Has the euro paid off? A study of the trade-induced welfare effects of the EMU

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Abstract

This paper aims to provide policy-relevant insights into the effect of the euro on trade. It uses a new data set of bilateral international and intranational manufacturing trade flows for 69 countries over the period 1986 to 2016. A general equilibrium gravity model is estimated to quantify the welfare effect of the euro and its impact on consumer prices and producer prices within countries (i.e., distributional effects). The results of three counterfactual experiments indicate that the euro has successfully increased welfare for the Economic and Monetary Union (EMU) and non-EMU member countries. The results suggest that a two-speed euro design would have further increased welfare, with some heterogeneity within countries. The growth effects of the euro are mainly driven by trade creation outside the EMU. This finding raises questions over the cohesiveness of the euro area as an optimum currency area.

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1. Introduction

Building on the influential work of Rose (2000), much research has examined the effect of currency unions on trade. The effect of the Economic and Monetary Union (EMU) on trade has attracted particular attention from researchers and policymakers,[1] given that the EMU is the largest and most important monetary union worldwide.[2] More than 50 papers have investigated its partial or direct effects on bilateral trade flows, providing mixed results.[3] These studies have assessed the EMU's initial impact on trade flows. However, they have focused on partial equilibrium trade effects, neglecting the effects that arise when considering variations in prices, income, and expenditure prompted by trade cost changes. This paper contributes to the literature by examining the general equilibrium effects of the EMU through its impact on trade costs.

Empirical research on the effect of the EMU on trade relies on the gravity equation of international trade. However, methodological advances and theoretical developments in the gravity equation literature over the last two decades have revealed that many studies of the effect of the EMU using gravity equations have theoretical, econometric, and data flaws for two main reasons. First, computational limitations precluded simultaneously dealing with all bias arising from (i) unobserved bilateral heterogeneity and endogeneity of trade policy variables, (ii) the omission of (theoretical) multilateral resistance terms, (iii) the heteroscedasticity of residuals, and (iv) the existence of zeros in bilateral trade flows.[4] Second, the omission of intranational trade flows prevented adequate

[1] In this paper, the EMU refers to the third stage of harmonization of the economic and monetary policies of EU member states. It came into effect on January 1, 1999, by the 11 early joiners of the euro.

[2] Interest in this topic started even before the euro was created. Several articles estimated or extrapolated the potential impact of the EMU on trade using pre-EMU data (e.g., Dell'Ariccia, 1999; De Grauwe and Skudelny, 2000; or Rose and van Wincoop, 2001). However, papers on the EMU's effect on trade have proliferated since the early 2000s with the availability of post-EMU data (e.g., Micco, *et al.*, 2003; De Nardis and Vicarelli, 2003; Barr *et al.*, 2003; Gil-Pareja *et al.*, 2003 and 2008; Aristotelous, 2006; Berger and Nistch, 2008; Glick and Rose, 2016; Larch *et al.*, 2018; Mika and Zymek, 2018; Larch *et al.*, 2019; and Esteve-Pérez *et al.*, 2020a).

[3] Rose (2017) provided a meta-analysis of 45 studies and a comprehensive review of the literature to date. See Esteve-Pérez *et al.* (2020a) for an overview of more recent studies.

[4] Two recent computational advances account for all cited sources of bias in large data sets. The first is Tom Zylkin's *ppml_panel_sg* Stata command, presented in Larch *et al.* (2019). The second is the *ppmlhdfe* Stata command developed by Correia *et al.* (2019) for fast estimation of (pseudo) Poisson regression models with multiple high-dimensional fixed effects. Larch *et al.* (2019) used the Zylkin algorithm to overcome the problems highlighted by Glick and Rose (2016) with Poisson

assessment of the effect of the EMU on trade in a structural gravity framework.[5] The use of data including domestic trade flows allows accurate assessment of the effects of trade creation (i.e., replacing domestic sales with trade with other EMU countries) due to the currency union. It also allows identification of country-specific EMU effects on trade between EMU members and non-member countries, which is not possible when using only international trade flows.[6] To the best of the authors' knowledge, only three papers (Larch *et al.*, 2018; Felbermayr and Steininger, 2019; and Esteve-Pérez *et al.*, 2020a) provide unbiased and theory-consistent estimates of the EMU effect relying on the gravity model and accounting simultaneously for all sources of bias listed earlier.

