Quantifying the Germany Shock: Labor Market Reforms, Nominal Rigidities and Trade Spillovers in the Eurozone

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September 2022

Preliminary and Incomplete

Abstract

We analyze the impact of the increase in German competitiveness that followed the introduction of the Euro on employment and trade in the Eurozone (EZ). We first provide broad reduced-form evidence supporting the view that German labor market reforms in the late 90s and early 2000s led to an increase in German labor supply, a decline in German real wages, an increase in manufacturing exports relative to those of other EZ economies and a crowding-out of their manufacturing exports and employment. We then quantitatively assess the impact of the German competitiveness shock using a calibrated multi-sector quantitative trade model with downward nominal wage rigidities. In this model, a fixed nominal exchange rate may make nominal ridigities binding in response to a foreign real shock, like the one implied by German labor market reforms. This induces a large contraction of manufacturing sectors and significant involuntary unemployment in other EZ countries. Finally, we consider a number of counterfactual scenarios, such as the impact of German labor market reforms in the absence of a fixed exchange rate and coordinated labor market reforms in the EZ.

Keywords: Euro, labor market reforms, nominal rigidities, import competition, monetary union
JEL: F16, F41, F45

We have benefited from discussions with Alejandro Cuñat, Guido Lorenzoni, Peter Schott, and comments from seminar audiences at the Federal Reserve Board. Funding by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) through CRC TR 224 (Project B06) is gratefully acknowledged. Schymik thanks Harvard Business School for its hospitality where parts of the paper were written.

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1 Introduction

A well known fact about the introduction of the Euro is that it led to large capital inflows from the core of the Eurozone into its peripheral countries which lasted up to the global financial crisis. This resulted in a boom in the periphery – particularly in non-tradable service sectors – which lasted up to the global financial crisis (Baldwin and Giavazzi, 2015). Less appreciated but equally important is that the same period saw the beginning of a German manufacturing-export boom, while manufacturing sectors in other Eurozone countries were hit harshly.

In this paper, we study the effects of the German labor market reforms that were implemented in the 1990s and early 2000s on trade, employment and welfare of the Eurozone economies. Starting in the 1990s, Germany experienced a substantial increase in wage flexibility, driven by an increasing fraction of firms that opted out of collective wage bargaining. Second, from 2003-2005 Germany went through a set of important labor market reforms (the so-called "Hartz reforms"), which (i) increased incentives for labor market participation and (ii) reduced the generosity of unemployment insurance. We argue that these labor market reforms, in combination with increased wage flexibility, substantially increased labor supply and reduced real wages in Germany, leading to a significant gain in competitiveness of Germany relative to other Eurozone economies. Simultaneously, the fixed nominal exchange rate that was introduced with the Euro adoption in 1999 prevented a currency depreciation of the other Eurozone economies relative to Germany. In response to increased German competition nominal wages should have adjusted downward in the rest of the Eurozone to clear local labor markets. However, as wages were strongly downward rigid in the rest of the Eurozone, they could not fall, leading to a large contraction in manufacturing employment and to involuntary unemployment.

To motivate this narrative, we first present a number of stylized macroeconomic facts, focusing on the period from the mid-1990s up to the financial crisis of 2008. First, following the implementation of the Hartz reforms, labor force participation strongly increased in Gemany, while the German real wage declined simultaneously. Second, this resulted in a substantial real depreciation of German goods relative to those of other Eurozone economies and implied a large gain in German manufacturing competitiveness within the Eurozone. Third, we show that this competitiveness shock led to substantial crowding-out of exports from other Eurozone countries. In fact, for Eurozone economies the "Germany shock" was far more important than the "China shock" in terms of its magnitude. While average German manufacturing import penetration into the Eurozone (measured as imports per domestic EZ absorption) increased from 7 to more than 16 percentage points between 1995 and 2008, average Chinese import penetration increased from less than 1 percentage point to 6 percentage points during the same period. Fourth, we find that other Eurozone countries experienced substantial declines in manufacturing employment as a con-

sequence of German competition, in particular in those sectors that were most exposed to it. At the same time, nominal wages did not fall in response to increased competition from Germany. Finally, during that period the German current account surplus increased strongly. This increase was mostly due to trade imbalances and substantially driven by a rise in net exports into the Eurozone.

Motivated by these empirical facts, we then quantify the consequences of the German labor market reforms on employment, trade and welfare. We build and calibrate a quantitative New-Keynesian multi-sector model of international trade. The model features downward nominal wage rigidities (henceforth DNWR) à la Schmitt-Grohé and Uribe (2016). In the model, downward wage-adjustments in response to shocks can only occur slowly over time causing temporary involuntary unemployment. Our model builds on Rodríguez-Clare et al. (2020) and fits into the class of gravity models of international trade with multiple sectors and an input-output structure as in Caliendo and Parro (2015). We further assume that there are multiple countries within the Eurozone sharing a fixed nominal exchange rate which prevents reductions in real wages via nominal devaluations. In contrast to Caliendo et al. (2021), we abstract from labor mobility across countries. Instead we assume that labor supply is upward sloping because workers decide whether to engage in home production or to participate in the labor market. Our model distinguishes from Rodríguez-Clare et al. (2020) in two aspects that are critical to study Eurozone adjustments to the Germany shock. First, we include unemployment benefits for agents who become involuntarily unemployed. Unemployment benefits are financed with a revenue-neutral income tax on labor incomes. Second, our model also features an endogenous saving decision and international trade in financial assets. This allows for an endogenous adjustment of countries' current accounts in response to German labor market reforms. Furthermore, we can assess the role of a German savings glut by backing out intertemporal saving preferences from the model using exogenous data on trade imbalances.

We model the Germany shock as a combination of several factors. First, we estimate DNWR for Eurozone economies and find greater downward nominal wage flexibility in Germany compared to other Eurozone countries. Second, we calibrate the model to match the time series of countries' labor force participation rates and manufacturing TFPs We can back out the reduction in the utility from not participating in the labor market based on the large increase in German labor force participation. In our model, lowering the attractiveness of non-market activities increases labor force participation (labor supply) for given real wages and puts downward pressure on nominal wages and prices. Additionally, increases in manufacturing productivity raise the labor supply via an increase in the real wage. The associated reduction in manufacturing prices adds further to a higher international competitiveness. Third, we directly feed in data on replacement rates to assess the role of a tougher unemployment insurance on labor supply and international competitiveness. As unemployment benefits are financed via a revenue-neutral income tax, we abstract here from

demand-side effects and focus on the labor supply channel, instead. Time series of replacement rates show a strong reduction in the replacement rate for Germany starting in 2003. Lastly, we can assess the role of a German savings glut as a competing explanation for the increase in Eurozone trade imbalances through the lens of our model. Investors can save and borrow on the international bond market and we can use time series on trade balances to back out changes in saving preferences over time.

In our model a country that is more exposed to the German competitiveness shock (driven by a combination of labor market reforms and manufacturing productivity growth) because its industry structure and export market composition is more similar to the German one suffers a negative (export) demand shock relative to a less exposed country. In turn, a negative manufacturing demand shock implies a contraction in labor demand. Depending on whether the exchange rate regime is fixed or floating, this may have a differential impact on local employment and wages. Under flexible exchange rates, nominal rigidities are never binding, since the nominal exchange rate will depreciate in response to a negative demand shock and a nominal depreciation implies a reduction in real wages. In this case the demand shock is cushioned by a reduction in the real wage, while employment is largely preserved. By contrast, under a fixed exchange rate regime, the DNWR may become binding. In the short run, nominal wages cannot fully adjust downward to equalize labor supply and labor demand. This leads to excess supply of labor and a temporary increase in involuntary unemployment that only subsequently dies out over time as nominal wages adjust downwards. If home production is available to workers, then DNWR leads to even bigger declines in employment as more workers prefer to engage in home production instead of being active in the labor market and facing the possibility of involuntary unemployment.

We explore a number of counterfactual scenarios. First, we consider the impact of the Germany shock in the absence of the Euro. We find that in this case the negative spillover effects on other Eurozone countries are much smaller, as their real wages decline and hence employment is largely preserved. Second, we consider higher wage rigidity in Germany in combination with the same labor market reforms. In this case, DNWR become binding in Germany in response to the reform-induced increase in labor supply, leading to involuntary unemployment. The resulting smaller expansion in output leads to a smaller crowding out of employment in other Eurozone countries compared to the baseline scenario. Third, we consider simultaneous labor market reforms in the Eurozone, modelled as a reduction in DNWR and a decrease in the utility from home production. This results in a large increase in the labor force participation rate and output in all Eurozone countries.

Our quantification results thus highlight the importance of coordinated intra-European labor-market policies within the currency area. The German competitiveness shock – triggered by

unilateral labor-market reforms – essentially allowed to shift unemployment from Germany to other Eurozone economies.[1]

We now discuss the related literature. Schmitt-Grohé and Uribe (2016) develop a small-open-economy model with DNWR that they apply to the boom-bust cycle in the Eurozone periphery countries which followed the introduction of the Euro. The Euro led to a reduction in real interest rates in the Eurozone periphery, which induced capital inflows from the core economies. This caused a boom in the non-tradable sector and an increase in nominal wages. When capital flows reversed in wake of the global financial crisis, wages could not adjust downward, and unemployment surged. We focus instead on the period before the financial crisis and the impact of German labor market reforms on the manufacturing sector of other Eurozone economies.

Our modeling approach borrows from Rodríguez-Clare et al. (2020) who apply a quantitative trade model with DNWR to study the impact of Chinese import competition on US local labor markets. Compared to their model, we add an endogenous savings decision and model labor market institutions, such as unemployment benefits. Dix-Carneiro et al. (2020) instead study the impact of a China shock in a similar model but with matching frictions in the labor market. Moreover, they also allow for a savings decision and endogenize the current account.

Farhi et al. (2013) discuss various forms of tax changes ("fiscal devaluations") that have the same real effects as nominal devaluations in the presence of nominal rigidities and fixed exchange rates. In our model, the German labor market reforms effectively work like a fiscal devaluation because they worsen the terms of trade and generate an increase in employment at the expense of the other Eurozone economies.

