy is part of a currency union, assuming, for simplicity, that the currency union is closed to the rest of the world, and focusing analysis within the union. In contrast to Gali & Monacelli (2005), credit markets are incomplete, a feature intended to capture the fact that the periphery faced steeply rising borrowing costs, at a large premium over the core at the onset of the crisis. Incompleteness is introduced in the form of a borrowing premium i.e. the interest rate is debt elastic.[11] Since I study the quantitative implications of a large borrowing shock, this paper is related to the sudden stop literature (e.g. Calvo 1998), even though that literature typically considers emerging economies. My approach follows the sticky price open economy literature (Cook & Devereux 2006), which focuses on modeling nominal rigidities and a complex economy, but where the friction always binds and hence local solution methods can be applied. Another strand of the literature (see Korinek & Mendoza 2014 for a review) has developed a class of models featuring occasionally binding constraints, and the resulting non-linearity implies the need for global methods to solve the model. The resulting curse of dimensionality means that the model cannot be as rich as needed for the purposes of this paper.

3.1 Consumers

The country is populated by a continuum of symmetric households, indexed by i, where $i \in [0, 1]$. The index i will be omitted whenever it is not necessary for brevity. Each household maximizes expected lifetime utility

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, L_t), \tag{2}$$

where L_t denotes hours of labor, and C_t is a consumption aggregator, given by

$$C_t = \left[\gamma_c^{\frac{1}{\epsilon}} C_{T,t}^{1-\frac{1}{\epsilon}} + (1-\gamma_c)^{\frac{1}{\epsilon}} C_{N,t}^{1-\frac{1}{\epsilon}} \right]^{\frac{\epsilon}{\epsilon-1}}, \tag{3}$$

where $C_{T,t}$ is the tradable consumption index, $C_{N,t}$ is its non-tradable counterpart, γ_c the tradable share of consumption, and ϵ the elasticity of substitution between tradable and non-tradable consumption.

[11] As is well known, small open economy models with incomplete markets feature a random walk in consumption, which precludes the use of approximation techniques, and stationarity needs to be induced (Schmitt-Grohe & Uribe 2003).

Aggregate demands Optimal allocations of tradable and non-tradable goods over total consumption are given by

$$C_{T,t} = \gamma_c \left(\frac{(1+\tau_{T,t})P_{T,t}}{P_t} \right)^{-\epsilon} C_t; \quad C_{N,t} = (1-\gamma_c) \left(\frac{(1+\tau_{N,t})P_{N,t}}{P_t} \right)^{-\epsilon} C_t \tag{4}$$

where $P_{T,t}$ and $P_{N,t}$ are the price indices for tradable and non-tradable goods, respectively. The price index

$$P_t = \left[\gamma_c (1+\tau_{T,t})^{1-\epsilon} P_{T,t}^{1-\epsilon} + (1-\gamma_c)(1+\tau_{N,t})^{1-\epsilon} P_{N,t}^{1-\epsilon} \right]^{\frac{1}{1-\epsilon}} \tag{5}$$

gives the total consumption CPI (consumer price index). I define τ_T and τ_N to be the VAT rates for tradables and non-tradables respectively. Note that P_t is a tax-inclusive price index, while the other indices are tax-exclusive. As VAT is ideally fully rebated, it is equivalent to a consumption tax. The more realistic case of explicitly accounting for partial rebates is more interesting but analytically cumbersome and outside the scope of this paper. As such, the VAT gap intends to capture the idea that tradables are taxed more heavily due to both exemptions and the fact that imperfect rebates disproportionately affect tradables. Writing price indices in this way also simplifies exposition.

Preferences Let preferences be given by

$$U(C_t, L_t) = \log(C_t - b\bar{C}_{t-1}) - \frac{L_t^{1+\nu}}{1+\nu}, \tag{6}$$

where $\bar{C}_{t-1}$ is the habit stock, a function of the per capita aggregate consumption of the economy in the last period, and $b \in [0,1]$. The constant ν is strictly positive, and gives the inverse elasticity of labor supply. The flow budget constraint is given by

$$P_t C_t + B_t \leq R_{t-1} B_{t-1} + W_t L_t + T_t, \tag{7}$$

where B_t are one period non-contingent bonds, W_t is the nominal wage, and T_t firm profits.

Market Incompleteness The simplest way to capture the fact that households are borrowing in their own currency but at a premium over other EMU members is by introducing a risk premium. Here, r_t, the gross home interest rate, is given by

$$R_t = R_t^* + \Phi(b_t), \tag{8}$$

where $\Phi = \chi\left[\exp\left(\frac{B}{PY} - \frac{B_t}{P_t Y_t}\right) - 1\right] + z_{r,t}$, where χ is a known constant, and $z_{r,t}$ is a shock to borrowing costs.[12] It is assumed that the representative consumer does not internalize the effect of her borrowing on the risk premium i.e. she takes $\Phi(.)$ as given.

Consumer Maximization The first order conditions are:

$$U_{C,t} = \lambda_t P_t \tag{9}$$

$$U_{L,t} = \lambda_t W_t \tag{10}$$

$$\lambda_t = \beta R_t E_t \lambda_{t+1}. \tag{11}$$

The intratemporal condition is given by

$$(C_t - H_t)L_t^{\nu} = \frac{W_t}{P_t}, \tag{12}$$

and the stochastic Euler Equation by

$$\frac{1}{R_t} = \beta E_t \left\{ \left(\frac{C_{t+1} - H_{t+1}}{C_t - H_t} \right)^{-1} \frac{P_t}{P_{t+1}} \right\}. \tag{13}$$

Here, $\frac{1}{R_t} = \Lambda_t = E_t\{\Lambda_{t,t+1}\}$ gives the price of the one period no-coupon bond paying $1/P_t$ units of aggregate consumption, and $\Lambda_{t,t+1}$ is the stochastic discount factor between periods t and $t+1$.

[12] It is well known that small open economy models with incomplete markets require such a modeling assumption to induce stationarity, otherwise the equilibrium features a random walk and the steady-state features initial conditions. See Schmitt-Grohe & Uribe (2003) for a discussion.

3.2 Producers

There is a final tradable good consumed by domestic consumers, whose production requires an intermediate tradable input, which can be domestic or foreign, but the importing of foreign goods is characterized by trade frictions. There is also a final non-tradable good, produced by domestic non-tradable intermediates. Energy is not used in final goods production. The final sector can be thought of as the retail sector. The tradable intermediate goods can be sold at home or abroad, and the non-tradable intermediates can only be sold at home. Both types of intermediates are produced with labor and energy, allowing for different factor intensities.

Final goods production is characterized by flexible prices and perfect competition, but intermediate production is monopolistically competitive, with Calvo sticky prices. This is a common approach in New Keynesian models to the model tractable. The setting is very close to Rabanal & Tuesta (2012). Here I will only give the main conditions, see the Appendix for full a derivation.

Trade costs As argued previously, the costs imposed on trade by the logistics sector are not the result of excessive market power in the distribution industry, and hence large markups, but rather several inefficiencies in the truck industry, the rail network, and the state bureaucracy. As such, the more appropriate way to model such costs is in the form of the standard ”iceberg costs” device common in the trade literature, where a fraction ζ of goods shipped abroad ”melts” in transit. This modeling device is especially convenient as it can be readily incorporate the tariff-equivalent estimates of trade costs derived by gravity models, and used for calibrating the model (see the relevant section below. The tariff equivalent measure is denoted by τ_d, where $(1-\zeta) = \frac{1}{1+\tau_d}$ (Novy 2007). Nevertheless, the term trade cost is more intuitively appealing, as tariffs also produce revenues, while the frictions I am modeling are purely wasteful.

Final Goods The good is produced by a continuum of identical firms, using intermediate goods, with production technology given by

$$Y_{T,t} = \left[\gamma_x^{\frac{1}{\xi}} X_{h,t}^{1-\frac{1}{\xi}} + (1-\gamma_x)^{\frac{1}{\xi}} [(1-\zeta) X_{f,t}]^{1-\frac{1}{\xi}} \right]^{\frac{\xi}{\xi-1}} . \tag{14}$$

The share γ_x give the relative intensities of the inputs, and ξ the elasticity of substitution between home and foreign traded intermediates, $X_{h,t}$ and $X_{f,t}$ respectively, used in production. These are standard Dixit-Stiglitz aggregators of varieties of home and foreign traded intermediates, with elasticity of substitution σ:

$$X_{h,t} = \left[\int_0^1 X_{h,t}(h)^{1-\frac{1}{\sigma}} dh \right]^{\frac{\sigma}{\sigma-1}} \quad \text{and} \quad X_{f,t} = \left[\int_0^1 X_{f,t}(f)^{1-\frac{1}{\sigma}} df \right]^{\frac{\sigma}{\sigma-1}} \tag{15}$$

The optimal demands for intermediate varieties from the final goods producers are given by

$$X_{h,t}(h) = \gamma_x \left(\frac{P_{h,t}(h)}{P_{h,t}} \right)^{-\sigma} \left(\frac{P_{h,t}}{P_{T,t}} \right)^{-\xi} Y_{T,t}, \text{ and} \tag{16}$$
$$X_{f,t}(f) = (1-\gamma_x) \left(\frac{P_{f,t}(f)}{P_{f,t}} \right)^{-\sigma} (1-\zeta)^{\xi-1} \left(\frac{P_{f,t}}{P_{T,t}} \right)^{-\xi} Y_{T,t}.$$

where

$$P_{h,t} = \left[\int_0^1 P_{h,t}(h)^{1-\sigma} dh \right]^{\frac{1}{1-\sigma}} \quad \text{and} \quad P_{f,t} = \left[\int_0^1 P_{f,t}(f)^{1-\sigma} df \right]^{\frac{1}{1-\sigma}}, \tag{17}$$

and the final tradable price level given by $P_{T,t} = \left[\gamma_x P_{h,t}^{1-\xi} + (1-\gamma_x) \bar{P}_{f,t}^{1-\xi} \right]^{\frac{1}{1-\xi}}$, where $\bar{P}_{f,t} = P_{f,t}/(1-\zeta)$. The producer price is then $P_{f,t}$ but consumers pay $\bar{P}_{f,t}$.

The final non-tradable production is a simple Dixit-Stiglitz aggregator of intermediates, given by

$$Y_{N,t} = \left[\int_0^1 X_{N,t}(n)^{1-\frac{1}{\sigma}} dn \right]^{\frac{\sigma}{\sigma-1}}, \tag{18}$$

with the corresponding price index

$$P_{N,t} = \left[\int_0^1 P_{N,t}(n)^{1-\sigma} dn \right]^{\frac{1}{1-\sigma}}. \tag{19}$$

Intermediate Goods The standard approach in the literature is to consider linear production functions for intermediate goods. Instead, in order to account for energy, I follow Cuche-Curti et al. (2009) and consider a CES production function in energy and labor.

The production technologies are given by the following expressions, for tradable and non-tradable intermediates respectively

$$Y_{h,t}(h) = \left[\gamma_h^{\frac{1}{\alpha_y}} L_{h,t}(h)^{\frac{\alpha_y - 1}{\alpha_y}} + (1-\gamma_h)^{\frac{1}{\alpha_y}} E_{h,t}(h)^{\frac{\alpha_y - 1}{\alpha_y}}\right]^{\frac{\alpha_y}{\alpha_y - 1}} \tag{20}$$

$$Y_{N,t}(n) = \left[\gamma_n^{\frac{1}{\alpha_y}} L_{N,t}(n)^{\frac{\alpha_y - 1}{\alpha_y}} + (1-\gamma_n)^{\frac{1}{\alpha_y}} E_{N,t}(n)^{\frac{\alpha_y - 1}{\alpha_y}}\right]^{\frac{\alpha_y}{\alpha_y - 1}},$$

for $n, h \in [0,1]$.

I introduce price rigidity in the standard Calvo approach, with partial indexation, similar to Rudolf & Zurlinde (2014). In every period, a fraction θ_h of tradables intermediate producers cannot optimally set prices, and they instead set their price as a function of recent home intermediate tradables inflation:

$$P_{N,t}(n) = P_{N,t-1}(n) \left(\frac{P_{N,t-1}}{P_{N,t-2}}\right)^{\kappa_N}, \tag{21}$$

where $\kappa_N \in [0,1]$ is the indexation parameter.