This paper makes two contributions to the literature on the effect of the EMU on trade. First, following all econometric best practices for estimation of the gravity equation of international trade described by Yotov *et al.* (2016), this paper reassesses the partial equilibrium effects of the EMU (as a whole and for each country). The paper extends the period considered by Esteve-Pérez *et al.* (2020a) by one decade to cover more recent years. The study is based on a sample covering 69 countries for the period 1986 to 2016. This contribution is valuable because it enables a better assessment of an institutional change that led to gradual effects on trade. It also covers the years after the financial and debt crises in 2008 and 2010, respectively. The second contribution is to extend the analysis to a general equilibrium framework. This natural extension of the literature enables evaluation of the impact of the EMU on trade and welfare. This analysis is of interest to academics and has important policy implications.

This paper adds three relevant methodological features to the discussion of the welfare effects of the euro. First, it uses the GEPPML, a general equilibrium procedure developed by Anderson *et al.* (2018) to perform a general equilibrium (GE) comparative static analysis of gravity models with the Poisson pseudo-maximum-likelihood (PPML) estimator.[7] This procedure distinguishes between consumer and producer effects, which are relevant to explore the political economy beneath Europe's monetary integration. Second, the paper explicitly analyzes the

pseudo-maximum-likelihood (PPML) in the estimation of the effect of the EMU on trade using a large data set of only international trade data.

[5] Several studies using the gravity equation have shown the importance of accounting for intranational trade flows (e.g., Yotov, 2012; Dai *et al.*, 2014; Bergstrand *et al.*, 2015; Anderson and Yotov, 2016; Borchert and Yotov, 2017; Beverelli *et al.,* 2018; Baier *et al.*, 2019; Heid *et al.,* 2021; and Yotov, 2022).

[6] Larch *et al.* (2018) noted that the omission of data on intranational trade flows involves a departure from the structural gravity theory of international trade and prevents researchers from properly capturing trade effects with members and non-members.

[7] Felbermayr and Steininger (2019) were the first to attempt to answer this question using a computable general equilibrium framework based on the work of Caliendo and Parro (2015), in the spirit of the Ricardian trade model of Eaton and Kortum (2002).

EMU's trade creation/diversion effects, giving a more accurate measure of the EMU's effect inside and outside the euro area. Third, it partially captures the dynamic effect over time of the EMU using the panel's structural gravity estimates in the GE counterfactuals.

The counterfactual analysis is extended by studying the design or phasing in Europe's common currency. Three general equilibrium counterfactual experiments are presented to address three key questions: (i) What are the overall trade-induced welfare gains of the EMU? (ii) What are the welfare gains from trade for core EMU countries compared to those of peripheral member countries? (iii) What are the gains due to trade creation effects with countries outside the euro area?

The analysis shows that the EMU has boosted bilateral trade flows between member countries, especially between EMU members versus non-member countries. Interestingly, updating the study period to include more recent years substantially raises the estimated effect of the EMU on trade with respect to the estimates of Esteve-Pérez *et al.* (2020a), whose sample period ended in 2006. The overall trade creation effect of the EMU more than doubles and the positive effect on trade with non-member countries is approximately 50% larger when the most recent years are included in the sample period. Likewise, the analysis of the effect by country reveals an increase in the number of countries for which the EMU has boosted trade between members.

The general equilibrium analysis reveals several findings that have important policy implications. The results suggest that the EMU has had a sizable welfare-enhancing effect on participating countries. This effect is larger among smaller EMU members, where consumers (producers) encounter lower (higher) prices. The lower-bound estimates from the counterfactual analysis suggest that Germany's real GDP would have been about 2.16% lower than it was in 2016 if the euro had not existed. The results also suggest that the euro design could be improved and raises questions over the cohesion effect of the EMU among euro area member countries.