Dustmann et al. (2014) provide a comprehensive review of the German labor market reforms. Hünnekes et al. (2019) discuss the large magnitude of the German current account surplus and show that returns on German foreign assets are very low compared to those of comparable economies. Caliendo et al. (2021) investigate the labor and product market impact of EU Eastern enlargement and note that Germany opened its labor market to migrants from Eastern Europe as late as 2011 and thus only after the period under consideration.

2 Institutional Background

In this section, we first briefly explain the institutional setup of the Euro introduction and the scope of the German labor market reforms of the late 1990s and early 2000s.

[1] In the spirit of Farhi et al. (2013) this can be seen as a fiscal devaluation.

From 1979 to 1999, the future Eurozone economies were parties of the European Exchange Rate mechanism (EMS). Member countries' currencies were allowed to fluctuate within a band to the European Currency Unit (ECU), which was calculated as a weighted average of the member countries' currencies. Effectively, the German Mark formed the base currency and other central banks mostly (but not always) followed the monetary policy of the Bundesbank. Periodic realignments of the currencies' central parities were allowed and were also used regularly. Over time, such realignments became more and more coordinated between member countries. In 1992-1993 the EMS suffered a crisis as a consequence of a unilateral interest hike by the German Bundesbank. Several countries experienced speculative attacks and a number of them, including Italy and Spain, had to temporarily suspend their membership in the EMS. The UK even left the EMS permanently (Buiter et al., 1998). Thus, while the currencies of EU countries were not freely floating against each other before the introduction of the Euro, parities were regularly adjusted to fix misalignments between the real exchange rate and economic fundamentals. The Eurozone was officially created on January 1st 1999, locking in a hard currency peg between the initially 11 member countries Austria, Belgium, Finland, France, Germany, Italy, Ireland, Luxembourg, Netherlands, Portugal, and Spain. National currencies were initially kept in circulation at fixed parities. Euro banknotes and currency were physically introduced in 2002. Greece joined the Euro in the same year.

German structural labor market reforms already started in the mid-1990s and ended around 2005. The reforms were a response to sluggish growth during the 1990s and a high unemployment rate close to 10%. German unification in 1990 had suddenly increased the labor force by roughly one third. It was a core political objective to adjust East German wages to the comparatively high West German levels as quickly as possible. As a result, the East German economy experienced high unemployment and continuing dependence on federal subsidies and transfer payments from West to East. From the mid 1990s an increasing fraction of firms started to opt out of sectoral collective wage bargaining agreements and instead set firm-specific wages, which were often set below the collective bargaining wages.[2] These reforms strongly increased downward wage flexibility (Dustmann et al., 2014). A second wave of reforms occurred in the period 2003-2005 (the "Hartz reforms" and alike). These reforms are frequently cited as an explanation for the "German job

[2]In Germany, firms can opt in or out of a collective bargaining at will by joining or leaving the German Employer Association. The employer association negotiates collective bargaining agreements with union representatives on behalf of its members at the industry-region level. Collective bargaining agreements specify minimum requirements for wages, working hours and other working conditions. All employees of a firm that is a member of the employer federation are then covered by the agreement, independently of the workers' actual union status. For a detailed treatment of German industrial relations see Jäger et al. (2022). While in the mid '90s around 70 percent of the German labor force were covered by collective bargaining agreements, by 2005 this number had decreased to 55 percent (Jäger et al., 2022). Moreover, coverage over-states the actual proportion of workers receiving collectively bargained wages: even for workers covered by collective bargaining agreements, opening clauses, which allowed downward-deviations of individual firms from collective bargaining conditions, were widely applied since the early 2000s.

miracle" (Jacobi and Kluge, 2007). Before the Hartz reforms, German unemployment benefits were relatively generous. The replacement rate was 67% of the last net wage for up to 3 years and 57% thereafter for an unlimited period. In 2002, the Hartz Committee proposed directions for reform. Between 2003 and 2005, the reforms were set out in four laws aimed at strengthening job-search activities, providing incentives for the unemployed to accept a job, deregulation of the labor market and encouraging labor force participation, notably for women and older persons. Key measures accompanying the Hartz reforms included shortening the period of entitlement to wage-related unemployment benefits (Arbeitslosengeld I) to at most 12 months. After that period, the unemployed would receive lump-sum benefits close to the subsistence level (Arbeitslosengeld II). Complementary measures included ending options for early retirement and reducing other subsidies for non-market activities. Effectively, the Hartz reforms sharply reduced outside options to market work, thus inducing an increase in labor force participation.

By contrast, wage setting in other Eurozone economies continued to be highly centralized during the same period and no major reforms of labor market institutions were implemented. Specifically, countries like Austria, Belgium, Finland, France, Greece, Italy, the Netherlands, Portugal and Spain were characterized by industry-level collective wage bargaining between worker unions and employers' representatives. Collective bargaining agreements set minimum wage levels and wage increases, which are typically extended by law to all firms in a given industry (Addison, 2016).

3 Empirical Facts

We now present a number of stylized facts to illustrate key adjustments around the introduction of the Euro and the German competitiveness shock.

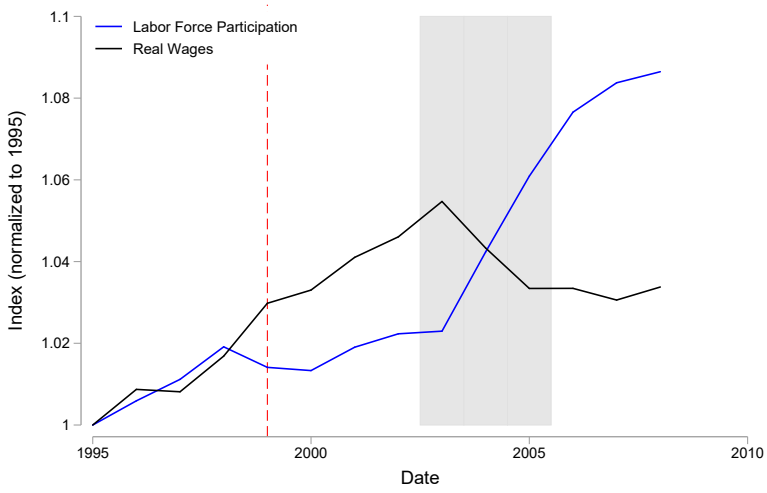
Fact 1: Labor force participation increased while the real wage decreased around the implementation of labor market reforms in Germany.

Figure 1 plots the evolution of real labor costs and labor force participation from 1995 to 2008. While labor force participation grew little compared to real labor costs until the implementation of the Hartz reforms, this pattern reversed from 2003 onwards. The real wage started to decline until around 2007, while labor force participation increased steeply by almost 10 percentage points. This pattern suggests that there were forces at play other than increases in real wages (e.g., labor market reforms), that induced an increase in labor supply.

Fact 2: Germany experienced a real depreciation since the introduction of the Euro.

Figure 2 depicts the evolution of the German real exchange rate relative to the real exchange

Figure 1: Labor Force Participation and Real Labor Costs in Germany

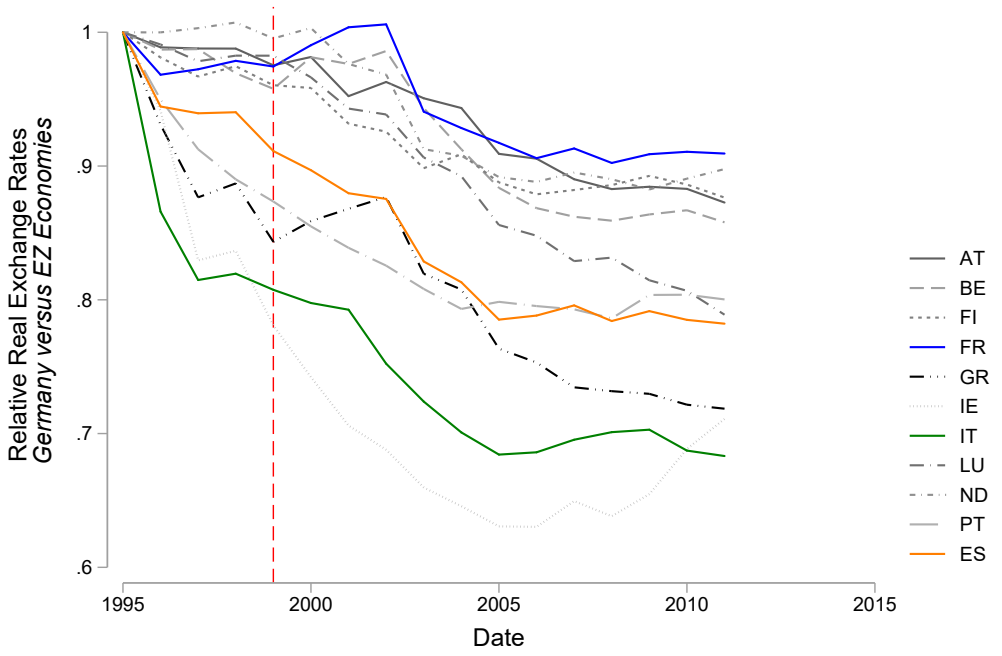


Notes: The Figure plots indices of labor force participation and real labor costs in Germany. Index values are relative to the base year 1995. Labor force participation is based on OECD data for working ages 20-64 years and real labor costs are deflated labor compensation per employment, using EU KLEMS data.

rates other Eurozone countries during the period 1995 to 2012. Relative real exchange rates are defined as the German expenditure-based price level of GDP in purchasing power parities vis-à-vis the U.S. Dollar, relative to the according price level from the respective Eurozone economy using data from the Penn World Tables 8.0. Relative real exchange rates are normalized to unity in 1995. Decreases in the relative real exchange rate denote a real appreciation relative to Germany and thus a loss in trade competitiveness of the respective Eurozone economy. It is evident that the real exchange rates of all Eurozone countries appreciated relative to Germany during the sample period. The Eurozone periphery countries (Greece, Italy, Ireland, Portugal, Spain) started to appreciate relative to Germany already before the introduction of the Euro and continued to appreciate during the Euro period. These countries' real exchange rate appreciated by between 20 and 30 percent during the sample period. By contrast, the core economies in the Eurozone (Austria, Belgium, Finland, France, Netherlands) initially maintained their level of competitiveness relative to Germany and started their sharp appreciation around 2003. These countries' real appreciation amounted to around 10 percent during the sample period.