The price-setting non-tradable intermediate goods firms choose their price by maximizing the following profit function:

$$\max_{P_{N,t}(n)} E_t \sum_{k=0}^{\infty} \theta_N^k \Lambda_{t,t+k} \left\{ \left[\frac{P_{N,t}(n) \left(\frac{P_{N,t+k-1}}{P_{N,t-1}}\right)^{\kappa_N}}{P_{t+k}} - MC_{N,t+k} \right] Y_{N,t+k}^d \right\}, \tag{22}$$

subject to the demand for the non-tradables intermediate goods, given by

$$Y_{N,t+k}^d = \left[\frac{P_{N,t}(n)}{P_{N,t+k}} \left(\frac{P_{N,t+k-1}}{P_{N,t-1}}\right)^{\kappa_N} \right]^{-\sigma} Y_{N,t+k}, \tag{23}$$

where $Y_{N,t+k}$ is total demand for final non-tradables at period $t+k$, as defined above. $MC_{N,t}$ is the marginal cost of production, given by

$$MC_{N,t} = \frac{\left[\gamma_n W_t^{1-\alpha_y} + (1-\gamma_n) P_{EN,t}^{1-\alpha_y}\right]^{\frac{1}{1-\alpha_y}}}{P_t}. \tag{24}$$

In the above, $P_{EN,t}$ is the price of energy, γ_n the labor share, and α_y the elasticity of substitution between labor and energy. Moreover, the price level for non-tradables evolves according to the following expression:

$$P_{N,t} = \left\{ \theta_N \left[P_{N,t-1} \left(\Pi_{N,t-1} \right)^{\kappa_N} \right]^{1-\sigma} + (1-\theta_N) \hat{p_{N,t}}^{1-\sigma} \right\}^{\frac{1}{1-\sigma}}, \tag{25}$$

where $\Pi_{N,t-1} = \frac{P_{N,t-1}}{P_{N,t-2}}$ is non-tradable inflation, and $\hat{p_{N,t}}$ is the optimal price by the price-setting firms.

The profit maximization problem for the tradables intermediates is analogous, except that now the demand is given by $Y^d_{h,t} = X_{h,t}(h) + X^*_{h,t}(h)$, where $X^*_{h,t}(h)$ is the foreign demand for home intermediate variety h.

Wage Setting Wage stickiness is introduced as in Erceg et al. (2000), a standard approach in New Keynesian Models. Each household is a monopolistic supplier of labor variety $L_t(i)$, where

$$L_t = \left[\int L_t(i)^{1-\frac{1}{\eta}} di \right]^{\frac{\eta}{\eta-1}}, \tag{26}$$

where $\eta > 1$ is the elasticity of substitution across the different labor varieties. Wages are assumed to be set by workers and taken as given by firms; as pointed out in Gali (2008), many households (of infinitesimal joint mass) can be assumed to provide the same type of labor, and a union composed of workers of the corresponding variety posts the relevant wage. The demand for each variety is hence given by

$$L_t(i) = \left(\frac{W_t(i)}{W_t} \right)^{-\eta} L_t, \tag{27}$$

where $W_t(i)$ is the wage demanded by variety i. The aggregate wage index is accordingly equal to $W_t = \left[\int W_t(i)^{1-\eta} di \right]^{\frac{1}{1-\eta}}$, and the aggregate wage bill for the economy is given by $W_t N_t = \int W_t(i) N_t(i) di$.

Wage setting is characterized by a Calvo distortion, where only a fraction $1-\theta_W$ of workers can reset their wages at each time period. The utility maximizing problem for the resetting workers is then given by

$$\max_{W_t(i)} E_t \sum_{k=0}^{\infty} (\beta\theta_W)^k \{U(C_{t+k}, L_{t+k})\}, \tag{28}$$

subject to the flow budget constraint

$$P_{t+k}C_{t+k} + B_{t+k} \leq R_{t+k-1}B_{t+k-1} + W_t(i)L_{t+k}(i) + T_{t+k}, \tag{29}$$

and labor demand

$$L_{t+k}(i) = \left(\frac{W_t(i)}{W_{t+k}}\right)^{-\eta} L_{t+k}. \tag{30}$$

Foreign Economy It is assumed that the home economy is too small to matter for the foreign economy. The shares of home goods are zero in the foreign economy, and hence the only relevant equations are the following:

$$X^*_{h,t} = (1-\zeta)^{\xi-1}\left(\frac{P^*_{h,t}}{P^*_{T,t}}\right)^{-\xi} Y^*_{T,t} \tag{31}$$

$$Y^*_{T,t} = \gamma^*_C \left(\frac{P^*_{T,t}}{P^*_t}\right)^{-\xi} C^*_t \tag{32}$$

$$Y^*_{N,t} = (1-\gamma^*_C)\left(\frac{P^*_{N,t}}{P^*_t}\right)^{-\xi} C^*_t \tag{33}$$

$$P^*_{T,t} = P^*_{f,t}. \tag{34}$$

Assuming then exogenous values for $P^*_{f,t}$, $P^*_{N,t}$, and C^*_t pins down all the other foreign variables.

Closing the model Market clearing requires that production equals consumption in both sectors, and the aggregate labor supply equals labor demand. The following conditions hold:

$$Y_{N,t} = C_{N,t} + G_{N,t} \tag{35}$$
$$Y_{T,t} = C_{T,t} + G_{T,t}. \tag{36}$$

$G_{h,t}$ and $G_{N,t}$ are exogenous government spending shocks, which provide a convenient way to introduce demand shocks to the model. These are financed by lump-sum taxes. Market clearing in the debt market implies

$$B_t + B_t^* = 0, \tag{37}$$

while the evolution of net foreign assets is equal to net exports

$$B_t = R_{t-1}B_{t-1} + NX_t. \tag{38}$$

Concerning monetary policy, the path of borrowing costs for the government and the private sector in the peripheral countries (and especially Greece) diverged so much from the path of ECB stance during the crisis that it is not worthwhile to complicate the model by adding explicit monetary rules. I simply set R_t to equal $1/\beta - 1$ in the baseline model, and for the stochastic simulation I explicitly relate the path of interest rates to that of credit creation.

4 Calibration

I select the model parameters to capture an average GIIPS country. Otherwise, they are standard, and so the discussion on these will be short.

The habit formation parameter h is set to 0.6, as is standard for the euro area (Smets & Wouters 2003). I follow Papageorgiou (2014) and set the Calvo parameter θ_N and θ_T to 0.7059 for both tradable and non-tradable producers, which imply that prices are reset on average every 3.4 quarters. These are parameters estimated from firm-level data for European firms (Druant et al. 2009). For foreign firms, the Calvo parameter is set to 0.697 (adjustment every 3.3 quarters, equal to the mean euro area country). Similarly, I set the indexation parameters κ_T and κ_N to 0.259. These correspond to the fraction of firms that consider past inflation when resetting prices, as reported in Druant et al. (2009).

Concerning wage stickiness, a big concern with using pre-crisis parameters is the well-established downward nominal rigidity in wage contracts. As pre-crisis data predominantly reflect wage increases, not reductions, it is likely that these parameters do not apply in a deflationary setting. Indeed, wages across the EU changed less frequently in the 2010-2013 (every 17 months) period compared to the 2002-2007 (every 15 months).[13]. In fact, the three countries with the higher fraction of firms who report to never changing wages are Ireland, Greece, and Portugal. The seeming paradox of nominal rigidity together with falling unit labor costs can be explained by large infrequent wage cuts (e.g. when minimum wage reductions took place). In the 2010-2013 period, over 60% of firms in Greece and Ireland and over 40% in Portugal instituted wage freezes at least once. Overall, over 80% of firms in Greece and Ireland and over 70% in Portugal change wages less frequently than once a year, with over 35% in all three countries never changing wages in the 2010-2013 period, compared to approximately 48% and 8% for the EU average. Spain is slightly more flexible but overall less than the EU average. As such, I set θ_W to 0.85, a value consistent with the average wage spell lasting for 20 months.

I set the fraction of tradables in consumption to 0.4 (Rabanal & Tuesta 2012), and the fraction of home tradable intermediates in final tradables γ_x to 0.6 (Farhi et al. 2014). Note that these are the only foreign parameters that I need to pin down, as they determine the relative size of the final goods sectors and foreign imports. The elasticity of substitution between home and foreign intermediates (ξ) is more challenging, because of the wide range of estimates reported in the literature. Rabanal & Tuesta (2012) estimate a posterior mean of 0.85 for the US and the EU, Rudolf & Zurlinde (2014) 0.83 for Switzerland. Papageorgiou (2014) estimates 3.351 for the Greek economy, while Adolfson et al. (2007), in a prominent open-economy DSGE estimation exercise use a calibrated value of 5. The latter are large scale models while the former are compact, so an appropriate value for this paper is on the lower side of this band. I set ξ to 1.5 to match the export performance of Greece after the shock, though values as low as 1 and as high as 2 also deliver a close match to the data. The baseline elasticity of substitution in varieties σ, which also pins down production markups, is set to 4, which gives a markup of 33%. Regarding η, the elasticity of substitution between labor varieties, Acemoglu & Autor (2011) estimate it at 1.8 in a recent survey. This is typically lower than what is used in the literature, so I set it at 2.

The elasticity of substitution between core and energy consumption, as well as between

[13] ECB Economic Bulletin, https://www.ecb.europa.eu/pub/pdf/ecbu/eb201605.en.pdf.

labor and energy in production, is set to 0.3, a value around the median of standard calibrations in the literature (e.g Alvarez et al. 2009, Jacquinot et al. 2006, Natal 2012), and estimates from Kilian & Murphy (2014). I set ϵ, the elasticity of substitution between tradables and non-tradables, to 0.6.

The interesting counterfactual regarding exports is not the unrealistic case of zero trade costs, but rather the gains (steady-state or dynamic) in exports and output emanating from reducing trading costs. In 2007-2009, mean trading costs against major trading partners were 91% and 69% for Portugal.[14] Portugal and Greece are the most directly comparable of all the peripheral economies, as they share similar levels of economic size, development and balance of payments problems pre-crisis. These figures translate into iceberg costs of approximately 47.6% and 40.83%, respectively, in the context of the model.

Another challenging set of parameters regards the energy shares in intermediate production $(1 - \gamma_h)$ and $(1 - \gamma_n)$. Bodenstein et al. (2008) and Natal (2012) set it to 0.02 for the US, citing evidence from sectoral value-added data, as well imports of oil and gas, and Cuche-Curti et al. (2009) also use a value of 0.02 for Switzerland. Edelstein & Kilian (2007) report a value of 0.03 for the US, using energy share in value-added. To my knowledge, there is no paper directly looking at the energy inputs of different industries, let alone a separation into tradables and non-tradables. A more granular approach is to account for energy use as a fraction of value-added across tradable and non-tradable industries. Since such information is not available for GIIPS countries, I use US data from the BEA.[15]

[14] Data come from the Observatory of Economic Complexity at MIT. Major trading partners are those countries that comprise a cumulative 67% of export destinations of an economy.

[15] GDP-by-Industry Data, http://www.bea.gov/industry/gdpbyind_data.htm.

Table III: Preference and Technology Parameters

Preference Parameters		
β	Discount factor	0.995
h	Habit formation parameter	0.600
χ	Debt elasticity of the interest rate	0.001
ν	labor elasticity	1.000
Elasticities of Substitution		
σ	Varieties	4.000
ϵ	Tradable and non-tradable core consumption goods	0.600
α_y	labor and energy in intermediate production	0.300
ξ	Home and foreign intermediate inputs in final goods production	1.500
Production and Consumption Shares		
γ_c	Share of tradables in consumption, home	0.400
γ_x	Share of home intermediates in final good production	0.600
γ_h	Share of labor in home tradable intermediates	0.978
γ_n	Share of labor in home non-tradable intermediates	0.961
Calvo parameters		
θ_h	Tradable intermediates	0.706
θ_N	Non-tradable intermediates	0.706
θ_W	Wages	0.850
Indexation parameters		
κ_h	tradable intermediates	0.259
κ_N	non-tradable intermediates	0.259

The classification of production as tradable or not is fraught with problems. A more appropriate methodology (the modified indirect approach) has been recently pioneered by the OECD, and it is this approach I utilize.[16] For the US, and excluding government and utilities, the shares of energy are 0.026 for non-tradables and 0.053 of tradables. I choose to calibrate the shares to Greece (though Portugal has similar values): using the US energy input to value-added in GDP ratio for each industry, the values are 0.025 and 0.091, respectively, owing overwhelmingly to the much larger shares amongst Greek tradables of transportation and warehousing, and to a much lesser extent agriculture, the two most energy intensive industry groups. Removing the transportation sector reduces the inputs to 0.022 and 0.039, respectively. For the purposes of the model, the latter approach is more sensible, as transportation is really a cost to other trade activities. I use this values as my benchmark, and examine how the model behaves under different magnitudes of trade costs.

[16] According to this approach, the following industries are classified as tradable: agriculture, mining, manufacturing, wholesale trade, transport, information, and professional services. I also assign accommodation to tradables, to account for the tourism industry.