The rest of the paper is organized as follows. Section 2 outlines the methodology. Section 3 describes the data set. Section 4 discusses the empirical results. Section 5 concludes.

2. Methodology: The structural gravity model

2.1 Partial equilibrium analysis

The gravity model is one of the most popular and successful frameworks in international economics. It allows researchers to investigate the determinants of international trade. In particular, it enables quantification of the partial or direct effects of economic integration agreements on bilateral trade flows. Several contributions since the late 1970s have made the gravity model a structural model with solid theoretical foundations. It is now highly suited to counterfactual analysis.[8] It represents a realistic general equilibrium environment that can be used to capture the possibility that countries are linked and that trade policy changes in one market will cause ripple effects in the rest of the world (Yotov *et al.*, 2016).

The empirical strategy for this study began with estimation of the partial equilibrium effects of the EMU on international trade flows. We estimated several specifications of the gravity equation following all best practices and recommendations of Yotov et al. (2016) and Yotov (2022).[9] This approach gave reliable and unbiased partial equilibrium estimates within a theoretically consistent econometric specification, in line with developments in the literature over the last two decades. First, we used panel trade data and included time-invariant country-pair fixed effects to account for the effect of all time-invariant (observable and unobservable) bilateral trade costs and the endogeneity of trade policy variables.[10] Second, following Egger et al. (2022), we used consecutive-year data to capture dynamic-adjustment effects.[11] Third, we included exporter-time and importer-time fixed effects to capture all time-variant observable and unobservable country characteristics and control for changes in multilateral resistance terms (Anderson and van Wincoop, 2003).[12] Fourth, we used the PPML estimator to deal with the

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[8] Initially, the gravity equation lacked theoretical foundations. Anderson (1979) was the first to provide a theoretical basis for the gravity model of international trade. Eaton and Kortum (2002) and Anderson and van Wincoop (2003) offered the two most prominent theoretical foundations of the structural gravity model. For a review of alternative theoretical foundations of the structural gravity model, see Head and Mayer (2014) and Yotov *et al.* (2016).

[9] The empirical gravity equation has often been estimated with a-theoretical versions of the gravity equation that overlook some of the critical estimation challenges. Such an approach may lead to biased and even inconsistent estimates.

[10] Baier and Bergstrand (2007) showed that *ex post* estimation of the partial effects of free trade agreements suffered from endogeneity bias, mainly due to self-selection of country-pairs into agreements (as a result of pre-existing trade levels). They found that this self-selection bias was substantially reduced when employing pair-specific fixed effects or using first-difference regressions with panel data. Glick and Rose (2002), Egger and Pfaffermayr (2003), and Cheng and Wall (2005) had already discussed these issues.

[11] Egger et al. (2022) challenged the common practice of estimating gravity equations with time-interval data and listed the advantages of using consecutive-year data. Trefler (2004) and Cheng and Wall (2005) had already recommended using panel data with intervals instead of data pooled over consecutive years to allow for adjustment in trade flows in response to changes in trade policy. This approach has been widely used in the literature. As a robustness check, we also estimated the gravity equation with interval data.

[12] Anderson and van Wincoop (2003) noted that gravity model theory implies that bilateral trade flows depend not only on bilateral trade barriers between any two countries but also on trade barriers of each country with other trading partners (i.e., multilateral resistance). Failing to control for multilateral resistance produces biased estimates. Baldwin and Taglioni (2007) dubbed it the "gold medal mistake."

econometric problems resulting from heteroscedastic residuals and the prevalence of zeros in bilateral trade flows.[13] Piermartini and Yotov (2016) also recommend using the PPML estimator because it delivers theory-consistent estimates of general equilibrium effects. Finally, we performed the estimations using intranational (in addition to international) trade flows, as suggested by all micro-foundations of the gravity model of trade.[14]