While the real appreciation of the periphery countries may be partially explained by the boom due to capital flows from the core to the periphery following the introduction of the single market in 1993 and the Euro in 1999 (Baldwin and Giavazzi, 2015), this is not the case for the core countries, which did not experience net capital inflows. The real depreciation is also reflected in

Figure 2: Real Exchange Rate Fluctuations in the Eurozone



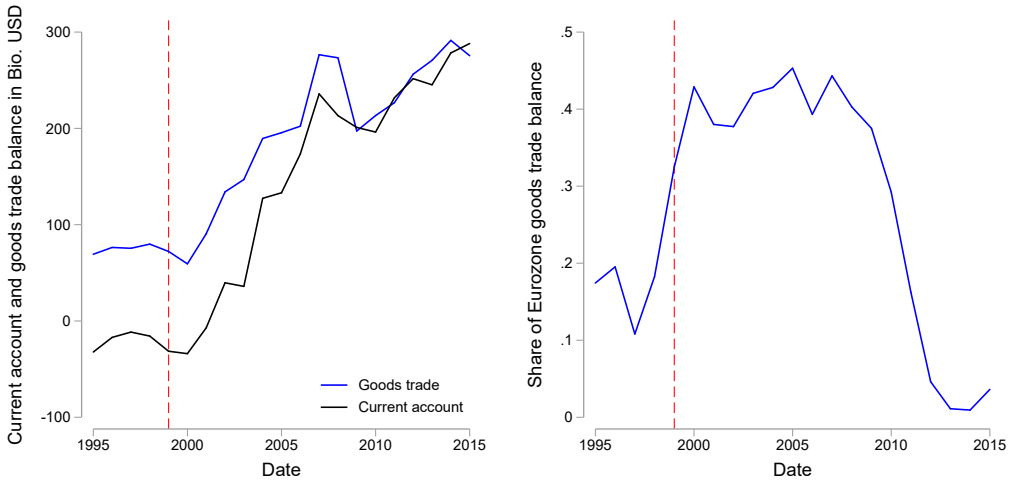
Notes: The Figure plots indices of real exchange rates for Eurozone economies relative to the German real exchange rate. Relative real exchange rates are the German expenditure-based price level of GDP in purchasing power parities vis-à-vis the U.S. Dollar, relative to the according price level from the respective Eurozone economy using data from the Penn World Tables 8.0. Decreases in the relative real exchange rate denote a relative loss in trade competitiveness of the respective Eurozone economy.

decreasing relative export prices of Germany relative to other Eurozone countries (see Figure A.1 in the Appendix).

Fact 3: Germany accumulated a large current account surplus after the introduction of the Euro, mostly driven by trade imbalances.

Figure 3 takes a look on the evolution of the German current account. Since the introduction of the Euro in 1999, Germany started to accumulate a substantial current account surplus. The development of the (goods) trade balance largely follows that of the current account. This suggests that the majority of the German current account imbalance is driven by trade imbalances instead of imbalances in net factor income from abroad. The right plot in Figure 3 depicts the fraction of the trade imbalance that is due to trade within the Eurozone. This fraction increased steeply from 1997 on to more than 40 percent until around 2010. Only from then onwards, Germany reached a balanced trade account relative to the Eurozone.

Figure 3: German Goods Trade Balance and the Current Account



Notes: The Figure plots the German current account and the goods trade balance in Bio. USD over time. The right plot depicts the fraction German goods trade surplus that accrues to trade within the Eurozone. Data are obtained from the World Bank World Development Indicators (WDI) and trade data from Eurostat Comext.

Fact 4: Increases in German exports into the Eurozone crowded out exports from other Eurozone economies.

We now present evidence that the German real depreciation resulted in increased export competitiveness relative to the other Eurozone economies and a crowding-out of other countries' exports by German exports. We present evidence based on yearly 4-digit NACE industry-level bilateral exports for the sample period 1991 to 2018 sourced from Eurostat Comext trade data. We run the following regression at the sector-destination-year level for individual country pairs (a given Eurozone country relative to Germany):

$$\frac{\Delta E^p_{cit}}{E^p_{cit-1}} = \beta_1 \frac{\Delta E^p_{DEit}}{E^p_{DEit-1}} + \beta_2 \frac{\Delta E^p_{DEit}}{E^p_{DEit-1}} \times Shock_t + \delta_t + \delta_c + \delta_i + \epsilon_{cipt}.$$

Here, the dependent variable $\frac{\Delta E^p_{cit}}{E^p_{cit-1}}$ is the annual growth rate of export value or export quantity of Eurozone country c to partner country p in industry i in year t. Partner countries are all OECD economies plus China. The main regressor of interest is $\frac{\Delta E^p_{DEit}}{E^p_{DEit-1}}$, the annual growth rate of German exports to the same partner country in the same industry and year and its interaction with $Shock_t$, a dummy equal to unity for all years from 2003 onward (the start year of the Hartz reforms).The regression includes year, industry, reporter and partner fixed effects. The coefficient β_1 is proportional to the correlation between the export growth rates of country c and Germany

to a given partner. A positive coefficient implies that export growth is driven by demand shocks originating in the partner country, so that all exporters increase their sales to the partner. The coefficient β_2 on the interaction term tests if the correlation between the two countries exports to the partner was different after the introduction of the Euro and the implementation of reforms in Germany. In particular, an increase in German competitiveness relative to another exporting country (a positive supply shock in Germany) would result in substitution away from the other country's exports to German exports implying a negative coefficient on the interaction term.

Table 1 presents the result for these regressions. In panel A, we show results for export values and in panel B those for export quantities. Columns (1)-(10) present results for individual Eurozone countries and column (11) for the pooled Eurozone excluding Germany. For all countries except for Greece and Portugal, the correlation between countries' export growth and German export growth was positive before 2003 and became smaller afterwards. For example, before 2003 a one p.p. increase in German export growth was associated with 0.6 p.p. increase in Austrian exports. This number was reduced to 0.25 p.p. after 2003. For the Eurozone as a whole, the numbers changed from 0.5 to 0.3. The results for export quantities show a similar pattern. Thus, from 2003 on, German exports crowded out other Eurozone countries' exports.

Fact 5: Rising competition from Germany in the Eurozone is associated with declining manufacturing employment in other Eurozone economies.

Next, we look at the impact of competition from Germany on employment and wages in other countries' tradable sectors. We first look at German competition in third markets within the Eurozone (export market competition). Export competition in third markets is important in the context of Eurozone economies whose domestic markets are often small and whose most important sales destinations are mostly other Eurozone economies. Our baseline measure of export market competition from Germany that an individual Eurozone country c is exposed to is

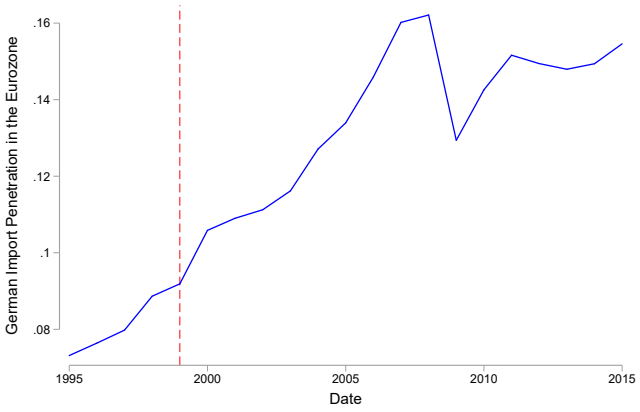
$$EC_{cit}^{EZ} = \sum_{p \in EZ} \phi_{ci}^{p} \frac{M_{DEit}^{p}}{Y_{i95}^{p} + M_{i95}^{p} - E_{i95}^{p}},$$

where M_{DEit}^{p} are imports by Eurozone economcy p from Germany in industry i during year t. In line with Acemoglu et al. (2016), we normalize imports by initial absorption of that industry in country p in 1995. Initial absorption is defined as gross output produced Y_{i95}^{p} plus imports M_{i95}^{p} (excluding those from Germany) net of exports E_{i95}^{p} (again excluding those to Germany).[3] To better capture

[3]Data on gross output are obtained from EU KLEMS data. Trade data are obtained from Eurostat Comext. For total exports and imports, we consider OECD economies plus China as partner countries. The level of industry aggregation is based on EU KLEMS (corresponding roughly to 2 digit NACE Rev. 2 sectors). We omit Luxembourg from the set of Eurozone countries since Comext trade data for Luxembourg start only in 1999.

the strength of exposure to German export competition in individual third markets, we weight each Eurozone country c with its respective market share ϕ_{ci}^{p} in partner country p and industry i in 1995.

Figure 4: Rising German Competition in the Eurozone



Notes: The Figure plots export market competition from Germany in other Eurozone economies. Export market competition is weighted across countries and sectors according to initial gross output. Trade data are from Eurostat Comext and data on gross outputs from EU KLEMS.

Figure 4 depicts the evolution of German export market competition in the Eurozone (averaged across countries manufacturing sectors). Between 1995 and 2003, it increased from around 7 to more than 11 percent and then further sharply increased to over 16 percent between 2003 and 2008. After that period it stayed roughly constant until 2015. In terms of magnitudes, German export market competition within the Eurozone exceeds Chinese export market competition by far, which increased from less than 1 percent to 6 percent between 1995 and 2008.

Next, we use our measure of trade exposure from Germany to evaluate the effect of German export market competition on manufacturing employment and labor costs in other Eurozone economies. We run the following regression:

$$L_{cit} = \beta_1 EC_{cit}^{EZ} + \beta_2 EC_{cit}^{EZ} \times PostEuro_t + \delta_{ci} + \delta_{(c)t} + \epsilon_{cit},$$

where the outcome variable L_{cit} is either employment or labor costs per employee (in logs) in Eurozone country c, 2-digit industry i and year t. We interact EC_{cit}^{EZ} with a Post-Euro dummy to see if German export market competition affected other Eurozone countries differently after the introduction of the Euro peg. We include country by industry fixed effects δ_{ci}, so that we exploit variation within country-industry pairs and we include country by year or year fixed effects to

control for variation over the business cycle. Standard errors are clustered at the country-industry level.