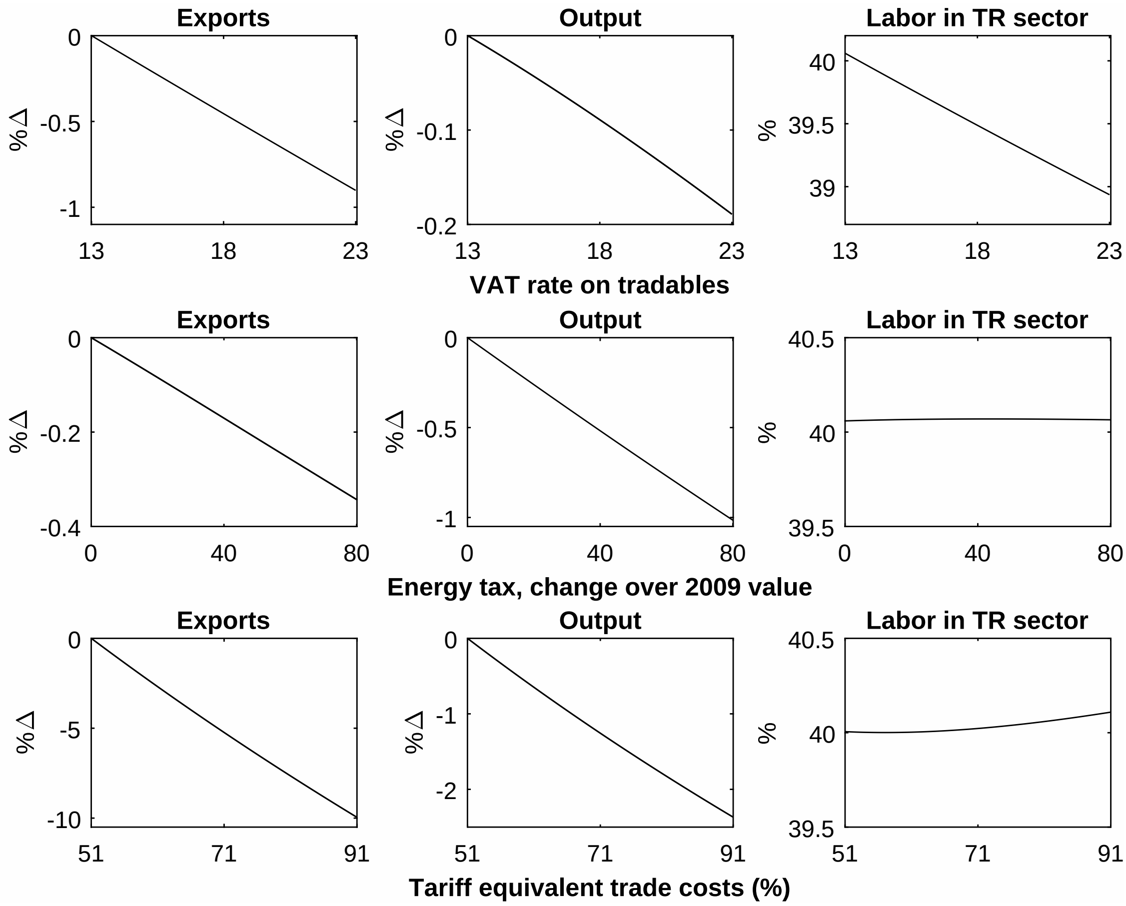
5 Adjustment, Trade Costs, and Taxes

To illustrate the behavior of the model and the relative importance of trade costs and taxes in explaining export behavior during adjustment, in this section, I conduct two sets of quantitative exercises. First, I examine the quantitative comparative statics of different policies on the steady-state level of exports, output, as well as the relative size of the tradable sector. Second, I compare the dynamics of the model when hit by an interest rate shock (intending to capture the large rise in the cost of borrowing during the crisis, as well as the fall of overall demand) under alternative scenarios regarding government policies in a perfect foresight environment (following the initial shock). In the following, I evaluate the behavior of the model by comparing it to the data in a stochastic setting by using actual interest rate shocks for the 2010-2014 period.

5.1 Steady State

To begin with, the top panel of figure 6 shows the steady-state of exports, output, and the relative size of the tradable sector under a range of effective VAT asymmetries with respect to tradables and non-tradables. Starting from a uniform VAT of 13%, I sketch out the response of the steady of the model for a rise in tradables VAT, up to the statutory maximum of 23%. This exercise is only meant to be illustrative at this stage but in the next section I explicitly account for the path of VAT. We see that the steady-state volume of exports is lower by approximately 0.8% at the statutory maximum. GDP responds little, falling by approximately 0.2% lower, though it should be noted that as VAT proceeds are spent in the same way as private consumption, this is equivalent to a rebate, and so a small output response is expected. Finally, the share of labor used in the tradable sector responds more strongly, falling by over one percentage point. Overall these responses are not trivial and are consistent with the theory.

Figure 6: Steady-State responses to different policies



The second panel in figure 6 conducts the same exercise against rising energy costs. This captures the actual rise of excise taxes in Greece, which rose by 60% during the crisis (Mitsopoulos 2014). The response of output is significantly larger here, falling by 1%; conversely, the effect is much smaller for exports, which are only about 0.35% lower in the steady-state, and similarly for the size of the tradable sector. This is because the energy share of production is only somewhat larger in tradables, and hence the effect of energy costs falls almost uniformly on all production. This is true, of course, of the total tradable sector. As shown in Pelagidis & Mitsopoulos (2014), certain sectors are so energy intensive that energy cost hikes can completely neutralize any reduction in the cost of labor (by up to a factor of 3 in Greece) and the labor cost fall meant that the former was over 3 times higher than the latter.

Finally, the bottom panel in figure 6 plots the results of the exercise where the tariff equivalent trade cost rises from 51% to the baseline of 91%. The response here is stark. Steady-state exports are almost 10% higher at the low cost level, and output 2.1% higher.[17] It is clear that trade costs are much more important than either VAT non-uniformity or energy costs in the steady-state.

5.2 Dynamic Analysis

I consider how dynamics are affected by the different taxes and costs in a stylized environment. I introduce a borrowing shock to the economy to generate a 9.5% decline in output within 5 quarters, and analyze counterfactual impulse responses under different policies, in a context where after the initial shock, there is perfect foresight regarding both the future path of the interest rate and government policies.[18]

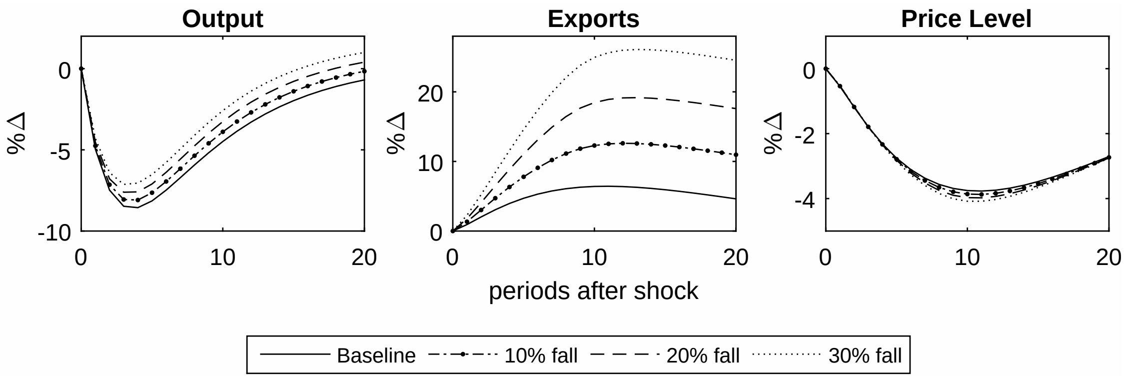
First, I consider whether policies to reduce trade costs would imply different adjustment dynamics. Starting at the baseline tariff equivalent cost of 91%, figure 7 shows the response of consumption and exports to the same shock under different reform scenarios, where the cost falls by 10%, 20%, and 30% within ten periods, and the results again are stark regarding exports. A reduction of 20% would have raised exports by 12% after ten quarters relative to the baseline, enough to raise output by around 1.6%. Notice that the price level is little affected by the trade cost reduction. This is because lower trade costs only directly affect tradables prices, specifically the prices of imports. At the same time, as lower trade costs and the less steep decline in output moderate the wage fall (compared to the baseline model), the price of non-tradables does not fall at the same rate as the price of imports, neutralizing the effect of lower trade costs on the price level. The implicit improvement in competitiveness then comes with little effect to the RER (aside from the improvement caused by the borrowing shock).

Next, consider indirect taxes. Figure 8 shows the response of exports after the interest rate shock, assuming no change to trade costs, comparing the case of a VAT hike on tradables by 20% (with the tax on non-tradables steady at 13%, and an 80% energy tax hike. The baseline case is a uniform VAT at 13% and no energy tax hike. The VAT hike moderates the initial shock by raising labor through the income effect (and due to the assumption of full rebates), though this effect evaporates within a quarter. The dynamic effect here is more pronounced than the static one for both consumption and energy taxes. The

[17] Interestingly, note that the share of labor in the tradable sector actually rises with trade costs, due to import substitution.

[18] In this and the next section, all the amounts are given relative to the pre-shock level.

Figure 7: Borrowing shock - alternative paths for trade costs

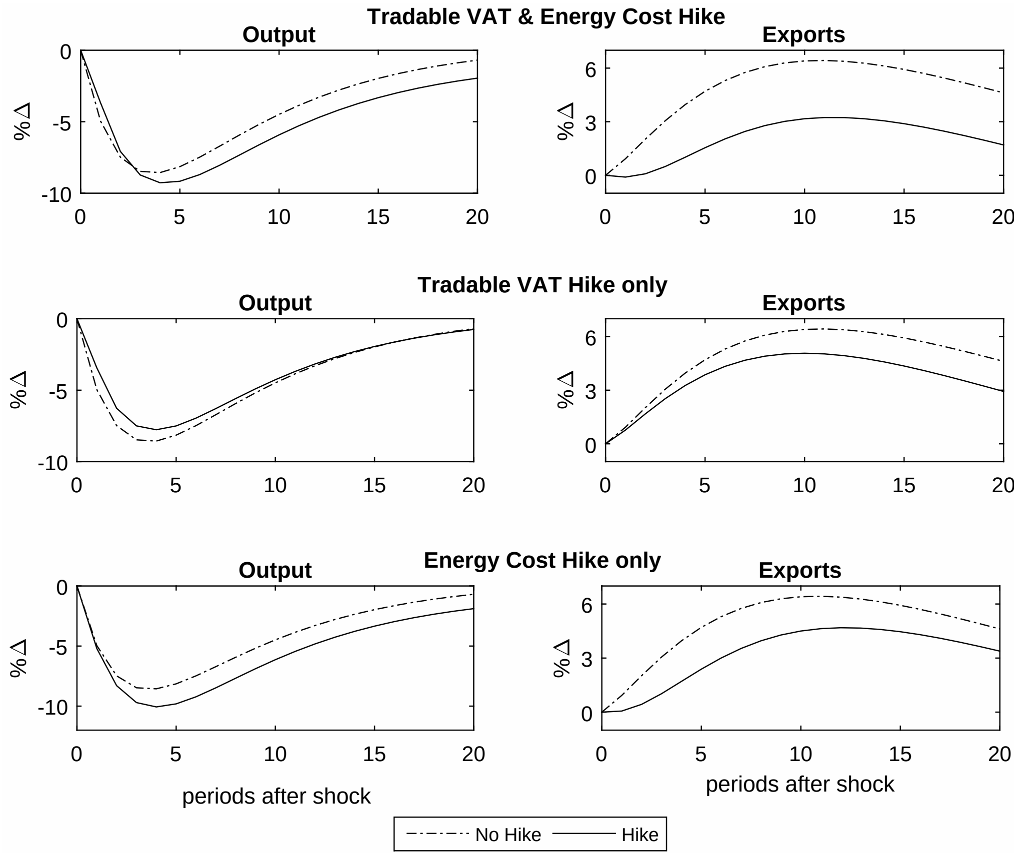


consumption tax has a larger effect on exports and a small effect on output, while the energy tax has a substantial effect on output and a moderate effect on exports. Overall, exports are approximately 3.3% higher after 10 quarters in the absence of these policy changes.

Price rigidities in the form of uncompetitive product markets can also be important in hindering adjustment. Though the small-scale model used here is too simple to fully account for such issues, it is instructive to examine how the economy behaves under different assumptions about steady-state markups. Figure 9 shows the impulse responses to the shock under structural policies that would reduce markups within ten periods, by 10%, 20%, and 30%, from the somewhat high benchmark of 35%. In the context of the model, policies that reduce markups have a sizable impact on both output and exports, but much larger on the former relative to the effect of trade costs. After ten periods, a 20% reduction in markups leads to 3.5% higher exports relative to the baseline, and 3% for output. Reducing markups has a balanced effect on both sectors, unlike trade cost reduction, which only directly benefits the tradable sector, and so output and exports rise together as markups fall, implying little change in exports as a fraction of GDP.

Directly comparing trade cost versus markup reduction policies is not straightforward, and there is no obvious way to gauge, say, whether reducing trade costs by 20% is easier than a 20% reduction of markups. Furthermore, as argued previously, the two issues are largely independent, as trade costs are the results of administrative costs and low productivity associated with lack of scale in the distribution sector, not monopoly rents. This is nevertheless a useful exercise in comparing different policies across countries, and in that sense, trade costs appear to be quantitatively more important in the model economy.