We estimated several specifications of gravity equation (1) in its multiplicative form (instead of logarithmic form) with the PPML estimator. We included exporter-time, importer-time, and country-pair fixed effects and used annual data on both international and intranational trade flows. This approach currently constitutes the state of the art in this area of research:

$$X_{ij,t} = exp\big(\beta_1\big(BothEMU_{ij,t} \times INTER_{ij}\big) + \beta_2\big(OneEMU_{ij,t} \times INTER_{ij}\big) + \beta_3\big(nonEMU\_CU_{ij,t} \times INTER_{ij}\big) + \beta_4\big(EU_{ij,t} \times INTER_{ij}\big) + \beta_5\big(nonEU\_RTA_{ij,t} \times INTER_{ij}\big) + \beta_6\big(EUtrend_{ij,t}\big) + \beta_6\big(EUtrendsq_{ij,t}\big) + \chi_{i,t} + \lambda_{j,t} + \eta_{ij}\big) \times \epsilon_{ij,t} \quad (1)$$

where the dependent variable is the nominal value of bilateral trade flows (in levels) from country i (exporter) to country j (importer) at time t. The two variables of interest in gravity equation (1) are $BothEMU_{ij,t} \times INTER_{ij}$ and $OneEMU_{ij,t} \times INTER_{ij}$. The first variable is the product of two terms: (i) the bilateral indicator variable $BothEMU_{ij,t}$, which takes the value 1 when countries i and j are both EMU members at time t, and 0 otherwise; and (ii) a dummy variable, $INTER_{ij}$, which takes the value 1 for international trade flows, and 0 otherwise. This interactive variable takes the value 1 when the source and destination countries are different ($i \neq j$), and 0 when they are the same ($i = j$). Hence, $BothEMU_{ij,t} \times INTER_{ij}$ takes the value 1 for international trade flows between EMU members and 0 otherwise. Crucially, the reference group includes intranational trade flows, which capture potential EMU trade creation effects that arise from replacing domestic sales with trade with other EMU member countries. The second variable of interest to capture the EMU effect is an interaction term between $OneEMU_{ij,t}$ and $INTER_{ij}$. $OneEMU_{ij,t}$ is a binary dummy variable that takes the value 1 if either the importer or the exporter (but not both at once) are EMU members at time t. While the $OneEMU_{ij,t}$

[13] Santos Silva and Tenreyro (2006 and 2010) noted that despite its wide use in the literature, the log-linear versions of the gravity equation using ordinary least squares (OLS) have two drawbacks. First, they cannot account for the information contained in zero trade flows because these observations are dropped from the sample with the logarithmic transformation. This problem results in a sample selection bias that can be particularly serious in data sets with a large number of zeroes in bilateral trade flows. Second, and most importantly, in the presence of heteroscedasticity (due to Jensen's inequality) the estimates of the log-linear gravity equations with OLS are not only biased but also inconsistent.

[14] Yotov (2012), Dai *et al.* (2014), Bergstrand *et al.* (2015), Heid *et al.* (2021), and Yotov (2022) showed the importance of incorporating intranational trade flows in structural gravity estimation for several reasons, including consistency with gravity theory.

dummy is country-time-specific and its impact cannot be identified in the presence of country-time fixed effects, the interaction term (*OneEMU*$_{ij,t}$ *x INTER*$_{ij}$) is time-varying and bilateral by construction. Therefore, its effect can be identified even in the presence of exporter-time and importer-time fixed effects when using domestic trade flows.

The rest of the variables in equation (1) are the same covariates used in the complete specification given by Esteve-Pérez *et al.* (2020a). We controlled for membership of both countries of a given pair in currency unions other than the EMU (*nonEMU_CU*$_{ij,t}$), the European Union (*EU*$_{ij,t}$), and regional trade agreements other than the EU (*nonEU_RTA*$_{ij,t}$). Given the presence of intranational trade flows, the interaction of these variables with *INTER*$_{ij}$ captures possible trade creation effects of the three types of economic integration agreements. The EU has grown over time. Therefore, we allowed for a linear and a quadratic EU-specific trend in bilateral trade flows (*EUtrend*$_{ij,t}$ and *EUtrendsq*$_{ij,t}$) to control for the impact of the EU on trade as it evolves over time, as is common in the literature.[15] The equation also includes a set of exporter-time fixed effects ($\chi_{i,t}$), importer-time fixed effects ($\lambda_{j,t}$), and country-pair fixed effects (η_{ij}).[16] Finally, $\epsilon_{ij,t}$ is the error term.