The results for these regressions are reported in Table 2. Panel A presents results for Employment and Panel B for Labor Costs. Odd columns include country by industry and year fixed effects, even columns instead include country by industry and country by year fixed effects. Columns (1) and (2) show that a one percentage-point increase in German Eurozone export market competition implies approximately a half-log-point reduction in manufacturing industry employment in other Eurozone economies. In columns (3) to (5) we split the effect into a pre and post Euro period. Indeed, German export market competition in the Eurozone has a statistically significant and large negative effect on competing countries after the Euro was introduced, while the estimate is positive and marginally statistically significant before the Euro introduction. A one percentage-point increase in German export market competition reduces manufacturing employment in other Eurozone economies by around 0.66 log points. For the average Eurozone economy, this implied a manufacturing employment reduction between 1995 and 2008 of around 7.5 percentage points.[4] The positive coefficient before the Euro introduction may reflect that during this period the increase in German import penetration into the Eurozone is driven mostly by demand shocks or by input-output linkages. The stronger negative employment impact of export market competition after the introduction of the currency peg is consistent with the Euro making DNWR binding.

In Panel B of Table 2, we report results for manufacturing wages (measured as log labor costs) as an alternative outcome to provide additional evidence for the significance of nominal rigidities. By contrast to employment, our results indicate that manufacturing wages did not fall in response to Eurozone export market competition from Germany. The coefficients in columns (1) and (2) instead imply a statistically insignificant relation between German Eurozone export market competition and nominal wages in the Eurozone. Despite large employment losses, not only did nominal wages not fall in the industries more exposed to German competition, but the workers who stayed received higher wages. One potential explanation for this effect is selection: the workers who kept their jobs were more productive than the average worker.

While our baseline measure EC_{cit}^{EZ} varies across countries and industries over time, it only considers competition in third market effects but does not include import competition in the domestic market. An alternative measure of German competition in the Eurozone that also picks up import competition in each country's domestic market in industry i is given by:

$$\tilde{EC}_{it}^{EZ} = \frac{M_{DEit}^{EZ}}{Y_{i95}^{EZ} + M_{i95}^{EZ} - E_{i95}^{EZ}},$$

[4]The increase in export market competition was 11 percentage points. Hence, $7.5 = (exp(0.66 * 0.11) - 1) * 100$.

where M^{EZ}_{DEit} are German total imports into the Eurozone in industry i and $Y^{EZ}_{i95} + M^{EZ}_{i95} - E^{EZ}_{i95}$ is initial industry-level absorption in 1995 at the Eurozone level. Note that $\tilde{EC}^{EZ}_{it}$ does not vary across countries as it captures total German competition within the Eurozone. We report results for this alternative measure of competition in the Empirical Appendix (Table A.1). The result for the alternative measure are similar to those for the baseline measure. A one-percentage-point increase in German competition in the Eurozone is associated with an around one-log-point reduction in manufacturing industry employment. The interaction effects show that after the Euro introduction, the negative impact of the German supply shock is prevailing. Note also that, differently to the baseline measure, there is now significantly negative effect of German competition on nominal wages. In contrast to this result, competition from Germany is not associated with lower labor costs in other Eurozone countries despite of the estimated employment losses.

Table 1: Crowding-Out of Eurozone Exports

	(1) *FR*	(2) *ES*	(3) *IT*	(4) *NL*	(5) *PT*	(6) *AT*	(7) *BE*	(8) *GR*	(9) *FI*	(10) *IE*	(11) *Eurozone*
Panel A:	*Growth in Export Values*										
Export Growth DE	0.197***	0.353***	0.146***	0.341***	0.582**	0.587***	0.339***	0.189	0.476***	0.507**	0.153***
	(0.0311)	(0.0561)	(0.0240)	(0.0634)	(0.267)	(0.187)	(0.0545)	(0.127)	(0.124)	(0.208)	(0.0183)
× Post Shock	-0.0919**	-0.197**	-0.0840***	-0.108	0.0218	-0.342*	-0.134**	0.297	-0.158	-0.163	-0.0848***
	(0.0371)	(0.0876)	(0.0227)	(0.0823)	(0.373)	(0.196)	(0.0676)	(0.288)	(0.166)	(0.258)	(0.0212)
Observations	209823	190527	209472	206712	123226	154780	196948	105869	123515	110445	232085
Ind. Clusters	268	263	267	267	261	265	268	256	259	260	269
Panel B:	*Growth in Export Quantities*										
Export Growth DE	0.193***	0.211***	0.150***	0.242***	0.0989	0.273***	0.231***	0.152*	0.152**	0.290***	0.134***
	(0.0254)	(0.0357)	(0.0217)	(0.0303)	(0.0719)	(0.0887)	(0.0409)	(0.0824)	(0.0626)	(0.101)	(0.0165)
× Post Shock	-0.0930***	-0.0617	-0.0982***	-0.0735	0.0272	-0.0971	-0.131**	0.189	-0.0756	-0.153	-0.0682***
	(0.0324)	(0.0599)	(0.0253)	(0.0635)	(0.0967)	(0.0986)	(0.0523)	(0.145)	(0.0766)	(0.127)	(0.0192)
Observations	203634	183545	204461	200095	113132	144844	186698	96649	110436	100709	228961
Ind. Clusters	265	261	263	266	259	263	267	255	256	259	267
Sample Frame	1991 - 2018	1991 - 2018	1991 - 2018	1991 - 2018	1991 - 2018	1991 - 2018	1991 - 2018	1991 - 2018	1991 - 2018	1991 - 2018	1991 - 2018
NACE Ind. F.E.	×	×	×	×	×	×	×	×	×	×	×
Year F.E.	×	×	×	×	×	×	×	×	×	×	×
Partner F.E.	×	×	×	×	×	×	×	×	×	×	×

Notes: The Table presents estimates from regressing export growth rates for Eurozone countries on German export growth rates and its interaction with a dummy *Post Shock* which equals 1 from the 2003 onwards. The unit of observation is a NACE Rev. 2 4-digit industry and export data are obtained from the Eurostat Comext database. Export growth rates are defined relative to the previous year and measured at the annual level and for each OECD partner country individually (plus China). All estimations include a full set of industry fixed effects, year fixed effects and trade partner fixed effects. The upper panel considers growth rates in export values and the lower panel considers growth rates in export quantities. Standard errors are clustered at the country-industry level; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 2: Eurozone Employment, Labor Costs and German Export Competition

	(1)	(2)	(3)	(4)	(5)
Panel A:	*Employment*				
Eurozone EC	-0.537***	-0.487***	0.329	0.403*	0.352*
	(0.160)	(0.156)	(0.239)	(0.230)	(0.212)
× Post Euro			-0.659***	-0.677***	-0.473***
			(0.219)	(0.189)	(0.152)
Observations	4020	4020	4020	4020	2856
Country-Ind. Clusters	194	194	194	194	194
Panel B:	*Labor Costs*				
Eurozone EC	0.138	0.141*	0.0908	0.0778	0.0599
	(0.0895)	(0.0823)	(0.137)	(0.135)	(0.155)
× Post Euro			0.0362	0.0480	0.0190
			(0.106)	(0.104)	(0.0997)
Observations	4002	4002	4002	4002	2844
Country-Ind. Clusters	193	193	193	193	193
Sample Frame	1995 - 2015	1995 - 2015	1995 - 2015	1995 - 2015	1995 - 2009
Country-Ind. F.E.	×	×	×	×	×
Year F.E.	×		×		×
Country-Year F.E.		×		×	

Notes: The Table presents estimates from regressing employment or labor costs (in logs) for Eurozone countries on Eurozone export competition from Germany and its interaction with a dummy *Post Euro* which equals 1 from the introduction of the Euro in 1999 onwards. Export competition (*Eurozone EC*) is defined according to EC_{cit}^{EZ} in the main text. Data are obtained from the EU KLEMS database and Eurostat Comext. All estimations include a full set of country-industry fixed effects and either year or country-year fixed effects. Standard errors are clustered at the country-industry level; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4 Model

Our modeling approach builds on the setup of Rodríguez-Clare et al. (2020). Unless noted otherwise, all monetary values are denoted in nominal Euros.

4.1 Basic Assumptions

Preferences and Demand We assume that there is a set I of geographic entities (indexed by i or j): a subset of M countries in the Eurozone (with a fixed nominal exchange rate) and $I - M$ countries outside the Eurozone (with a floating nominal exchange rate). There are two types of agensts: workers and investors. Both types of agents are immobile across countries. There are S (narrow) sectors (indexed by s or k). We introduce the concept of "broad sectors", indexed with $b \in 1, ..., B$ and associate them with manufacturing, services and agriculture. Each narrow sector s belongs to exactly one broad sector b. We assume that labor is mobile within any given broad sector such that each sector $s \in b$ shares the same wage rate. By contrast, workers face frictions to moving across broad sectors.

Workers are hand to mouth and spend all their (labor) income in each period t. Investors instead own the capital stock of each country and have access to international financial markets, where they can trade safe bonds. The stock of capital of each country is given and capital is immobile across countries. Investors have the same preferences as workers and thus split their consumption across sectors in the same way. Aggregate expenditure of each country is denoted by $P_{jt}C_{jt} = P_{jt}(C^w_{jt} + C^k_{jt})$, where P_{jt} is the aggregate price index of country j and C_{jt} is the aggregate consumption basked. C^w_{jt} denotes workers' aggregate consumption, while C^k_{jt} is investors' aggregate consumption. Consumption is a Cobb-Douglas aggregate of sectoral bundles with expenditure shares α_{js}. Within sectors, consumption is a CES Armington aggregate of goods produced by each country with a sector-specific elasticity of substitution $\sigma_s > 1$.