Figure 8: Borrowing shock - Consumption and Energy Taxes

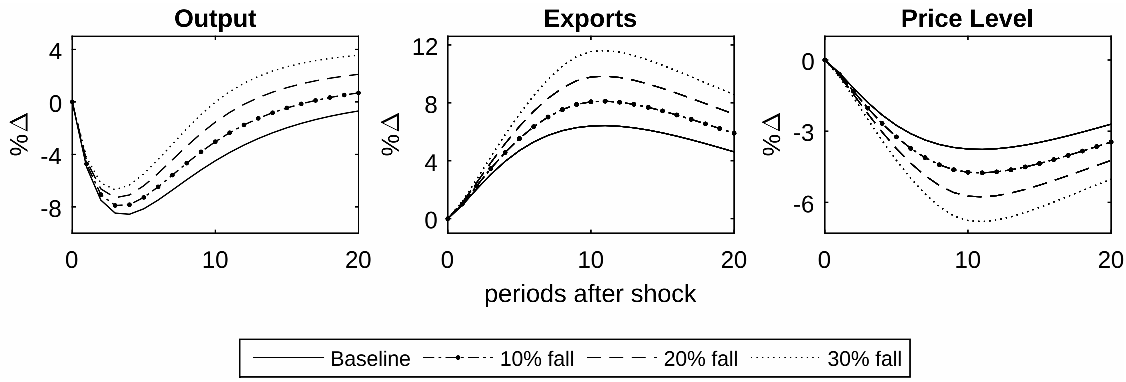


Tradable VAT hike: 20% from uniform 13%. Energy cost hike: 80% over initial steady-state.

5.3 Wage flexibility

Next, I consider the role of wage flexibility. In a recent paper, Gali & Monacelli (2016) show that, in a very similar model to the one considered here, wage flexibility in a currency union does not necessarily lead to higher welfare. They point out that, in contrast to a classical environment, where wages affect employment, in New Keynesian models aggregate demand affects employment and hence wages. As such, they argue, lower wages affect output and employment through sequential reductions in marginal costs, inflation, and nominal and real interest rates, through the endogenous policy channel. In currency unions, this channel is muted, and hence only the competitiveness channel of lower wages, by raising exports, is operative. Gali & Monacelli (2016) show that for a wide range of values, higher flexibility is utility reducing in currency union, because higher flexibility, in addition to making exports more competitive, also raises wage inflation volatility.

Figure 9: Borrowing shock - alternative paths for markups



I instead consider the dynamic behavior of the model economy as it responds to the shock, focusing on real variables. Figure 10 shows the growth of output, exports, and prices 10 periods after the borrowing shock. We see that for low levels of rigidity, there is little change on either of these variables. Substantial effects appear to kick in after θ_W rises over 0.5, after which output and export losses rise exponentially. It should be noted that values of θ^W below 0.6 are not realistic. Ireland, typically assumed to have one of the most flexible labor markets in Europe, exhibited a wage persistence of 2.8 quarters before the crisis, implying a θ_W of 0.65 (Druant et al. 2009). Moreover, this value characterized the pre-crisis period, when downward nominal rigidity was much less of a concern than during downturns. Indeed, as mentioned above, and consistent with what is known in general about the behavior of wages in recessions (Bewley 2000), θ_W is, in fact, higher in downturns. For realistic values of θ^W, say from 0.65 to 0.85, the output and export gains from higher flexibility are not trivial (2% for output, 3% for exports), but much less dramatic than from trade cost (or even tax) reductions.

Figure 10: Borrowing shock - sensitivity to wage flexibility

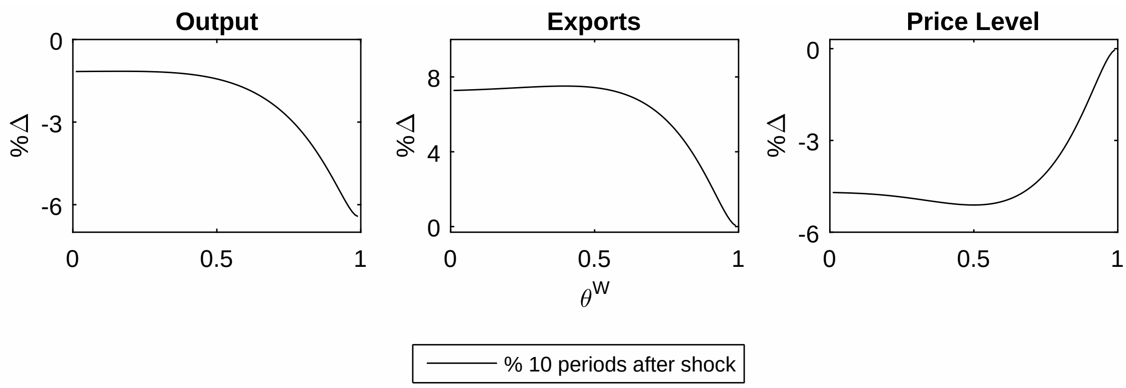


Figure 11: Borrowing shock - reforms and wage flexibility

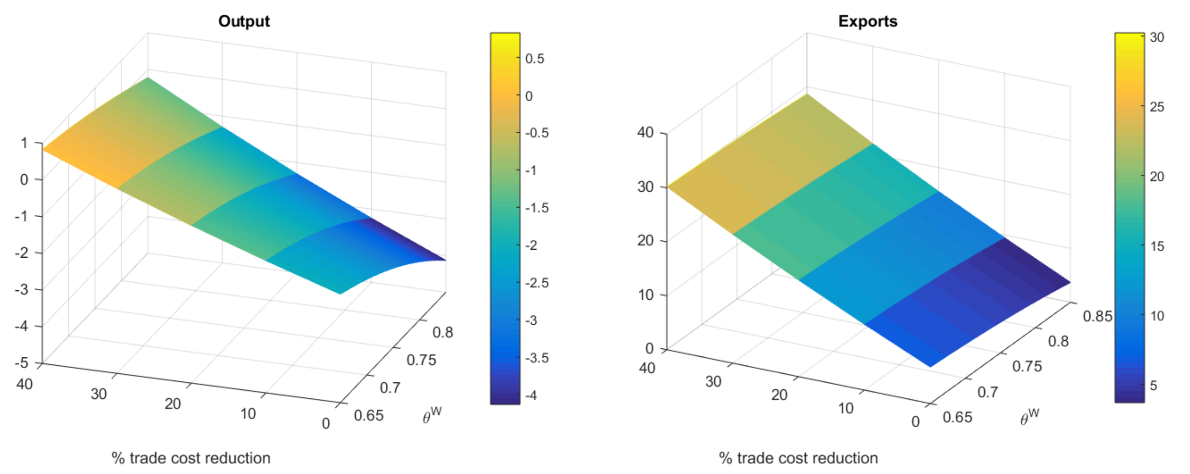


Figure 11 considers the impact of wage rigidity on the effect of the trade cost reform policies considered previously. It shows the cumulative gain in output and exports 10 periods after the shock, for reforms reducing trade costs after 10 periods by 10, 20, 30, and 40%. We see that the gains of flexibility, while positive, are trivial compared to the benefit of trade cost reduction, even for modest reforms of 10 or 20%.

6 Application

In this section, I evaluate the model using Greece as a case study, using the actual path of borrowing costs in a stochastic setting and accounting for the actual path of government policies in regards to taxes. This allows me to evaluate the role of policies in the particular case of the euro peripheral adjustment, and evaluate the predictions of the stylized model of the previous section. Greece is the more interesting country in the GIIPS in that regard, because it has by far the highest trade costs and the poorest export performance during the crisis.

I simulate the model in a stochastic context, where agents expected zero mean random shocks to their borrowing costs each period. I feed into the model the actual path of interest rates the Greek economy experienced from the last quarter of 2009, when the impending crisis became apparent, until the last quarter of 2014. At the same time, I maintain the assumption that the government commits to a policy after the initial shock, as the ultimate goal of this paper is to study the efficacy of government policies. This is a necessary simplification to keep the model simple, particularly in regards to VAT hikes, which happened at several stages.[19]

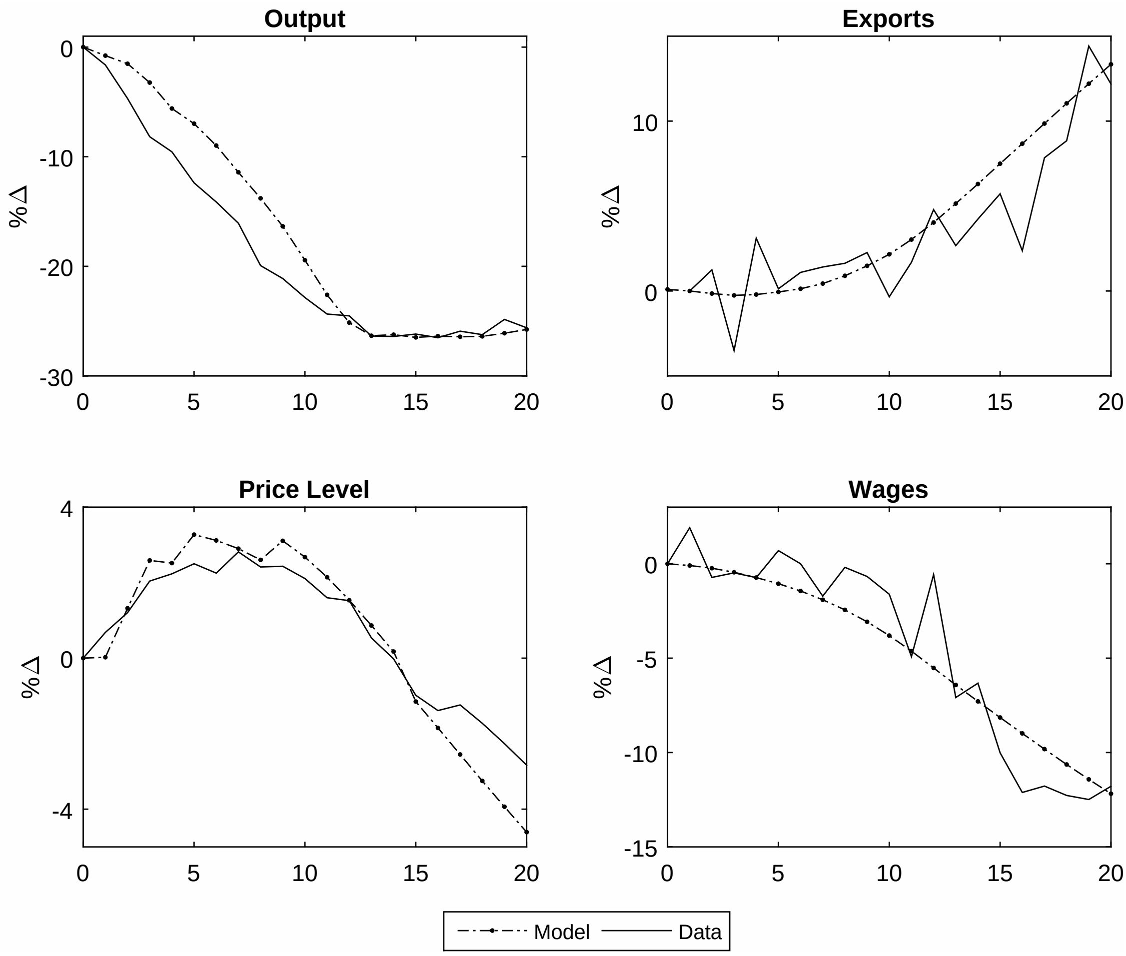
6.1 Data and model performance

The choice of interest rate data is not a straightforward one. Even though the stock of outstanding credit in the Greek economy collapsed to a third of its pre-crisis level, the average interest rate for NFC loans never exceeded 8%, and so credit adjustment took place in the quantity margin, with credit being rationed a-la Stiglitz & Weiss (1981). As such, I resort to credit default swaps (CDS), an indirect metric of borrowing costs for the sovereign or the bank (similar to Cook & Devereux (2006), who use sovereign credit risk premia). Due to the substantial private sector debt write-down (PSI) in 2012, sovereign CDS were triggered in 2012 and are thus not suitable as a metric of borrowing costs, and hence I use the CDS for the National Bank of Greece, the largest lender in Greece at the time. To bring the model to the data I also need to properly account for the path of taxes and energy costs, as well as energy prices. Details are given in the appendix.

Figure 12 compares the performance of the model to the data for output, exports, CPI (excluding food and energy, as energy is not part of consumption in the model), and wages. The model does quite well in capturing the main behavior of all variables, especially the price level. Wage reductions seem to have been quite sporadic across firms, occasionally spiking upwards, but the overall trend is well captured by the model. For exports, the model closely captures the slow growth in the first periods after the shock, missing short-term spikes, but tracks the trend very well. The model overshoots output in the first few periods, but catches up when output flattens.

[19] I use the simultxdet function of Dynare, which combines deterministic and stochastic shocks. The government policies are deterministic in that the agent knows the precise path from the initial period. The interest rate is a zero mean autoregressive stochastic process, but instead of having random shocks each period, I feed actual data into the model, in a sense "tricking" the agent. Though an adaptive expectations process may be more realistic, the model is not as naive as may seem, given the highly persistent nature of the shock (from the point of view of the agent).