Two features are worth noting. First, equation (1) is of a reduced form because we included exporter-time and importer-time fixed effects to proxy the multilateral resistance indexes of the structural gravity equation (Anderson and van Wincoop, 2003). Nevertheless, Fally (2015) showed that the PPML estimator with fixed effects is consistent with these multilateral resistance indexes. This feature is in fact critical for estimating the general equilibrium model discussed in Section 2.2. Second, we controlled for the endogeneity of economic integration agreements using bilateral fixed effects. Such fixed effects have been used to mitigate possible endogeneity concerns since early studies of the impact of the EMU on trade (e.g., Micco et al., 2003; Gil et al., 2003; Baldwin and Di Nino, 2006, and Baldwin and Taglioni, 2007). In the literature on the effect of free trade agreements, Baier and Bergstrand (2007) assumed that the main source of bilateral bias is time-

[15] All members of the EMU are also members of the EU. Given the definition of the variables EU and EMU in our specifications and the inclusion of bilateral fixed effects, β_4 in equation (1) captures the effect of joining the EU, whereas β_1 captures the incremental effect on trade of joining the EMU.

[16] In addition to accounting for the unobservable (outward and inward) theoretical multilateral resistances, the exporter-time and importer-time fixed effects also absorb (control for) the exporter and importer size variables in the structural gravity model, as well as all other observable or unobservable exporter-specific and importer-specific time-varying characteristics that may influence trade. Moreover, the bilateral fixed effects control for the impact of any time-invariant determinant of trade, be it observed (bilateral distance, contiguity, common language, etc.) or unobserved. Bilateral fixed effects also address endogeneity concerns of trade policy variables (Baier and Bergstrand, 2007).

invariant. They argued that panel regression techniques (estimations with country-pair fixed effects or first differencing) are a suitable way to account for endogeneity.[17] However, country-pair fixed effects do not entirely eliminate the concern about potential selection bias (endogeneity) because countries could adopt the euro after a surge in trade within the sample period.

2.2 General equilibrium analysis

The structural gravity framework enabled general equilibrium analysis of the EMU's trade-induced welfare effects. We followed the procedure recently developed by Anderson *et al.* (2018) to perform general equilibrium comparative static analysis of gravity models with the General Equilibrium PPML procedure (henceforth GEPPML). The GEPPML uses a theoretical property that only holds for PPML and enables calculation of theory-consistent general equilibrium effects of trade policy. Fally (2015) showed that the exporter and importer fixed effects estimated with PPML are precisely equal to the multilateral resistances that satisfy the trade structural gravity equation system.

The GEPPML is a three-step procedure with two stages in each step.[18] The first step delivers the baseline estimates and the baseline GE indexes. The first stage of this step is to estimate the baseline gravity equation using the PPML estimator with exporter and importer fixed effects. However, as noted by Anderson *et al.* (2018), the procedure can be implemented with estimates of the trade cost elasticities obtained with any other estimator of choice.[19] The second stage of the first step is to construct the multilateral resistance indexes and any other baseline GE indexes of interest (e.g., predicted exports), relying on the estimates of the fixed effects from the baseline gravity equation and data on output and expenditure. The second step of the GEPPML procedure delivers the conditional gravity estimates

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[17] An alternative way to deal with endogeneity is to use instrumental variables (IVs). However, finding appropriate instruments is difficult. In the literature on the effect of the euro, the instrumental variable approach was followed by Barr et al. (2003). They used correlation of cycles as an instrument for currency union because the optimum currency area literature suggests that there should be a close correlation between country pairs. However, Frankel and Rose (1997 and 1998) showed that cycle correlation was also strongly associated with trade intensity, suggesting that this instrument is not ideal. Head and Mayer (2014) also noted the difficulty of finding compelling instruments. They argued that when "lacking plausible IVs, the most promising approach is to include country pair-fixed effects" to handle endogeneity.