Production Within each country, each sector k produces with a Cobb-Douglas production function. TFP, denoted by A_{jkt}, varies at the sector-country-time level. The sectoral labor share is denoted by ϕ_{jk}, the sectoral capital share by ψ_{jk} and the intermediate-input shares by $\phi_{j,sk}$ such that $\phi_{jk} + \psi_{jk} + \sum_s \phi_{j,sk} = 1$. Intermediates from different origins are aggregated in the same way as consumption goods (CES with elasticity σ_s). Product markets are perfectly competitive and there exist iceberg trade costs $\tau_{ijkt} > 1$ for good k to flow from i to j in period t. Finally, we denote the nominal wage rate in country i, (broad) sector $b\,(k)$ during t by W_{ibt} and the rental

rate of physical capital by $\mathcal{R}_{it}$. The aggregate price index in country j in period t is given by

$$P_{jt} = \prod_s P_{jst}^{\alpha_{js}}, \tag{1}$$

where P_{jkt} denotes the price index of sector k in country j in period t:

$$P_{jkt} = \left[\sum_i \left(\tau_{ijkt} A_{ikt}^{-1} W_{i,b(k),t}^{\phi_{ik}} \mathcal{R}_{it}^{\psi_{ik}} \prod_s P_{ist}^{\phi_{j,sk}} \right)^{1-\sigma_k} \right]^{\frac{1}{1-\sigma_k}}. \tag{2}$$

4.2 Labor Supply

We assume that the number of workers in each country i is time-invariant and given by $\overline{L}_i$ and we treat treat labor supply as endogenous. Workers can engage in home production, in which case they receive flow utility μ_{it} or participate in the labor market to obtain *expected* real labor income in broad sector b equal to ω_{ibt}. The flow utility μ_{it} arises from non-market activities. Thus, an increase in incentives to participate in the labor market can be modeled as a reduction in μ_{it}.

Let $\pi_{it} = \frac{\sum_b l_{ibt}}{\overline{L}_i}$ be the *labor force participation rate*. Here, l_{ibt} denotes the number of workers looking for work in broad sector b and let $\pi_{ibt} = \frac{l_{ibt}}{\sum_{b'} l_{ib't}}$ be the *participation rate* in sector b. This implies that

$$l_{ibt} = \pi_{it} \pi_{ibt} \overline{L}_i \tag{3}$$

To obtain structure for π_{it} and π_{ibt}, we follow Rodríguez-Clare et al. (2020) and assume that agents' per-period utility is given by $\ln \mu_{it} + z_0$ if choosing home production and $\ln w_{ibt} + z_b$ if choosing to supply labor in broad sector b. Moreover, each agent draws a set of utility parameters z_b for each $b \in \{0, 1, ..., B\}$ from a nested Fréchet distribution involving parameters η and κ with $\eta \geq \kappa$ and with the following cumulative distribution function:

$$F(z) = \exp\left(-\exp(-\kappa z_0) - \left(\sum_{b \in B} \exp(-\eta z_b) \right)^{\frac{\kappa}{\eta}} \right).$$

With these assumptions, agents will choose to work in the sector b that gives them the maximal utility. One can show that labor force participation is given by

$$\pi_{it} = \frac{\omega_{it}^{\kappa}}{\mu_i^{\kappa} + \omega_{it}^{\kappa}}. \tag{4}$$

Thus, it increases with the expected real wage ω_{it} and falls with the flow utility from non-market activities. Furthermore, the participation rate in sector b increases when its expected real wage

increases relative to the expected real wages in other sectors:

$$\pi_{ibt} = \frac{\omega_{ibt}^{\eta}}{\omega_{it}^{\eta}}, \text{ with } \omega_{it} = \left(\sum_{b} \omega_{ibt}^{\eta} \right)^{1/\eta}. \tag{5}$$

Workers' indirect utility corresponds to the exponential of the expected maximum instantaneous utility, where the expectation is over the realization of the utility shocks for working in each sector.

$$u_{it} \propto \left(\mu_i^{\kappa} + \omega_{it}^{\kappa} \right)^{1/\kappa}.$$

Thus, workers' indirect utility is homogeneous of degree one with respect to the real wage and μ_i.

4.3 Downward Nominal Wage Rigidity

We introduce downward wage stickiness à la Schmitt-Grohé and Uribe (2016). This might lead to equilibria with involuntary unemployment such that employment levels are strictly smaller than labor supply, i.e. $L_{ibt} \leq l_{ibt}$. This may happen if nominal wages are too high to ensure full employment, so that DNWR is binding. So far, all wages and prices have been expressed in nominal Euros. However, a given country faces DNWR in terms of its local currency. DNWR takes the following form:

$$W_{ibt}^{LCU} \geq \delta_{ib} W_{ibt-1}^{LCU}, \text{ with } \delta_{ib} \geq 0.$$

Here, W_{ibt}^{LCU} denotes nominal wages measured in local currency units. The term δ_{ib} captures how rigid wages in sector b are in country i. Nominal wages cannot fall below a fraction δ_{ib} of the previous period's wage rate. Thus, $\delta_{ib} = 1$ implies completely downward rigid wages, while $\delta_{ib} = 0$ implies completely flexible wages. Let E_{it} denote the nominal exchange rate in Euros per LCU. Thus, an increase in E_{it} implies an appreciation of the local currency. Hence, $W_{ibt} = W_{ibt}^{LCU} E_{it}$ is the nominal wage rate in Euros and we can rewrite DNWR measured in Euros as

$$W_{ibt} \geq \frac{E_{it}}{E_{it-1}} \delta_b W_{ibt-1}.$$

Note that under a flexible exchange-rate regime, the DNWR constraint can always be made non-binding by letting the domestic currency depreciate sufficiently, i.e. by setting $E_{it} < E_{it-1}$. However, within the Eurozone, the nominal exchange rate is fixed at $E_{it} = 1$ and $W_{ibt}^{LCU} = W_{ibt}\ \forall i \in M$. DNWR in Euros can then be captured as

$$W_{ibt} \geq \delta_{ib} W_{ibt-1}. \tag{6}$$

We will assumes that all countries outside the Eurozone and Eurozone countries before the introduction of the common currency have a flexible exchange rate regime. Hence, these countries can nominally devaluate their currencies such that DNWR never binds. This is captured by setting $0 < \delta_{ib} \leq 1$ for countries within the Eurozone ($\forall i \in M$) and $\delta_{ib} = 0$ for countries outside the Eurozone ($\forall i \notin M$).

Note that either DNWR is non-binding and then the labor markets clears, or DNWR is binding and then labor supply exceeds labor demand (i.e., there is involuntary unemployment). This can be expressed using the following complementary slackness condition:

$$(l_{ibt} - L_{ibt})\,(W_{ibt} - \delta_{ib} W_{ibt-1}) = 0. \tag{7}$$

4.4 Unemployment Benefits

We model unemployment benefits to broadly match three key characteristics of the German unemployment benefits scheme ("Arbeitslosengeld I"). First, eligibility for unemployment benefits requires workers to actively search for employment. Second, unemployment benefits are proportional to the individual's wage. Third, insurance fees are a fraction of labor income. Hence, we model unemployment benefits as a fraction τ_{it} of nominal wages that are received by those workers that are involuntarily unemployed, where τ_{it} denotes the *replacement rate*. Furthermore, unemployment benefits are financed via a revenue-neutral labor income tax such that

$$\sum_b t_{it} W_{ibt} L_{ibt} = \sum_b \tau_{it} W_{ibt} (l_{ibt} - L_{ibt}), \tag{8}$$

where aggregate labor income in country i is given by $\sum_b W_{ibt} L_{ibt}$. Finally, the expected real wage in broad sector b is

$$\omega_{ibt} = \frac{L_{ibt}}{l_{ibt}} \frac{(1 - t_{it}) W_{ibt}}{P_{it}} + (1 - \frac{L_{ibt}}{l_{ibt}}) \frac{\tau_{it} W_{ibt}}{P_{it}}. \tag{9}$$

Observe that in the absence of unemployment insurance, the expected real wage simplifies to the product of the realized real wage and the probability of employment:

$$\omega_{ibt} = \frac{W_{ibt} L_{ibt}}{P_{it} l_{ibt}}.$$

Note that in the model the unemployment rate is zero unless DNWS is binding. Thus, unemployment benefits only impact on labor supply when DNWS binds. In this case, an increase in the replacement rate τ_{it} increases the expected real wage and thus encourages labor force participation $\sum_b l_{ibt}$. As long as DNWS is binding, this increases the unemployment rate because labor demand is given by the wage constraint.

4.5 Investors and the Current Account

Investors are infinitely lived and maximize live-time utility under perfect foresight. They receive income from renting out their capital and they can trade a safe bond in international financial markets. Their utility function is given by:

$$U_j^k = \sum_{t=0}^{\infty} \varphi_{jt} \beta^t u_{jt}^k(C_{jt}^k).$$

Here β is the rate of time preference and φ_{jt} is a patience shock. Let $u_{jt}^k = \frac{(C_{jt}^k)^{1-\sigma}}{1-\sigma}$, where $1/\sigma$ is the intertemporal elasticity of substitution. Investors in each country have access to one-period debt D_{jt}, denoted in Euros, with net return r_t. Thus, their per-period budget constraint (in Euros) is given by

$$P_{jt} C_{jt}^k + (1 + r_{t-1}) D_{jt-1} = \mathcal{R}_{jt} K_{jt} + D_{jt}.$$

Investors are born with an initial level of debt D_0. In each period t they receive D_t Euros from borrowing and they need to repay the principal and the interest of the debt assumed in the previous period $(1+r_{t-1})D_{t-1}$. The left-hand-side of the flow budget constraint equals investors' expenditure on consumption and debt. The right-hand side is their capital income and the resources received from their current debt.

The current account (in Euros) is defined as the change in the country's net foreign asset position (minus the change in debt stocks), which equals the difference between investors' income and their expenditure (note that workers always spend their income):

$$CA_{jt} = -(D_{jt} - D_{jt-1}) = \mathcal{R}_{jt} K_{jt} - P_{jt} C_{jt}^k - r_{t-1} D_{jt-1}. \tag{10}$$

The country's trade balance then equals the current account minus the interest payment on assets.

$$TB_{jt} = CA_{jt} + r_{jt-1} D_{jt-1} = \mathcal{R}_{jt} K_{jt} - P_{jt} C_{jt}^k \tag{11}$$

From the investors' intertemporal maximization problem, we can derive the following Euler equation:

$$\varphi_{jt} (C_{jt}^k)^{-\sigma} = \varphi_{jt+1} \beta (1 + r_t) \frac{(C_{jt+1}^k)^{-\sigma}}{\left(\frac{P_{jt+1}}{P_{jt}}\right)} \tag{12}$$

Intertemporal optimality requires the marginal utility of consumption to be equalized across periods. An increase in φ_t or a increase in the inflation rate (P_{jt+1}/P_{jt}) increases the marginal utility of consuming today relative to the one of consuming in the future and thus reduce savings (the

current account), while a temporary increase in the world interest rate or an increase in φ_{t+1} induce investors to shift consumption to the future and thus increase the current account.