Figure 12: Model Performance

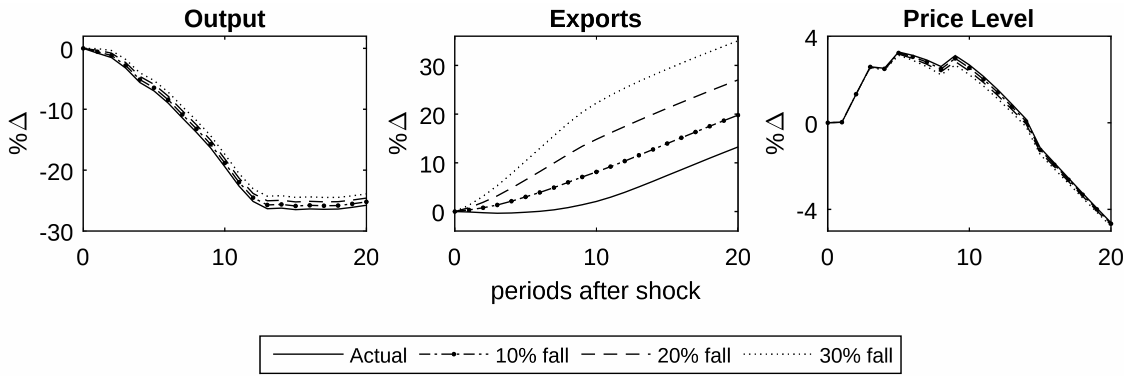


6.2 Counterfactual Policies

Having established that the model does well in capturing the broad behavior of the data, I can now study the counterfactual behavior of the economy under the policies outlined in the previous section. Results from the stochastic simulations are shown in figures 13-15.

Just as in the one-off shock in the previous section, trade costs are shown to be extremely important in holding back export growth. A reduction of trade costs by 30% relative to the baseline, would have led to an export growth of around 20% after 10 periods relative to the baseline. As a comparison, Portugal's trade costs were 25% lower at the start of the crisis and were reduced to 30%, while Greece's stayed flat. A 30% also implies that output is about 2% higher than the baseline after 10 periods. Finally, the trade cost reduction does

Figure 13: Borrowing shock - counterfactuals for trade costs



not translate into lower prices, for the same reasons as in the previous section.

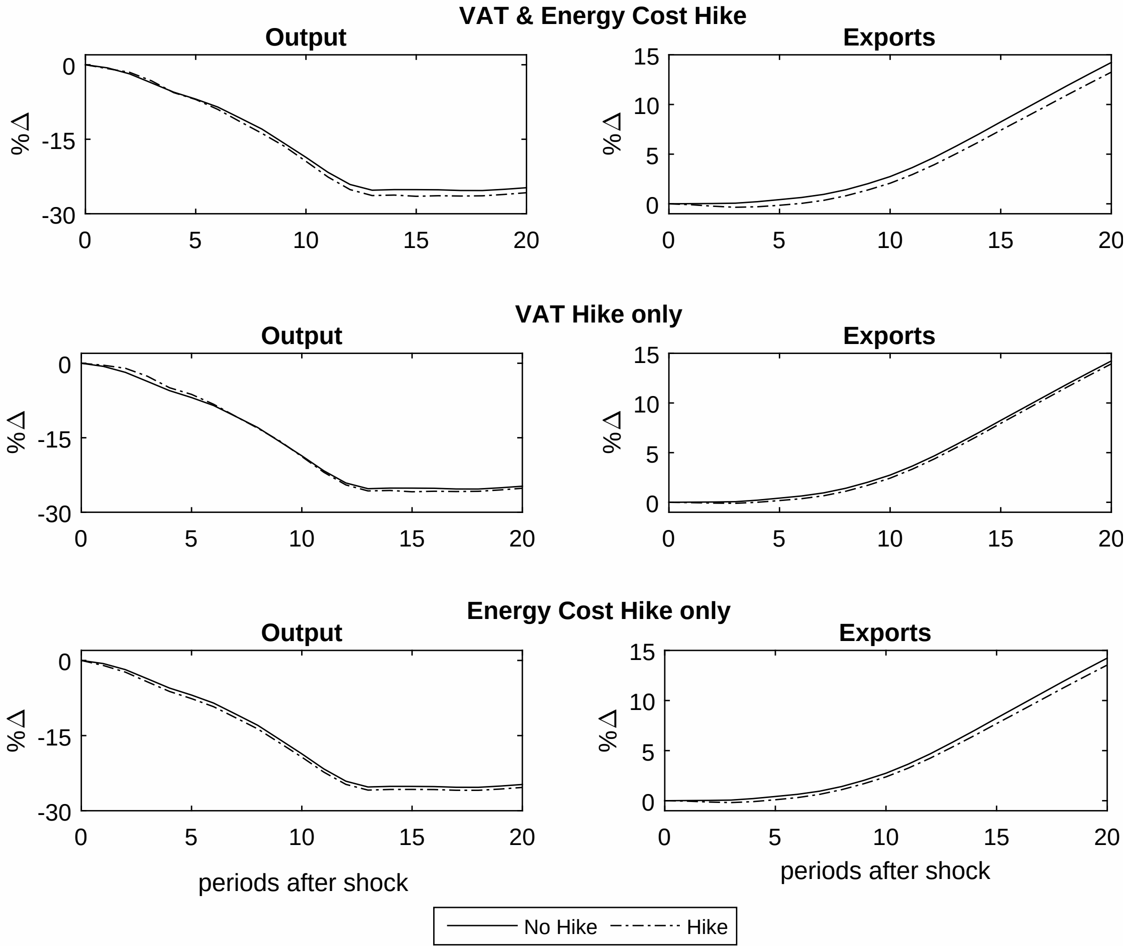
Turning to taxes, the aggregate effect is smaller on both output and exports compared to the deterministic case, because the shock is much deeper and protracted here (and also because the stylized policy experiments in the one-off case involved sharper hikes). Nevertheless, the small fall in exports observed in the first few quarters goes away in the counterfactual exercise with no hikes, where instead exports start rising right after the shock, instead of after 6 periods. As hypothesized, while the tax hikes cannot explain why exports did not rise, they can explain their initial fall.

Finally, figure 15 shows the behavior of the model in the presence of policies that would reduce markups by respective amounts through 10 periods. As before, markups have an appreciably higher impact on output than trade costs: the gain of a 30% reduction is 4.3% after 10 periods, which persists after 20 periods. This is of course achieved by reducing prices: for the same reform, the price is 2.9% lower than the baseline after 10 periods. At the same time, exports gains are smaller than for an equiproportional reduction of trade costs: the gain is roughly 5% for a 30% reduction in markups after 10 periods, about a quarter of the gain from a proportional reduction in trade costs.

7 Conclusion

This paper considers the importance of trade costs in obstructing export adjustment policies in currency unions. In a standard New-Keynesian small open economy model, I show that trade costs and indirect taxes, hitherto ignored features of policy packages, can be an important obstacle in fiscal devaluations. I illustrate their role in explaining deviations in

Figure 14: Borrowing shock - Consumption and Energy Taxes

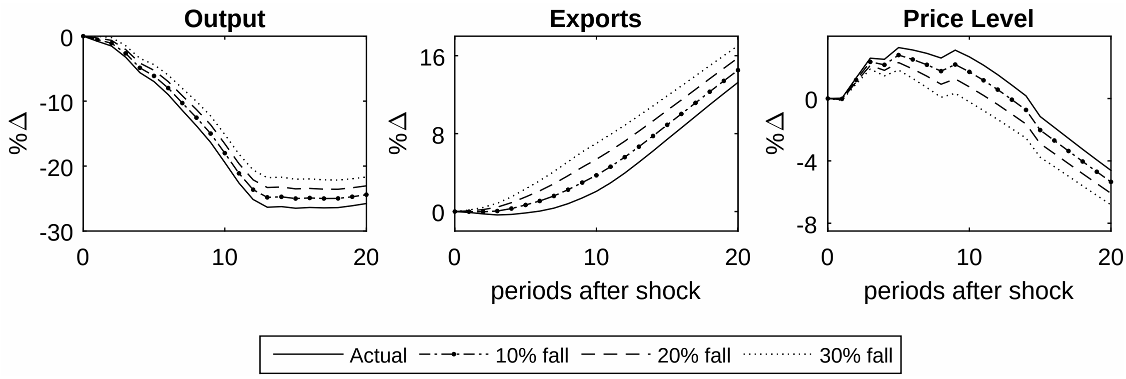


export performance among euro peripheral countries during the recent crisis.

First, even moderate trade costs reductions can have significant effects on export performance. Secondarily, consumption and energy taxes can also be important in reducing exports (and output), due to their effect on shifting labor resources away from the tradable sector, but are less important than trade costs. Similarly, price rigidities, in the form of production markups, have a larger effect on output, as they affect both tradable and non-tradable sectors, but a more moderate impact on imports.

Furthermore, for realistic parameters, wage flexibility also has a moderate effect on exports and output, much smaller than trade costs (for the former) or markups (for the latter). For very low levels of rigidity (wages resetting every two quarters or less), the real or prices effects of higher or lower rigidities are almost nonexistent.

Figure 15: Borrowing shock - alternative paths for markups



The policy implications of this paper are clear: current account adjustment policies have to take into account the efficiency of the logistics and transportation sector of the adjusting economy. This is not only true in the case of fixed exchange rate regimes, but also apply to flexible regimes. In fact, a key corollary of the results of this paper is that the adjustment benefits of a flexible currency can be severely hampered by a failure to reduce trade costs.

References

Acemoglu, D. & Autor, D. (2011), *Skills, Tasks and Technologies: Implications for Employment and Earnings*, Vol. 4 of *Handbook of Labor Economics*, Elsevier, pp. 1043–1171.

Adolfson, M., Laseen, S., Linde, J. & Villani, M. (2007), 'Bayesian Estimation of an Open Economy DSGE Model with Incomplete Pass-Through', *Journal of International Economics* **72(2)**, 481–511.

Alessandria, G. & Choi, H. (2014), 'Do falling iceberg costs explain recent U.S. export growth?', *Journal of International Economics* **94**(2), 311–325.

Alvarez, L., Hurtado, S., Sanchez, I. & Thomas, C. (2009), 'The impact of oil price changes on Spanish and Euro Area Consumer Price Inflation', *Bank of Spain Working Paper* .

Anderson, J. E. & Wincoop, E. V. (2003), 'Gravity And Gravitas: A Solution To The Border Puzzle', *American Economic Review* **93**.

Arkolakis, C., Doxiadis, A. & Galenianos, M. (2014), The Challenge of Trade Adjustment in Greece, *in* 'Reforming the Greek Economy', MIT Press.

Bewley, T. (2000), *Why Wages Don't Fall during a Recession*, Harvard University Press.

Bodenstein, M., Erceg, C. & Guerrieri, L. (2008), 'Optimal Monetary Policy with Distinct Core and Headline Inflation Rates', *Journal of Monetary Economics* **55**, 18–33.

Calvo, G. (1998), 'Capital flows and Capital-Market Crises: The Simple Economics of Sudden Stops', *Journal of Applied Economics* **1(1)**, 35–54.

Choi, H. & Alessandria, G. (2016), The Dynamics of the Trade Balance and the Real Exchange Rate: The J Curve and Trade Costs?, Working paper.

Coeurdacier, N. (2009), 'Do trade costs in goods market lead to home bias in equities?', *Journal of International Economics* **77**(1), 86–100.

Cook, D. & Devereux, M. (2006), 'Accounting for the East Asian Crisis: A Quantitative Model of Capital Outflows in Small Open Economies', *Journal of Money, Credit and Banking* **38(3)**, 721–749.

Cuche-Curti, N., Dellas, H. & Natal, J.-M. (2009), 'DSGE-CH: A Dynamic Stochastic General Equilibrium Model for Switzerland', *SNB Economic Studies* .

de Mooij, R. & Keen, M. (2012), 'Fiscal Devaluation" and Fiscal Consolidation: The VAT in Troubled Times', *IMF Working Paper* .

Desai, M. & Hines, J. R. (2005), 'Value-added Taxes and International Trade: The Evidence'. University of Michigan Working Paper.

Druant, M., Fabiani, S., Kezdi, G., Lamo, A., Martins, F. & Sabbatin, R. (2009), 'How are Firms' Wages and Prices Linked. Survey Evidence in Europe', *European Central Bank Working Paper* .

Eaton, J., Kortum, S. & Neiman, B. (2016), 'Obstfeld and Rogoff's International Macro Puzzles: A Quantitative Assessment', *Journal of Economic Dynamics and Control* .

Edelstein, P. & Kilian, L. (2007), 'The Response of Business Fixed Investment to Changes in Energy Prices: A Test of Some Hypotheses About the Transmission of Energy Price Shocks', *The B.E. Journal of Macroeconomics* **7(1)**.

Erceg, C. J., Henderson, D. W. & Levin, A. T. (2000), 'Optimal Monetary Policy with Staggered Wage and Price Contracts', *Journal of Monetary Economics* **46**(2), 281–313.

Farhi, E., Gopinath, G. & Itskhoki, O. (2014), 'Fiscal Devaluation', *Review of Economic Studies* **81**, 725–760.

Feldstein, M. & Krugman, P. (1990), International Trade Effects of Value-Added Taxation, *in* 'Taxation in the Global Economy', University of Chicago Press.

Gali, J. (2008), *Monetary Policy, Inflation and the Business Cycle: An Introduction to the New Keynesian Framework*, Princeton University Press.

Gali, J. & Monacelli, T. (2005), 'Monetary Policy and Exchange Rate Volatility in a Small Open Economy', *Review of Economic Studies* p. 707–734.

Gali, J. & Monacelli, T. (2016), 'Understanding the Gains from Wage Flexibility: The Exchange Rate Connection', *American Economic Review* .