[18] A detailed description of the three-step procedure to obtain the general equilibrium effects of trade policy with the PPML estimator can be found in Anderson *et al.* (2018). We briefly describe the main steps in Appendix A.

[19] To avoid perfect collinearity, either the fixed effects for one exporter and one importer or one fixed effect and the constant must be dropped. Following the indications of Anderson *et al.* (2018), we dropped the fixed effect for one importer and the constant. Hence, all other fixed effects were identified relative to that of the dropped fixed effect. Additionally, solving the system of inward and outward multilateral resistance terms required normalizing one of the multilateral resistance terms.

and conditional GE indexes. In this step, the term *conditional* means that it allows for changes in inward and outward multilateral resistances in response to changes in trade costs but without considering output and expenditure changes. Again, the first stage of the second step is to estimate the conditional gravity equation by PPML, redefining the policy variable(s) of interest to reflect the desired trade policy change (e.g., the counterfactual scenario such as the non-existence of the EMU). The second stage is to construct the conditional GE indexes with the new fixed effects estimates from the conditional gravity and original data on output and expenditure. Finally, the third step of the GEPPML procedure also has two stages. It delivers the full endowment gravity estimates and full endowment GE indexes. The expression *full endowment* in this step means that, in addition to changes in inward and outward multilateral resistances, it also considers changes in output and expenditure. A notable feature of the Anderson *et al.* (2018) procedure is its compatibility with standard software packages (e.g., STATA) to estimate a constrained Poisson model capable of handling loops. We examined the EMU's impact on trade and welfare in three alternative scenarios.

The first counterfactual experiment (CFL1) assessed the trade-induced effects of the EMU on consumer prices, producer prices, and GDP. We followed the indications of Mayer *et al.* (2019), who suggested that trade-related GE effects of economic integration can be measured by counterfactually removing trade integration gains. Accordingly, CFL1 posed an alternative scenario where the only difference with the baseline specification was the non-existence of the euro. In this alternative scenario, the euro was assumed to have never been adopted after the Maastricht Treaty in 1992. However, the remaining observable and unobservable trade determinants, including borders and distance, remained unchanged. We then computed the EMU-enhanced gains from trade by comparing the predicted level of trade costs in CFL1 (where EMU member countries faced the same impediments as non-EMU members) with the baseline trade costs.

Therefore, CFL1 was executed by removing the variables *BothEMU* and *OneEMU* and removing their parameters in the counterfactual regression. We first estimated a specification of Model 1 that included all the usual gravity terms for 2016 to generate our baseline scenario. Because it was a cross-sectional regression, we controlled for country-pair heterogeneity with *distance*, *contiguity*, and *INTER*, which entered directly into the regression. Hence, the CLF1 scenario was obtained from estimation of Model 1 when *BothEMU* and *OneEMU* were set to zero and information for 2016 was used. Thus, we obtained a prediction of the fixed effect (i.e., multilateral resistance terms) setting the coefficients of *INTER* and the other variables at the same level as in the baseline scenario and omitting *BothEMU* and *OneEMU.* These predicted fixed effects were used to generate an alternative set of trade costs for the GE analysis.

However, this standard procedure might not capture the euro GE effects fully. The cross-sectional nature of the GEPPML procedure means that only the level effects can be quantified. The full dynamics related to the change over time of the variables of interest cannot be quantified. Proper identification of the effects of trade policy variables requires the use of panel data. We partially resolved this issue by recovering the coefficients associated with *BothEMU* and *OneEMU* from estimation of the structural gravity equation (1) in the full data set. Thus, we utilized the panel dimension of the data. We used the estimates for gravity equation (1), following all best practices, to identify the estimated coefficients of EMU and other trade policy variables. The baseline trade costs were then generated with these coefficients instead of the cross-sectional regression coefficients. We thus aimed to capture the dynamics of both the level and the time variation of the euro effect on trade in reduced form.