4.6 Nominal Anchor

Finally, we need to introduce a nominal anchor that prevents nominal wages from rising so much in each period as too make the DNWR always non-binding. Assume that in the background each country (or the Eurozone) has a central bank that is unwilling to allow inflation to be "too high". The cost of inflation is thus exogenous but it could be endogenized in a macro model by modelling a central bank following a Taylor rule where the nominal interest rate reacts to inflation in order to keep price growth in check.

We model the nominal anchor in a way that world nominal GDP in Euros grows at a constant rate γ across years:

$$\sum_i \sum_b W_{ibt} L_{ibt} = \gamma \sum_i \sum_b W_{ibt-1} L_{ibt-1}. \tag{13}$$

4.7 Equilibrium

The following set of product-market-clearing and factor-market-clearing conditions are additionally required to characterize an equilibrium. Product markets clear if:

$$R_{ist} = \sum_{j=1}^{I} \lambda_{ijst} \left[\alpha_{js} \left(\sum_b W_{jbt} L_{jbt} + \mathcal{R}_{it} K_{it} - TB_{jt} \right) + \sum_s \phi_{jsk} R_{jkt} \right]. \tag{14}$$

Here, R_{ist} are the total revenues in sector s of country i, $\phi_{jsk} R_{jkt}$ is the demand of country-industry jk for intermediates from country-industry is. The terms λ_{ijkt} are the "trade shares" (i.e. market share that country i has in serving country j in sector k) given by

$$\lambda_{ijkt} = \frac{(\tau_{ij,k,t} A_{ikt}^{-1} W_{i,b(k),t}^{\phi_{ik}} \mathcal{R}_{it}^{\psi_{ik}} \prod_s P_{ist}^{\phi_{j,sk}})^{1-\sigma_k}}{\sum_{r=1}^{I} (\tau_{rj,k,t} A_{rkt}^{-1} W_{r,b(k),t}^{\phi_{rk}} \mathcal{R}_{rt}^{\psi_{rk}} \prod_s P_{rst}^{\phi_{r,sk}})^{1-\sigma_k}}. \tag{15}$$

Labor markets clear if

$$W_{ibt} L_{ibt} = \sum_{s \in b} \phi_{is} R_{ist}. \tag{16}$$

Capital markets clear if

$$\mathcal{R}_{it} K_{it} = \sum_{s \in S} \psi_{is} R_{ist}. \tag{17}$$

World bond market clearing implies that current accounts balance at the world level:

$$\sum_j CA_{jt} = 0 \tag{18}$$

Given the vector of initial wages W_{ib0}, initial employment levels L_{ib0} and initial debt levels D_{i0}, an equilibrium is a sequence of world interest rates $\{r_{t-1}\}$, wage vectors $\{W_{ibt}\}$, rental rates $\mathcal{R}_{it}$, investors' consumption levels $\{C^k_{it}\}$, employment $\{L_{ibt}\}$, country and sector prices $\{P_{it}\}$ and $\{P_{ist}\}$, revenues $\{R_{ist}\}$, trade shares $\{\lambda_{ijst}\}$ and labor-market variables $\{l_{ibt}, \omega_{ibt}, \omega_{it}, \pi_{ibt}, \pi_{it}\}$ such that equations (1) to (18) hold.

4.8 Exact Hat Algebra

To solve the model, we follow the exact hat algebra methodology suggested by Dekle et al. (2007) and the dynamic extension proposed by Caliendo et al. (2019) and express the system of equations in relative changes $\hat{x}_t = x_t/x_{t-1}$. This allows to solve for the model responses to a sequence of shocks $\left\{\hat{\mu}_{it}, \hat{A}_{ist}, \hat{\varphi}_{it}\right\}$

$$\hat{R}_{ist}R_{ist-1} = \sum_{j=1}^{I} \hat{\lambda}_{ijst}\lambda_{ijst-1}\left[\alpha_{js}\left(\sum_{b}\hat{W}_{jbt}\hat{L}_{jbt}W_{jbt-1}L_{jbt-1} + \hat{\mathcal{R}}_{jt}\hat{K}_{jt}\mathcal{R}_{jt-1}K_{jt-1} - \hat{TB}_{jt}TB_{jt-1}\right)\right.$$
$$\left. + \sum_{s}\phi_{jsk}\hat{R}_{jkt}R_{jkt-1}\right] \quad \forall i, \forall s \tag{19}$$

$$\hat{\lambda}_{ijst} = \frac{\left(\hat{\tau}_{ij,s,t}\hat{A}_{ist}^{-1}\hat{W}_{i,b(s),t}^{\phi_{is}}\hat{\mathcal{R}}_{it}^{\psi_{is}}\prod_k \hat{P}_{ikt}^{\phi_{i,ks}}\right)^{1-\sigma_k}}{\sum_{r=1}^{I}\lambda_{rjst-1}\left(\hat{\tau}_{rj,s,t}\hat{A}_{rst}^{-1}\hat{W}_{r,b(s),t}^{\phi_{rs}}\hat{\mathcal{R}}_{rt}^{\psi_{rs}}\prod_k \hat{P}_{rkt}^{\phi_{r,ks}}\right)^{1-\sigma_k}} \quad \forall i, \forall s \tag{20}$$

$$\hat{P}_{ist} = \left[\sum_{j}\lambda_{jist-1}\left(\hat{\tau}_{ji,s,t}\hat{A}_{jst}^{-1}\hat{W}_{j,b(s),t}^{\phi_{js}}\hat{\mathcal{R}}_{jt}^{\psi_{js}}\prod_k \hat{P}_{jkt}^{\phi_{j,ks}}\right)^{1-\sigma_s}\right]^{\frac{1}{1-\sigma_s}} \quad \forall i, \forall s \tag{21}$$

$$\hat{\mathcal{R}}_{it}K_{it}\mathcal{R}_{it-1}K_{it-1} = \sum_{s\in S}\psi_{is}\hat{R}_{ist}R_{ist-1} \quad \forall i \tag{22}$$

$$\hat{W}_{ibt}\hat{L}_{ibt}W_{ibt-1}L_{ibt-1} = \sum_{s\in b}\phi_{is}\hat{R}_{ist}R_{ist-1} \quad \forall i, \forall b \tag{23}$$

$$\prod_{q=1}^{t}\hat{L}_{ibq} \leq \prod_{q=1}^{t}\hat{l}_{ibq}, \hat{W}_{ibt} \geq \delta_{i,b}, \text{ complementary slackness} \quad \forall i, \forall s \tag{24}$$

$$\hat{l}_{ibt} = \frac{\hat{\omega}_{it}^{\kappa}}{\hat{\mu}_{it}^{\kappa}(1-\pi_{it-1}) + \hat{\omega}_{it}^{\kappa}\pi_{it-1}}\frac{\hat{\omega}_{ibt}^{\eta}}{\hat{\omega}_{it}^{\eta}} \quad \forall i, \forall s \tag{25}$$

$$\hat{\omega}_{ibt} = \frac{\left(1 - t_{it} - \tau_{it} + \frac{l_{ibt}}{L_{ibt}}\tau_{it}\right)}{\left(1 - t_{it-1} - \tau_{it-1} + \frac{l_{ibt-1}}{L_{ibt-1}}\tau_{it-1}\right)} \frac{\hat{W}_{ibt}\hat{L}_{ibt}}{\hat{P}_{it}\hat{l}_{ibt}} \quad \forall i, \forall s \tag{26}$$

$$\hat{\omega}^{\eta}_{it} = \sum_{b} \pi_{ibt-1}\hat{\omega}^{\eta}_{ibt} \quad \forall i \tag{27}$$

$$\hat{P}_{it} = \prod_{s} \hat{P}^{\alpha_{is}}_{ist} \quad \forall i \tag{28}$$

$$\sum_{b} t_{it} W_{ibt} L_{ibt} = \sum_{b} \tau_{it} W_{ibt} \left(l_{ibt} - L_{ibt}\right) \quad \forall i \tag{29}$$

$$\hat{C}^{k}_{it} = \left(\frac{\hat{P}_{it}}{\hat{\varphi}_i \beta (1 + r_{t-1})}\right)^{-1/\sigma} \quad \forall i \tag{30}$$

$$\hat{TB}_{it} TB_{it-1} = \hat{\mathcal{R}}_{it}\hat{K}_{it}\mathcal{R}_{it-1}K_{it-1} - \hat{P}_{it}\hat{C}^{k}_{it}P_{it-1}C^{k}_{it-1} \quad \forall i \tag{31}$$

$$\hat{CA}_{it} CA_{it-1} = \hat{TB}_{it} TB_{it-1} - r_{t-1} D_{it-1} \quad \forall i \tag{32}$$

$$\sum_{i} \hat{CA}_{it} CA_{it-1} = 0 \tag{33}$$

$$\sum_{i}\sum_{b} \hat{W}_{ibt}\hat{L}_{ibt} W_{ibt-1} L_{ibt-1} = \gamma \sum_{i}\sum_{b} W_{ibt-1} L_{ibt-1} \tag{34}$$

Changes in worker welfare can be expressed as

$$\hat{u}_{it} = \hat{\pi}^{1/\kappa}_{it} \hat{\omega}_{it}$$

5 Quantitative Analysis

5.1 Data and Calibration

We use trade and production data for 31 countries, and an aggregate rest of the world region, for a total of 32 countries for the year 1995. We consider three broad sectors, indexed by b in the model: one manufacturing sector, one service sector, and one agricultural sector. For the narrow sectors s we follow Rodríguez-Clare et al. (2020) and aggregate manufacturing industries from WIOD into 12 manufacturing sectors. We also aggregate the service industries to one service which is identical to the broad service sector.

For each country j and each sector s, we need data to compute the share of labor in production ϕ_{js}, the share of intermediates from all other sectors $\phi_{j,ks}$, and the aggregate consumption shares α_{js}. We use data from WIOD to calculate the labor and capital shares in gross output (ϕ_{js} and

ψ_{js}) and also to compute $\phi_{j,ks}$ as the share of purchases of sector s coming from sector k (the input-output coefficient).

In addition, our model requires data on bilateral trade flows for all sectors and all countries in our sample in order to compute deficits, revenue, and trade shares for the initial year 1995. We use the bilateral trade flows (combined with the input-output coefficients and deficits) to infer the consumption shares α_{js}'s. We take the sector-level bilateral trade between countries directly from WIOD.