Gorodnichenko, Y., Mendoza, E. & Tesar, L. (2012), 'The Finnish Great Depression: From Russia with Love', *American Economic Review* **102(4)**, 1619–1643.

Gourinchas, P.-O., Philippon, T. & Vayanos, D. (2016), The analytics of the greek crisis, Working Paper 22370, National Bureau of Economic Research.

Gross, D. B. & Souleles, N. S. (2002), 'Do Liquidity Constraints And Interest Rates Matter For Consumer Behavior? Evidence From Credit Card Data', *Quarterly Journal of Economics* **107**, 149.

International Monetary Fund, F. A. D. (2011), *Fiscal Monitor: Addressing Fiscal Challenges to Reduce Economic Risks*, International Monetary Fund.

Jacquinot, P., Mestre, R. & Spitzer, M. (2006), 'An Open-Economy DSGE Model of the Euro Area', *European Central Bank Working Paper* .

Keen, M. & Syed, M. (2006), 'Domestic Taxes and International Trade: Some Evidence', *IMF Working Paper* .

Kilian, L. & Murphy, D. (2014), 'The Role of Inventories and Speculative Trading in the Global Market for Crude Oil', *Journal of Applied Econometrics* **29**.

Korinek, A. & Mendoza, E. (2014), 'From Sudden Stops to Fisherian Deflation: Quantitative Theory and Policy', *Annual Review of Economics* **6**, 299–332.

Lama, R. & Rabanal, P. (2014), 'Deciding to Enter a Monetary Union: The Role of Trade and Financial Linkages', *European Economic Review* **72**, 138–165.

Mitsopoulos, M. (2014), Manufacturing, Competition and Business Environment. Removal of Obstacles - Opening to International Competition, *in* 'Competitiveness for Growth: Policy Proposals', Athens: Hellenic Bank Association.

Natal, J.-M. (2012), 'Monetary Policy Response to Oil Price Shocks', *Journal of Money, Credit and Banking* **44(1)**, 53–101.

Nicholson, M. W. (2013), 'The Impact of Tax Regimes on International Trade Patterns', *Contemporary Economic Policy* **31(4)**, 746–761.

Novy, D. (2007), 'Is the Iceberg Melting Less Quickly? International Trade Costs after World War II', *University of Warwick Working Paper* .

Novy, D. (2013), 'Gravity Redux: Measuring International Trade Costs With Panel Data', *Economic Inquiry* **51(1)**, 101–121.

Obstfeld, M. & Rogoff, K. (2000), 'The Six Major Puzzles in International Macroeconomics: Is There a Common Cause', *NBER Macroeconomics Annual* **15**, 339–412.

Papageorgiou, D. (2014), 'BoGGEM: A Dynamic stochastic General Equilibrium Model for Policy Simulations', *Bank of Greece Working Paper* .

Pelagidis, T. (2014), 'Why Internal Devaluation is Not Leading to Export-Led Growth in Greece'. Brookings Institution.
URL: *http://www.brookings.edu/blogs/up-front/posts/2014/09/12-internal-devaluation-export-growth-greece-pelagidis*

Pelagidis, T. & Mitsopoulos, M. (2014), *Greece. From Exit to Recovery?*, Brookings Institution Press.

Rabanal, P. & Tuesta, V. (2012), 'Nontradable Goods and the Real Exchange Rate', *Open Economies Review* .

Reyes-Heroles, R. (2016), The Role of Trade Costs in the Surge of Trade Imbalances, Working paper.

Rudolf, B. & Zurlinde, M. (2014), 'A Compact Open Economy DSGE Model for Switzerland', *SNB Economic Studies* .

Schmitt-Grohe, S. & Uribe, M. (2003), ‘Closing Small Open Economy Models’, *Journal of International Economics* **61**, 163–185.

Schneider, F. & Buehn, A. (2012), ‘Shadow Economies in Highly Developed OECD Countries: What Are the Driving Forces?’. IZA Discussion Paper No. 6891.

Smets, F. & Wouters, R. (2003), ‘An Estimated Dynamic Stochastic General Equilibrium Model of the Euro Area’, *Journal of the European Economic Association* **1(5)**, 1123–1175.

Stiglitz, J. & Weiss, A. (1981), ‘Credit Rationing in Markets with Imperfect Information’, *American Economic Review* **71(3)**, 393–410.

Vegh, C. (2013), *Open Economy Macroeconomics for Developing Countries*, MIT Press.

World Bank (2013), ‘Greek Logistics: Unlocking Growth Potential through Regulatory Reform and Complementary Measures’.

A Equilibrium

A.1 Households

The Euler equation is given by

$$\lambda_t = \beta R_t E_t \left\{\lambda_{t+1}\right\}, \tag{39}$$

where λ_t is the marginal utility of consumption

$$\lambda_t = \frac{1}{(C_t - bC_{t-1})P_t}. \tag{40}$$

The labor supply decision satisfies

$$L_t^{\nu} = \lambda_t W_t, \tag{41}$$

where

$$L_t = L_{N,t} + L_{h,t}. \tag{42}$$

Household demands for final goods are given by

$$C_{T,t} = \gamma_c \left(\frac{(1+\tau_{T,t})P_{T,t}}{P_{C_t}}\right)^{-\epsilon} C_t; \qquad C_{N,t} = (1-\gamma_c)\left(\frac{(1+\tau_{N,t})P_{N,t}}{P_t}\right)^{-\epsilon} C_t, \tag{43}$$

The CPI is given by

$$P_t = \left[\gamma_c (1+\tau_{T,t})^{1-\epsilon} P_{T,t}^{1-\epsilon} + (1-\gamma_c)(1+\tau_{N,t})^{1-\epsilon} P_{N,t}^{1-\epsilon}\right]^{\frac{1}{1-\epsilon}}. \tag{44}$$

A.2 Final Goods Producers

Final tradables are produced according to the following technology

$$Y_t = \left[\gamma_x^{\frac{1}{\xi}} X_{h,t}^{1-\frac{1}{\xi}} + (1-\gamma_x)^{\frac{1}{\xi}} \left[(1-\zeta)X_{f,t}\right]^{1-\frac{1}{\xi}}\right]^{\frac{\xi}{\xi-1}}. \tag{45}$$

Demands for intermediate tradable goods from the final goods producers are given by

$$X_{h,t} = \gamma_x \left(\frac{P_{h,t}}{P_{T,t}}\right)^{-\xi} Y_{T,t}, \text{ and } \quad X_{f,t} = (1-\gamma_x)(1-\zeta)^{\xi-1} \left(\frac{P_{f,t}}{P_{T,t}}\right)^{-\xi} Y_{T,t}.$$

The price indices for final tradables is given by

$$P_{T,t} = \left[\gamma_x P_{h,t}^{1-\xi} + (1-\gamma_x)\bar{P}_{f,t}^{1-\xi}\right]^{\frac{1}{1-\xi}}, \tag{46}$$

where $\bar{P}_{f,t} = P_{f,t}/(1-\zeta)$. The trade cost ζ is the iceberg cost of trade, linked to the tariff equivalent by the formula $\tau_d = \frac{\zeta}{1-\zeta}$. The law of one price will hold for tradable goods (excluding distribution costs), and $P_{h,t} = P^*_{h,t}$, and $P_{f,t} = P^*_{f,t}$.

A.3 Intermediate Non-tradable Good Producers

The profit maximization problem of the price-setting firms yields to following solutions:

$$\frac{\hat{p}_{N,t}(n)}{P_{N,t}} = \frac{\sigma}{\sigma-1} \left\{ \frac{E_t \sum_{k=0}^{\infty} \theta_N^k \Lambda_{t,t+k} \left(\prod_{s=1}^{k} \frac{(\Pi_{N,t+s-1})^{\kappa_N}}{\Pi_{N,t+s}}\right)^{-\sigma} MC_{N,t+k} Y_{N,t+k}}{E_t \sum_{k=0}^{\infty} \theta_N^k \Lambda_{t,t+k} \left(\prod_{s=1}^{k} \frac{(\Pi_{N,t+s-1})^{\kappa_N}}{\Pi_{N,t+s}}\right)^{1-\sigma} \frac{P_{N,t+k}}{P_{t+k}} Y_{N,t+k}} \right\}, \tag{47}$$

with

$$MC_{N,t} = \frac{\left[\gamma_n W_t^{1-\alpha_y} + (1-\gamma_n) P_{EN,t}^{1-\alpha_y}\right]^{\frac{1}{1-\alpha_y}}}{P_t}. \tag{48}$$

The price level for final non-tradables evolves from the following:

$$P_{N,t} = \left\{\theta_N \left[P_{N,t-1} (\Pi_{N,t-1})^{\kappa_N}\right]^{1-\sigma} + (1-\theta_N)\hat{p}_{N,t}^{1-\sigma}\right\}^{\frac{1}{1-\sigma}}, \tag{49}$$

and the production function is given by

$$Y_{N,t}(n) = \left[\gamma_n^{\frac{1}{\alpha_y}} L_{N,t}(n)^{\frac{\alpha_y - 1}{\alpha_y}} + (1-\gamma_n)^{\frac{1}{\alpha_y}} E_{N,t}(n)^{\frac{\alpha_y - 1}{\alpha_y}}\right]^{\frac{\alpha_y}{\alpha_y - 1}}. \tag{50}$$

A.4 Intermediate Tradable Good Producers

The profit maximization problem of the price-setting firms yields to following solutions:

$$\frac{\hat{p}_{h,t}(h)}{P_{h,t}} = \frac{\sigma}{\sigma - 1} \left\{ \frac{E_t \sum_{k=0}^{\infty} \theta_h^k \Lambda_{t,t+k} \left(\prod_{s=1}^{k} \frac{(\Pi_{h,t+s-1})^{\kappa_h}}{\Pi_{h,t+s}} \right)^{-\sigma} MC_{h,t+k} Y_{h,t+k}}{E_t \sum_{k=0}^{\infty} \theta_h^k \Lambda_{t,t+k} \left(\prod_{s=1}^{k} \frac{(\Pi_{h,t+s-1})^{\kappa_h}}{\Pi_{h,t+s}} \right)^{1-\sigma} \frac{P_{h,t+k}}{P_{t+k}} Y_{h,t+k}} \right\}, \tag{51}$$

with

$$MC_{h,t} = \frac{\left[\gamma_h W_t^{1-\alpha_y} + (1-\gamma_h) P_{Eh,t}^{1-\alpha_y}\right]^{\frac{1}{1-\alpha_y}}}{P_t}. \tag{52}$$

The price level for final tradables evolves according to the following expression:

$$P_{h,t} = \left\{ \theta_N \left[P_{h,t-1} \left(\Pi_{h,t-1} \right)^{\kappa_h} \right]^{1-\sigma} + (1-\theta_h) \hat{p}_{h,t}^{1-\sigma} \right\}^{\frac{1}{1-\sigma}}, \tag{53}$$

and the production function is given by the following:

$$Y_{h,t}(h) = \left[\gamma_h^{\frac{1}{\alpha_y}} L_{h,t}(h)^{\frac{\alpha_y - 1}{\alpha_y}} + (1-\gamma_h)^{\frac{1}{\alpha_y}} E_{h,t}(h)^{\frac{\alpha_y - 1}{\alpha_y}}\right]^{\frac{\alpha_y}{\alpha_y - 1}}. \tag{54}$$

A.5 Market Clearing

Following Rabanal & Tuesta (2012), I assume that government consumption only falls on the final sector. The market clearing conditions for tradable and non-tradable final goods is given by

$$Y_{N,t} = C_{N,t} + G_{N,t} \tag{55}$$

$$Y_{T,t} = C_{T,t} + G_{T,t}. \tag{56}$$

The government runs a balanced budget, so spending is equal to revenue:

$$G_t = \tau_{T,t} P_{T,t} C_{T,t} + \tau_{T,t} P_{T,t} C_{T,t}. \tag{57}$$

The condition for market clearing in the intermediate tradable sector is:

$$Y_{h,t}(h) = X_{h,t}(h) + \zeta X^*_{h,t}(h) + (1-\zeta) X^*_{h,t}(h), \forall h \in [0,1]. \tag{58}$$

Writing the condition this way makes clear that a fraction ζ of exports is lost to trade costs, and the rest reaches the foreign economy. Similarly, the condition in the intermediate non-tradable sector is:

$$Y_{N,t}(n) = X_{N,t}(n), \forall n \in [0,1]. \tag{59}$$

Concerning the energy sector, the simplest approach is to abstract from issues relating to the processing of crude oil imports, and the domestic production of electricity, and assume all energy is costlessly produced domestically, where one unit of energy requires one unit of output in the respective sector it is used.

The economy imports intermediate tradables, and exports intermediate tradables, and so the trade balance (NX_t) is given by[20]

$$NX_t = \frac{P_{h,t} X^*_{h,t}}{P_t} - \frac{P_{f,t} X_{f,t}}{P_t}. \tag{60}$$

Aggregate real GDP is the sum of tradable and non-tradable final goods consumption for the public and private sector:

$$Y_t = \frac{(1+\tau_{T,t}) P_{T,t} (C_{T,t} + G_{T,t})}{P_t} + \frac{(1+\tau_{N,t}) P_{N,t} (C_{N,t} + G_{N,t})}{P_t}. \tag{61}$$

Finally, by definition of national accounting, the change in the net foreign asset position

[20]Recall that the distribution cost is not part of export revenue. It is however part of import cost.