For the labor market part of the model, we require data on the economy-wide labor force participation rate as well as the distribution of the labor force across sectors in the initial period. We take the economy-wide labor force participation rates from OECD data and add the values for China and Taiwan from the World Development Indicators.[5] For the distribution of workers across broad sectors, we turn to the WIOD socio-economic accounts.[6] Consistent with the approach in Rodríguez-Clare et al. (2020), we begin our counterfactual scenario under the assumption that the labor market is in steady state in the initial period. This allows us to interpret the observed employment values also as representing sectoral labor *supply* in that period.

We model the nominal wages of all countries that joined the Eurozone in the first round plus Greece as being subject to DNWR due to the fixed nominal exchange rate. By contrast, all other countries are assumed to have flexible exchange rates and thus DNWR is never binding for them. We set γ, the nominal growth rate of the world economy, equal to unity. This parameter can be normalized since it determines the degree of DNWR only in combination with the choice of δ_i. In order to make this compatible with the growth rate of trade, which we match with the one from WIOD, we detrend all variables in WIOD with the average nominal growth rate of the Eurozone economy in WIOD. For δ_i, which governs the extent to which nominal wages can adjust downward, we follow Schmitt-Grohé and Uribe (2016) and use the complementary slackness condition to estimate it: whenever the unemployment rate is increasing in a given country, the growth rate of nominal wages must equal δ_i, since the DNWS is binding in this case. We adjust the so obtained δ_i for the average Eurozone inflation rate, to make them comparable to the model. Observe that all countries except Germany have complete DNWS and we thus set δ_i to 0.99 for them. For Germany, we set δ_i to a smaller value, corresponding to the percentage difference relative to the rest of the Eurozone.

We use data on replacement rates from the OECD to construct time series of replacement rates for each country. We use information on the countries' net foreign asset position in the initial year

[5]We divide the number of Chinese workers aged 15 to 64 by the population of China and adopt the same value for Taiwan. Some countries have missing values for some years. We impute those values by linear interpolation where only single years are missing. In cases of missing values over several years, we impute the values backwards from the most recent available year by applying the OECD-wide growth rate of labor force participation.

[6]Also here, data on Chinese sectoral employment are missing. Therefore, we take the values directly from the Chinese National Bureau of Statistics.

1995 from IMF.

For the remaining parameters, we follow Rodríguez-Clare et al. (2020) The parameter κ, which determines the elasticity of labor supply, is set to 5.9 (implying a labor supply elasticity of around 2). Finally, we set η, which determines the sectoral mobility frictions, equal to κ, which implies that moving across broad sectors is equally difficult as moving between market and non-market activities. Finally, we set σ, the elasticity of substitution across varieties, to 6 for all narrow sectors.

5.2 Simulating the German Competitiveness Shock

We now simulate the model to fit the sequence trade balances, aggregate exports to the Eurozone, and labor force participation rates for each country. This allows us to back out the sequence of manufacturing TFP shocks, the sequence of utilities from home production and the sequence of patience shocks $\left\{\hat{\mu}_{it}, \hat{A}_{ibt}, \hat{\varphi}_{it}\right\}$ for each country.

In Figure 5, we report the sequence of shocks $\left\{\hat{\mu}_{it}, \hat{A}_{ibt}\right\}$ for Germany backed out from the model. The Figure plots cumulative changes between 1995 and 2008. Up until 2002, both manufacturing TFP and the utility from non-market activity were increasing in Germany. Starting in this period, there was sharp contraction in the utility of home production, which induced the strong increase in labor force participation. At the same time, TFP was also moderately decreasing. In contrast to utility from home production, TFP started to increase again strongly in 2005.

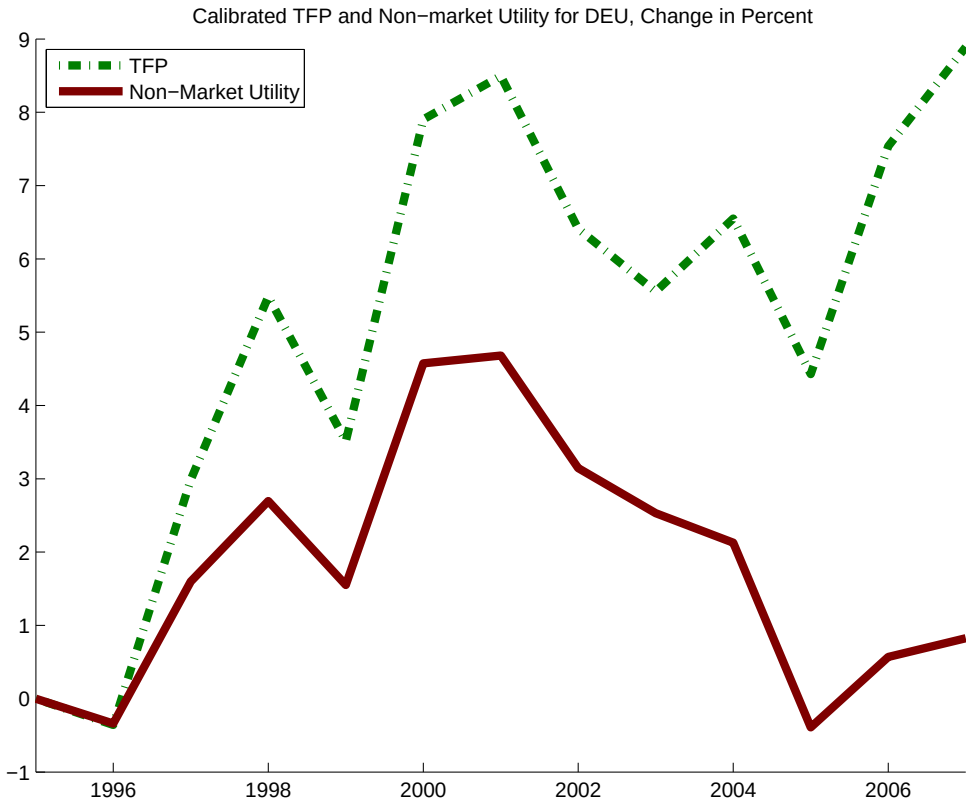
Next, we report the cumulative change in nominal wages in manufacturing and services; the unemployment rate in these broad sectors (defined as the ratio $(l_{ibt} - L_{ibt})/l_{ibt}$); the labor force participation rate; and the cumulative change in the real wage in Figure 6. In Germany, the nominal and real wages in both sectors increase between 1995 and 2002 and then strongly drop, reflecting the increase in labor supply due to lower utility from home production. The nominal wage in both broad sectors falls by around 5 percent between 2002 and 2005 and then starts picking up again. The drop in the real wages is somewhat less pronounced due to reductions in the price index. Due to a sufficient degree of downward wage flexibility in Germany, DNWS never becomes binding and the unemployment rate stays at zero.

By contrast, the impact of the German competitiveness shock is quite different for other Eurozone countries. As an example, let us consider France, a country close to Germany with a similar manufacturing structure. We depict outcomes for France in Figure 7 There, the reduced demand for French exports due to the German competitiveness shock would in principle require a downward adjustment in nominal wages. However, French nominal wages are strongly downward rigid and thus DNWR becomes binding around 2002. It takes around 3 years for nominal wages to adjust

completely to the shock. This slow adjustment generates an increase in involuntary unemployment by around 5 percent on impact that declines over time. Nominal and real wages also adjust downward, but not to a sufficient degree to clear the labor market. In the long run, real wages increase as the German competitiveness shock induces lower prices and a positive terms of trade effect for France.

Finally, in Figure 8 we consider the impact of the German competitiveness shock on the UK, a country with a flexible exchange rate. In contrast to its impact on Eurozone economies, the German competitiveness shock does not generate any unemployment in the UK, as the real wage can adjust downward in manufacturing and upward in services, generating reallocation of workers from manufacturing to services. This, generates overall an increase in the expected real wage due to lower prices and a small increase in labor force participation.

Figure 5: Effects of the German Competitiveness Shock on Germany



Notes: The Figure plots cumulative percentage changes in manufacturing TFP and the utility from home production for Germany.

Figure 6: Effects of the German Competitiveness Shock on Germany



Notes: The Figure plots cumulative percentage changes in the nominal wage, the real wage, the unemployment rate, and the labor force participation rate for Germany.