(NFA_t) has to be equal to the trade balance plus net investment income, or, in the context of this model, net returns on bonds held in the previous period. So we have that

$$NX_t = B_t - R_{t-1} B_{t-1}. \tag{62}$$

B Data

B.1 CDS

As mentioned in the tax, the significant write-down on Greek government debt in 2012 triggered CDS payments. As such data on sovereign CDS are not helpgul. However, bank CDS exhibit a very tight correlation with credit growth until the summer of 2012, when the price of bank CDS collapsed (due to restored confidence) but credit growth was sluggish to pick up. Prices on CDS for 1-2 year bonds were also extremely volatile during the PSI, reaching a value of several thousands basis points for a few months. This is a typical inverted yield curve situation.

I thus use data on M3 growth, and combine it with data on 5 year CDS for the National Bank of Greece until 2012Q2, as well as consensus estimates of the response of credit to interest rate changes, and impute a synthetic path of interest rates for 2012Q3 until the end of my sample. Regressing the $\Delta \log(M3)$ on ΔCDS (relative to 2009Q4) yields a coefficient of -.013, a number coinciding well with literature estimates of credit response to interest rate changes (Gross & Souleles 2002). The R^2 of this regression is 80%. I then regress ΔCDS on $\Delta \log(M3)$, get the coefficient, and impute values for CDS for the rest of the period.

B.2 Path of Taxes

Tax hikes, particularly for VAT, occurred in several stages, not only in regards to the headline rate, but also the progressive elimination of several deductions. VAT hikes or exemption eliminations occurred in March 2010, July 2010, January 2011, and September 2011. A reduction on VAT on dining took place in August 2013. This is obviously problematic for the model to capture. For simplicity, I assume that the path of the VAT is deterministic.

As discussed in the main text, the wedge in the burden VAT imposes on tradables versus non-tradables is recognized but non-quantified. As such the simulation exercise will have to be stylized. The table below shows the actual path of rates.

Accordingly, I set the pre-crisis levels at 13% for non-tradables and 15% for tradables. They rise to 14 and 17 in period 3 (2010Q2), 15 and 19 in period 4 (2010Q3), 16 and 20 in period 6 (2011Q1), 17 and 21 in period 9 (2011Q4), and 16.3 and 20.3 in period 16 (2013Q3).

Table IV: VAT Rates for Greece

Period of Change	VAT rate standard	reduced	ultra-reduced	Special rate changes
From 2005	19	9	4.5	
Mar 2010	21	10	5	
July 2010	23	11	5.5	
Jan 2011	23	13	6.5	Aegean special rates rise (16,9,5)
September 2011	23	11	5.5	Ready-made foods & alcohol from 11 to 23
August 2013	23	11	5.5	Ready-made foods & alcohol from 23 to 13

Regarding energy taxes, I use the difference of pre and post-tax prices for industrial use for medium consumption firms (20 to 500 MWh), as reported by Eurostat. Finally, I use oil prices as a proxy for energy prices, and set the global energy price to equal the 1 month futures price of one barrel of world not allocated brent crude oil.[21]

B.3 Trade Patterns

It is important to consider the trade relationships of the countries considered, to ensure there are no demand composition effects confounding the data, which could happen for several reasons. For instance, negative shocks to trade partners, as was the case for Finland after the Soviet collapse, can have severe real consequences, particularly when there is little diversification in trade destinations (Gorodnichenko et al. 2012). On the other hand, positive shocks to large trade partners would have the opposite effect. In general, rising global demand for goods or resources in high supply in a specific country can also lead to export growth, as was the case for Argentina and Chile in the mid 2000s.

Table V gives[22], for Greece, Ireland, and Portugal, the fraction of exports sold to their ten top trading partners (of 2007) for 2007 and 2014.

Greece is much more diversified in terms of exports destination, with 39% of exports going to its 5 largest partners in 2014 (down from 44% in 2007), versus 53% for Ireland and 57% for Portugal (64% in 2009). Ireland has benefited by the growth of the US market for

[21]Source: ECB Statistical Data Warehouse.
[22]Source: MIT Observatory of Economic Complexity.

Table V: Trade Partners by Country: % of Total Exports

Greece			Ireland			Portugal		
	2007	2014		2007	2014		2007	2014
DEU	13.12	10.58	GBR	18.76	15.07	ESP	28.63	23.49
ITA	11.84	11.08	USA	17.74	22.24	DEU	12.76	11.68
BGR	7.00	6.58	DEU	7.54	6.57	FRA	12.51	11.74
CYP	6.44	5.25	FRA	5.82	5.25	GBR	5.98	6.11
GBR	6.07	5.47	NLD	3.97	3.80	USA	4.60	4.39
ROM	4.84	3.66	ESP	3.68	2.76	ITA	4.09	3.21
FRA	4.49	3.77	ITA	3.56	2.36	NLD	3.39	3.97
USA	4.22	4.03	POL	0.66	1.07	SGP	1.85	.
ESP	3.48	3.07	SGP	0.57	.	POL	0.70	0.98
TUR	3.13	5.14	KOR	0.54	.	TUR	0.51	0.84

For Greece, oil products are not included.

its products, but even the lower shares versus the UK and Germany still reflect higher trade volumes. Portugal has reduced its dependence on Spain by becoming more diversified. Overall there is nothing in the data to suggest that the different export performances during the period considered were driven by external factors alone.

C Background

This section contains further discussion about the intuition behind the paper. In addition, it includes a broader look into the data for the euro-periphery crisis, particularly Greece.

C.1 Internal Devaluation

The basic idea of an internal devaluation that could boost competitiveness in the presence of fixed exchange rates goes back to Keynes, who was writing for the Gold Standard period, and argued that an export subsidy and an import tariff could mimic the effect of a currency devaluation, by reducing the relative price of home tradables (de Mooij & Keen 2012). As such predatory tax policies are illegal in the EU, the more recent discussion of the same concept evolved along the lines of the so-called "fiscal devaluation", where a reduction of employers' social insurance contributions (SCR) and a rise in VAT would bring about a revenue-neutral improvement in competitiveness. The mechanics of such a fiscal devaluation would be as follows. Starting from an initial low employment, high sticky nominal wage position, a reduction in SCR would raise labor demand and thus employment, as the labor cost would fall even with fixed nominal wages. The rise in VAT would serve a double purpose. First, it would raise the price of domestic consumption (but not exports), and so make domestic tradables more attractive only to foreign consumers. Second, it would ensure the reform is revenue neutral (International Monetary Fund 2011). Note that flexible wages would negate this effect, as workers would demand higher wages, while a flexible exchange rate would appreciate after the increased demand for home goods. This is of course redundant, as with flexible nominal wages and prices the adjustment would take place through the market and there would be no need for a fiscal devaluation.

Farhi et al. (2014) provide theoretical support for this idea, by providing conditions under which a combination of taxes and subsidies could mimic the real effects of a nominal devaluation under fixed exchange rates, in the context of a standard New Keynesian small open economy model with sticky prices. Interestingly, they show that, in the context of a currency union, fiscal devaluations can be unilaterally engineered and be effective without accommodating monetary policies, as long as the size of the country is sufficiently small relative to the union. This simple tax policy is only really equivalent to a nominal devaluation under certain conditions, some restrictive (namely that the policy is unanticipated). Otherwise, under sticky prices, the VAT rise will raise the real exchange rate, the exact opposite of a nominal devaluation, and the combination of a consumption subsidy with a change in the income tax is needed to offset this effect, making the policy quite complicated. Furthermore, while a nominal depreciation would affect the export prices of all goods in an identical way, the effects of fiscal devaluation will be more pronounced for labor-intensive goods, and since non-tradables tend to be more labor intensive, the required reallocation will be hard to achieve (International Monetary Fund 2011).

In any case, fiscal devaluation envisioned as such was never really implemented during the crisis, although it was tried to some extent in Denmark and Sweden in the late 1980s and early 1990s, but also in Germany in 2006, within the context of a currency union. If anything, the crisis countries in the euro area periphery would be better placed to run successful fiscal devaluations of the Farhi et al. (2014) type, as they are quite small relative to the union, and so they would not require monetary accommodation. An explicit fiscal devaluation approach was part of the bail-out deal for Portugal but was eventually scrapped. France announced such a plan in 2012 but never implemented it.

C.2 VAT and trade

There is an old argument about the competitiveness gains of VAT. The argument rested on the mechanics of VAT as a "destination-based" taxed. It is imposed on goods consumed domestically, but not on those exported, and so it can act as a tariff-cum-subsidy on its own. However, as Feldstein & Krugman (1990) showed, for the case of a uniform VAT, this argument misses the fact that domestic exporters will equalize the prices they demand both home and abroad. In a small open economy that is a price-taker in international markets, this means that the home price of exportable goods is simply equal to the international price plus the tax. The domestic importers will behave similarly, and thus the domestic price of imports will also equal to the international one plus the tax. Finally, the imposition of the VAT will raise the price of non-tradables in the same way, and so all absolute prices rise by the same rate, leaving relative prices unchanged. This makes VAT trade-neutral. Note that VAT is trade neutral in the sense that it does not affect the relative prices of exports and imports; just as any other tax, it will generally create intertemporal or other effects, which may or may not affect the trade balance, just like any other tax.

The theoretical trade-neutral nature of the VAT rests on two main assumptions.[23] First, the tax needs to be uniform, imposed at the same rate on all goods. Feldstein & Krugman (1990) made the specific distinction between tradable and non-tradable goods, as it is well known that non-tradables are typically taxed at a lower rate. This is partly due to administrative complexity in taxing certain non-traded activities, such as household production and, importantly, the informal sector. This is especially crucial for Greece, which has one of the largest informal sectors relative to GDP among OECD countries (Schneider & Buehn 2012). To the extent that informal activity is predominantly non-traded, there exists a natural tax-advantage to non-tradable production. Furthermore, modern welfare states typically tax-discriminate in favor of certain non-tradable services, such as healthcare and education, for equity reasons, magnifying the relative tax distortion between the two types of production.

The effect of the unequal tax treatment of tradables and non-tradables is straightforward. Non-tradables become relatively cheaper, so consumption, and hence production, shifts to that sector. This is particularly problematic for the implementation of internal devaluation, as the recovery strategy hinges on exactly the opposite goal, an export-led growth through a resource shift towards the tradable sector.[24] Furthermore, according to standard models (Vegh 2013), the higher relative demand for non-tradables following the hike will be followed by a rise in both price and production of non-tradables (by a shift in production), as this demand shift cannot be accommodated by imports.

The second requirement is that the rebate system is properly functioning. In the extreme case of no rebate on exports and a full tax on imports, VAT becomes a protectionist policy. Recall that with a full rebate the domestic exporter is indifferent between the international price when exporting, and the tax inclusive price domestically, the domestic price must be equal to the international price plus the tax. By contrast, in a system with no rebate, the producer will pay the tax no matter where the good is sold, and so the domestic *consumer* price will equal the world price. This has the effect of reducing the relative price of exportables over imports domestically. As such, non-rebate of the VAT amounts essentially to an export tax, and, at least in the short run, lower profits for exporters are likely to lead to a *fall* in trade.

[23] In addition, if VAT is imposed on an origin-basis, flexible exchange rates are needed to ensure neutrality. The policy-relevant case is that of destination-basis taxation, so I will not dwell on this special case.

[24] The precise impact of this wedge is very hard to estimate, not least because of the large practical difficulties in precisely delineating tradables and non-tradables from the data.

There are further nuances regarding the property functioning of the VAT system that are specific to Greece, emanating from the well-known problems the country has with regards to public finances in general, and the efficiency of the tax collection system in particular. A full analysis is outside the scope of this paper, but suffice it to say that evasion arguably affects exporting firms disproportionately, for the reasons previously mentioned.

Empirical evidence of the effects of VAT on trade is mixed. Keen & Syed (2006) consider the VAT together with corporate taxes. Their results are sensitive to the use of VAT variable, and to whether they account for corporate taxes. If the latter are excluded, VAT has a significant relative correlation with (net) exports, which goes to zero when accounting for the corporate tax. In a dynamic analysis, the VAT is irrelevant when using VAT revenue over consumption, or the standard VAT rate, but highly negative and significant if using VAT revenue over GDP. In the latter case, the effect is sharp but short-lived. Desai & Hines (2005) use cross-sectional and panel data and find that reliance on VAT is a significant trade hurdle. They conjecture that their results are primarily driven by the asymmetry with regards to non-tradables, and by incomplete rebates to exporters. They confirm the cross-country data with evidence from affiliates of US multinational firms, who also export less when they operate in countries that rely on VAT.

Nicholson (2013) looks more closely at the case of the United States competitiveness, and how it is affected by the fact that it is the only OECD country that does not use VAT. His panel is short, but has sectoral data, for 29 separate industries, which allows for a richer specification than Desai & Hines (2005), and he tests a gravity model of trade in relation to the US. He finds that VAT on other countries has a robust significant positive impact of US exports, and a negative (though less robust) impact on imports, which suggests that VAT negatively affects exports of adopted countries.

Overall, the message from those studies is that even though the estimates provided are not causal and more work is needed, the null hypothesis assuming no effect of VAT on trade should be at the very least questioned.

As regards to the relative intensities of VAT across tradables and non-tradables, there are no, to my knowledge, specific estimates, owning both to the complexity of the VAT system, and to the fact that exact definitions of tradables and non-tradable sectors are equally complex. The statutory level in Greece rose from 18% to 23% in 2010, with two special categories rising to 13% (reduced) and 6.5% ("ultra-reduced"), up from 9% and 4.5%. The statutory rate for the period under study was 30% lower on the three categories for all islands in the Aegean Sea, except for Crete. The ultra-reduced rate applies to certain cultural categories and hotels, while the reduced rate applies to foods and related categories, and most non-tradable services (dining a notable exception). Health and education are fully exempt from VAT. These, together with the fact that the large informal sector is by nature non-tradable and VAT exempt, imply that there exists a significant tax burden on the tradable sector.

Portugal and Ireland, by contrast, started from a higher VAT rate. Ireland had a maximum rate of 21%, only raising it to 23% in 2012. In Portugal, a rate of 20% rose to 23% in 2011. As such, the desired shift to tradables was mitigated to a larger extent in Greece than Ireland or Portugal, due to the larger rise in the statutory rate.[25] Even more important is the level of informality and the extent of non-compliance, both of which contribute to the divergence from trade-neutrality, as mentioned in the main text. Finally, Greece has a much larger informal sector than Portugal or Ireland, which, as discussed above, is by construction not affected by VAT and exclusively non-tradable. Specifically, the size of the informal sector was estimated to 25.1% of GDP in 2010 in Greece, versus 22.2% in Portugal, and 16.5% in Ireland (Schneider & Buehn 2012).

C.3 Energy

The energy cost situation is especially problematic for Greece, compared to the rest of the periphery. Rising energy costs have been widely blamed as one of the reasons for the underperformance of exports in Greece. The energy market is dominated by state-controlled enterprises in both the retail and wholesale sectors, though there has been a significant reduction in their market share in the past few years, from 85.6% of the total energy market in 2009 to 66% in 2011 and 2012[26]. This fall seems to have leveled off, as it was primarily due to the growth of the natural gas network. Around half of the energy source is lignite, a domestically extracted low-quality (and so both costly and highly polluting) type of coal.

Despite the gradual opening of the energy market, two developments during the crisis years have resulted in a large rise in energy costs, for both retail consumers and com-

[25]It is the change, and not the level, that is under consideration here. Thus, it is the change in VAT, not its level, that is relevant.

[26]DEI annual reports for several years, https://www.dei.gr/en/i-dei/enimerwsi-ependutwn/etisia-deltia.

panies. First, as part of the initial debt consolidation efforts by the government, taxes on energy rose significantly. This rise was primarily due to a hike in excise taxes, which are non-refundable. As taxes vary by type and intensity of use, it is more instructive to look at tax revenues by energy taxes. Even though energy taxes in Greece were quite low compared to the rest of the EU before 2009, tax receipts rose by 60% from 2008 to 2011 (when they peaked, falling slightly in 2012), whereas they fell in Portugal and Spain, rose modestly in Ireland (by 13%) and more significantly in Italy, rising by 25%.

Second, the government started leveraging its control of the energy market, through DEI bills, to use energy prices as an indirect source of revenue. One approach that caused much controversy was the imposition of several emergency "solidarity contributions" tied to DEI bills for retail consumers. An approach more relevant to this paper was the rise in the price demand for energy by DEI. According to official Eurostat data, tax-inclusive electricity prices for industrial production in Greece, though certainly higher than the EU average, are not excessive in comparison. The price of a unit of electricity for energy intensive companies was 7 cents in 2013 for Greece, compared to 8.4 for Ireland, 7.8 for Spain, 8.3 for Italy, and 5.9 for Portugal. However, as pointed out by Pelagidis (2014), simply comparing energy prices charged for industrial use across countries is highly misleading. The reason is that it is standard practice for energy-intensive companies across Europe to negotiate individual agreements at rates well below official market rates with energy providers, and these agreements are considered industrial secrets, and hence not included in averages quoted in Eurostat. In many countries, such agreements account for over 50% of total industrial energy use, which means that Eurostat-quoted prices substantially overestimate true energy costs. By contrast, Greece does not have such agreements, and hence the price recorded is the actual price paid. While precisely quantifying this disadvantage is not straightforward, an estimate is that energy-intensive Greek companies have to pay up to 80% more than similar firms in other EU countries (Pelagidis & Mitsopoulos 2014).

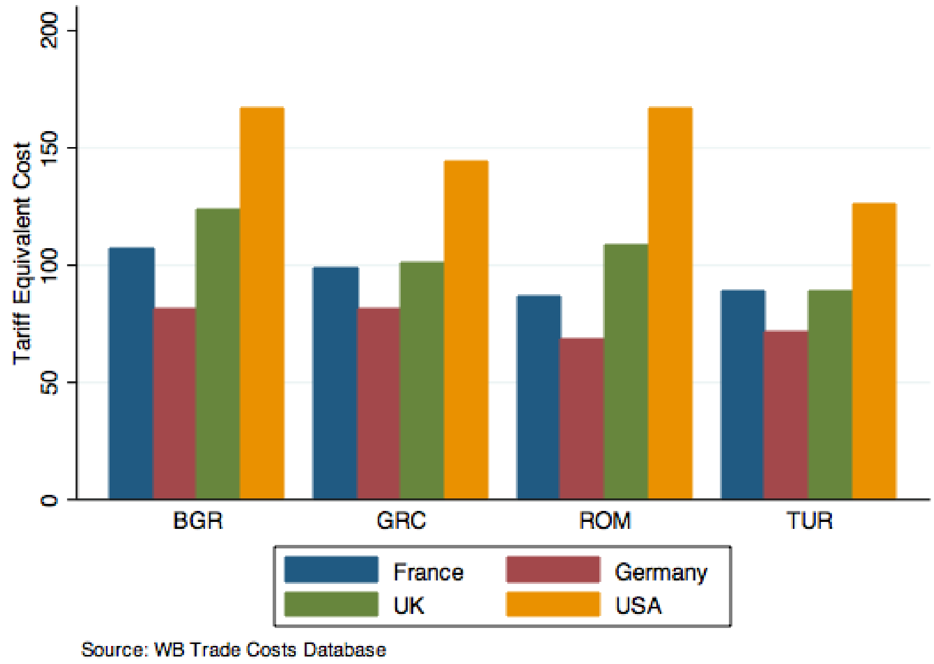
The combination of tax hikes and tax-like price hikes for energy use, combined with high costs of credit, are, according to Pelagidis (2014), the chief contributor to the failure of export-led growth to lead the Greek recovery, in spite of the fall in labor costs.

C.4 Trade Costs and Logistics

As showed in the main text, Greece is a major laggard in terms of lowering trade costs compared to the rest of the periphery, and hence the focus of this section is on Greece. The situation is deemed to be so dire by policy experts that it led the World Bank to publish a special report on the logistics sector in Greece (World Bank 2013), a rare move for a developed country. This section considers some more data on trade costs for Greece, and briefly presents the results of the World Bank report.

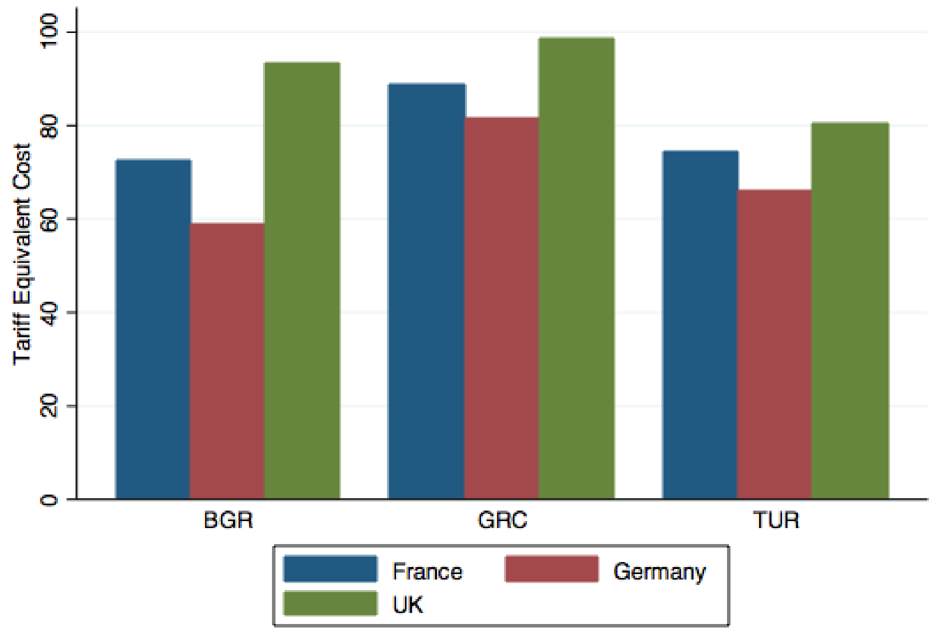
First, it is interesting to consider how Greece fares against its non-euro area neighbors in Southeastern Europe. Figures 16 and 17 show trading costs for Greece, Bulgaria, Romania, and Turkey for 2007 and 2012, respectively.

Figure 16: Trade Costs by Trading Partner: Southeast Europe, 2007



Here the differences are less pronounced, but it is important to consider the fact that Greece has a much higher level of GDP per capita than its neighbors. Greece has lagged compared to the Southeastern countries in reducing its costs. Bulgaria has made great strides, lowering by 32% costs of trading with France, 25% with Germany, and 27% for the UK. Turkey has been less successful than Bulgaria, but still performed better than Greece.

Figure 17: Trade Costs by Trading Partner: Southeast Europe, 2012



Another interesting metric to consider in this context is the Logistics Performance Index (LPI), also provided by the World Bank. It is an index, and a corresponding ranking, of inefficiencies in the supply chain, intended to assess the logistics performance of each country by surveying professionals in the major trading partners of the country. In 2007, Ireland was ranked 11, a position it still held in 2014, after a brief fall in 2012. Greece worsened significantly in the crisis, falling from 29 in 2007 to 69 in 2012, and then back to 44 in 2014. Italy and Portugal have improved slightly, from 22 to 20 and 28 to 26, while Spain has exhibited a more pronounced improvement, rising from 26 to 18. This index accords well with the trade cost data and shows again Greece as the major laggard.

According to the World Bank report, although the problems with the Greek distribution sector are varied and cannot be characterized by a single issue, an overarching hurdle to an improved value chain is the overwhelming reliance on road transportation through trucks, which accounts for 98% of land transport, versus 72% for the EU as a whole (World Bank 2013). The trucking sector is especially fragmented, with 90% of operators being characterized as ”own-account”, meaning that they transport their own goods. 1.27 million such companies operate, a stunning number for a country of fewer than 11 million inhabitants (World Bank 2013). The authors list a number of possible factors, such as more stringent regulation for commercial licenses as opposed to own-accounts, high fuel costs, VAT rates, road user charges, driver insurance costs and others. In all, the total cost per kilometer of transporting cargo on Greek roads is almost double that of French ones.

Nevertheless, reliance on trucks is a necessity due to the lack of a comprehensive rail network. The grid is state-owned and mired by inefficiencies, featuring mostly legacy stations, not designed for cargo transport, and a sparsely electrified. Furthermore, the bad shape of the train system means that the well-performing sectors in Greek logistics, notably shipping, are cut-off from the product sector. Recent large investments in the Port of Piraeus have not trickled down as the port is not well-connected with the train grid.

There are a number of further issues contributing to the low efficiency of the logistics sector, including the bad planning of logistics zones, restrictive licensing systems, poor enforcement of trade-related laws, and corruption among customs brokers.[27] Overall, the state of the logistics sector, imposes a significant tax on trading activity, and could potentially account for a substantial part of the lackluster performance of the Greek exporting sector during the recovery.

[27]Kathimerini newspaper, July 27, 2014.
http://www.kathimerini.gr/777866/article/epikairothta/ereynes/moy-evazan-lefta–kryfa-sta-xeria.

Acknowledgements

This paper was part of my dissertation at the University of Maryland. I would like to thank an anonymous referee for insightful comments, Felipe Saffie for his guidance and advice, Pablo Cuba Borda for detailed comments, Sebnem Kalemli-Ozcan for her insights, Pau Rabanal for sharing his code and advising on the model structure, and Alex Mourmouras for early discussions on the idea behind this project, and Melissa Kearney, Ethan Kaplan, and Lesley Turner for their support. All errors are mine.

Filippos Petroulakis

European Central Bank, Frankfurt am Main, Germany; email: filippos.petroulakis@ecb.europa.eu

Postal address 60640 Frankfurt am Main, Germany
Telephone +49 69 1344 0
Website www.ecb.europa.eu

ISSN	1725-2806 (pdf)	DOI	10.2866/398147 (pdf)
ISBN	978-92-899-2771-0 (pdf)	EU catalogue No	QB-AR-17-061-EN-N (pdf)