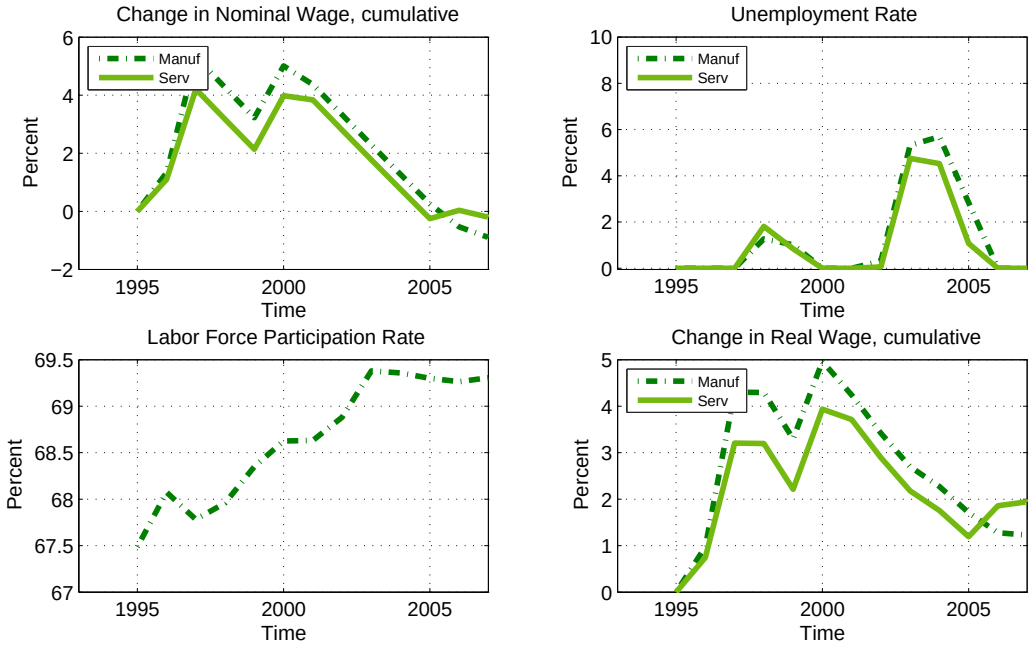
6 Counterfactuals

TO BE COMPLETED

7 Conclusion

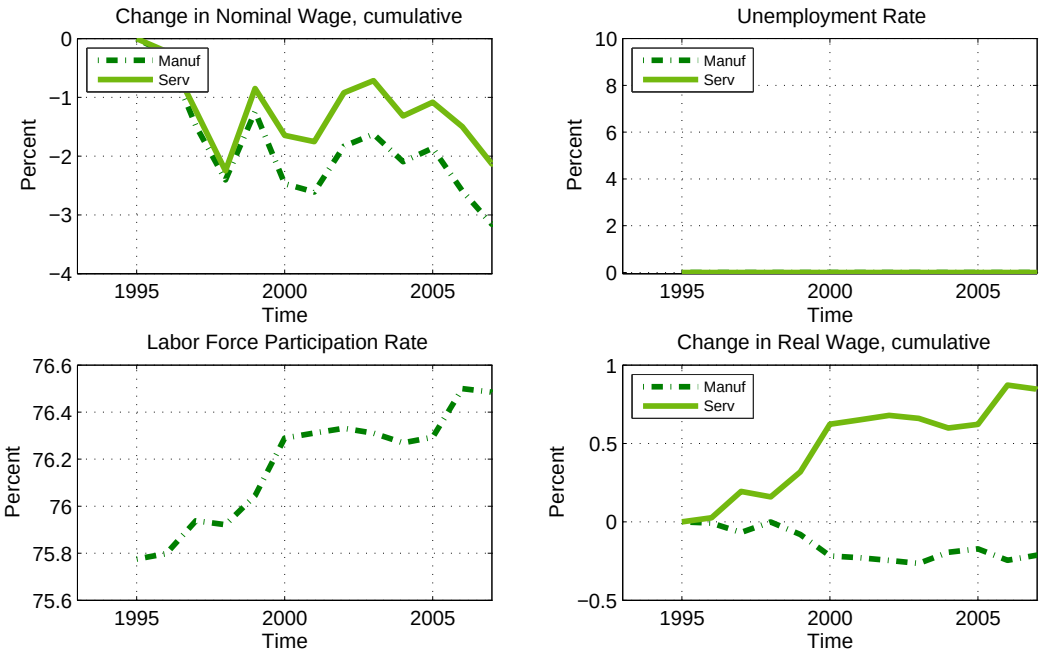
In this paper, we have studied the impact of the German manufacturing export boom that followed the introduction of the Euro on the other Eurozone economies. We have presented both reduced-form evidence and results based on a quantitative trade model with nominal wage frictions. We have shown that, starting in the early 2000s, Germany experienced a positive labor supply shock induced by structural labor market reforms. This shock implied a gain in competitiveness relative to other Eurozone economies, which lost export market shares to German producers. Due to the peg in the nominal exchange rate and downward nominal wage rigidity, nominal wages could not adjust suffficiently in response to the shock. This led to a temporary increase in involuntary unemployment in the rest of the Eurozone.

Figure 7: Effects of the German Competitiveness Shock on France



Notes: The Figure plots cumulative percentage changes in the nominal wage, the real wage, the unemployment rate, and the labor force participation rate for France.

Figure 8: Effects of the German Competitiveness Shock on the UK



Notes: The Figure plots cumulative percentage changes in the nominal wage, the real wage, the unemployment rate, and the labor force participation rate for the UK.

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Internet Appendix

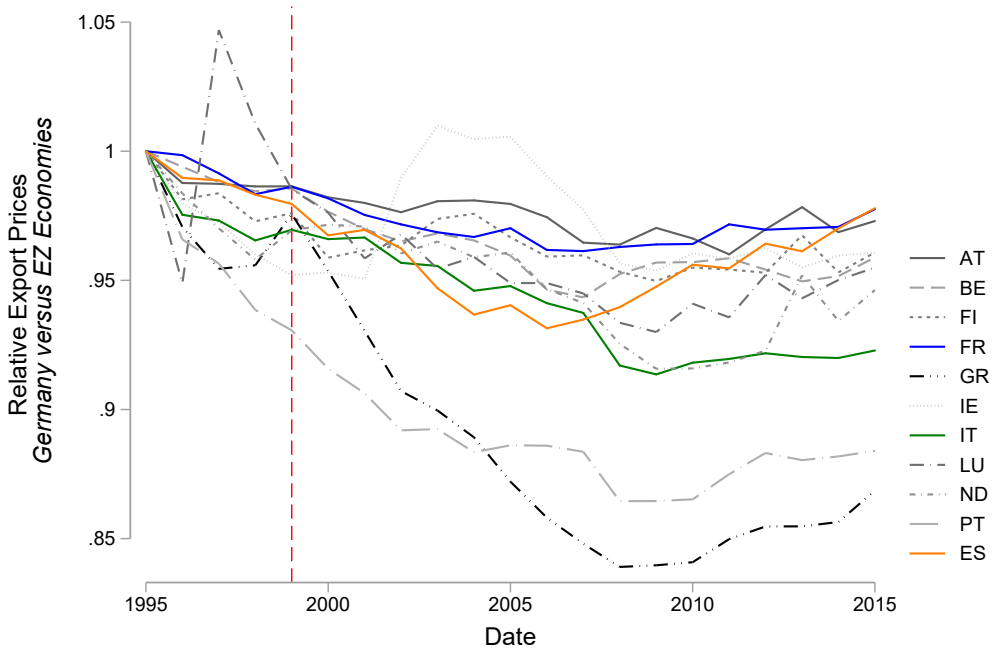
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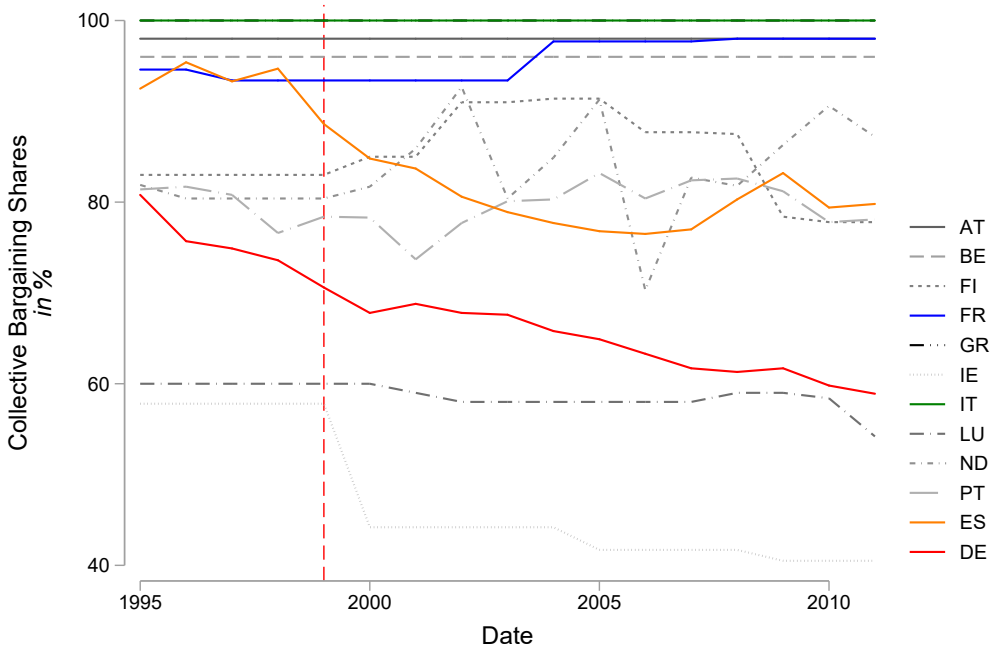
A Empirical Appendix

Figure A.1: Export Price Fluctuations in the Eurozone



Notes: The Figure plots indices of export price levels for Eurozone economies relative to the German export price level. Relative export prices are the German price level of exports relative to the according price level from the respective Eurozone economy using data from the Penn World Tables 8.0. Decreases in the relative export prices denote a relative loss in trade competitiveness of the respective Eurozone economy.

Figure A.2: Collective Wage Bargaining in the Eurozone



Notes: The Figure plots the share of workers with jobs covered by collective wage bargaining in percent for Eurozone economies using data from the OECD.

Table A.1: Robustness: Eurozone Employment, Labor Costs and Aggregate German Competition

	(1)	(2)	(3)	(4)	(5)
Panel A:	*Employment*				
Eurozone EC	-1.030***	-0.938***	-0.368	-0.288	-0.0229
	(0.299)	(0.286)	(0.465)	(0.461)	(0.394)
× Post Euro			-0.415*	-0.408*	-0.325*
			(0.223)	(0.212)	(0.178)
Observations	4,020	4,020	4,020	4,020	2,856
Country-Ind. Clusters	194	194	194	194	194
Panel B:	*Labor Costs*				
Eurozone EC	0.377**	0.374**	0.690**	0.700***	0.413*
	(0.189)	(0.179)	(0.289)	(0.248)	(0.248)
× Post Euro			-0.196	-0.204	-0.0998
			(0.145)	(0.133)	(0.126)
Observations	4,002	4,002	4,002	4,002	2,844
Country-Ind. Clusters	193	193	193	193	193
Sample Frame	1995 - 2015	1995 - 2015	1995 - 2015	1995 - 2015	1995 - 2009
Country-Ind. F.E.	×	×	×	×	×
Year F.E.	×		×		×
Country-Year F.E.		×		×	

Notes: The Table presents estimates from regressing employment or labor costs (in logs) for Eurozone countries on Eurozone export competition from Germany and its interaction with a dummy *Post Euro* which equals 1 from the introduction of the Euro in 1999 onwards. Data are obtained from the EU KLEMS database and Eurostat Comext. Import competition (*Eurozone IP*) is defined according to $\tilde{EC}_{it}^{EZ}$ in the main text. All estimations include a full set of country-industry fixed effects and either year or country-year fixed effects. Standard errors are clustered at the country-industry level; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

B Theoretical Appendix