The second counterfactual (CFL2) was a policy-relevant experiment. It consisted of building a scenario where only Germany, Austria, Belgium, Luxemburg, Finland, France, and the Netherlands joined the euro. This situation was simulated by splitting *BothEMU* and *OneEMU* into two sets of variables: the EMU core (countries that joined the euro in this alternative world) and the EMU periphery (all other countries). The counterfactual trade costs were computed by dropping the periphery EMU indicators. We thus quantified the effect of the EMU periphery on the EMU core.

In the last counterfactual (CFL3), we assessed the relative importance of trade creation effects outside the EMU. Initial studies of the effect of the EMU suggested that the euro would have a larger impact on trade creation outside the EMU (Lane, 2006). Other authors have suggested that core countries, particularly Germany, transferred their economic preferences to other members (Steinberg and Vermeiren, 2016). Testing this hypothesis is now relatively straightforward. We modified CFL1 slightly by removing *OneEMU*. In CFL3, the variable *BothEMU* appears in the baseline and the counterfactual trade costs.

3. Data

We used a new data set for this study. It updates the balanced panel data set provided by Thomas Zylkin for the period 1986 to 2006 by adding the years up to and including 2016.[20] The data include consistently constructed international

[20] See Baier *et al.* (2019) for a detailed explanation of the construction of the data set. This data set can be downloaded from https://vi.unctad.org/tpa/web/vol2/vol2home.html. A limitation of Zylkin's data set is that it includes manufacturing exports only, which account for about 68% of total merchandise exports in the last year of our sample period. This factor may be important when assessing the impact of the EMU on trade because it omits the potential impact on trade for non-manufacturing goods.

and intranational annual trade flows for aggregate manufacturing trade for 69 countries over the period 1986 to 2006.[21] Data on bilateral trade flows over the period 2006 to 2016 were gathered from the IMF's Direction of Trade (DoT) database. The data were adjusted to match Zylkin's manufacturing data for 2006 and updated accordingly throughout the rest of the period. Following the standard procedure in the original data set, domestic sales were the difference between total production and total exports (apparent consumption) of manufacturing products. To ensure consistency between international and intranational trade flows, *gross* production values were used to build intranational trade flows.[22]

Figure 1 displays the evolution of the share of international trade (with EMU and non-EMU member countries) and intranational trade flows of EMU member countries. The smooth trend after 2006 provides credibility to our data. For validity and robustness, we also used trade manufacturing data from the International Trade and Production Database for Estimation (ITPD-E; Borchert *et al.*, 2021). We did not observe significant differences in the data or estimation results when they were limited to the same period and countries used in this paper. We preferred the combined Zylking+DoT data set because the ITPD-E (release 1) time period for manufacturing trade data started in 2000. It thus precluded examination of the effect of the euro on early joiners.

The dash-dotted line in Figure 1 shows that the share of EMU members' aggregate domestic trade decreased over the period. The trade share (in this case, imports) with other EMU members (intra-EMU trade) and non-EMU members increased. Interestingly, this figure depicts a relative increase in international trade relative to domestic trade in EMU countries.

[FIGURE 1 ABOUT HERE]

In addition to the main variables of interest that capture the trade effects of the euro, we included dummy variables for other (non-EMU) currency unions and regional trade agreements (EU and non-EU regional trade agreements). Data on currency unions were drawn from Andrew Rose's website. The currency union series on this website was constructed from the IMF's *Schedule of Par Values* and the IMF's *Annual Report on Exchange Rates Arrangements and Exchange Restrictions*, supplemented with information from the *Statesman's Yearbook* available until 2016. Following Glick and Rose (2016), we used a transitive definition of a currency union. If dyads *x-y* and *x-z* are in currency unions, then *y-z* is a currency union. We used Mario Larch's Regional Trade Agreements Database from Egger and Larch (2008) for regional trade agreements.

[21] The list of countries included in the data set are listed in Table A1.

[22] Where the domestic trade difference between total production and total exports was negative (due to accounting in transshipment), we used linear interpolation to complete the data, as in Baier et al. (2019).

4. Empirical results

4.1 Partial equilibrium regressions

We began by estimating gravity equation (1) using annual data pooled over consecutive years. The results are reported in Column 1 of Table 1.[23] We obtained a largely positive and highly significant estimate of the partial trade effect of joining the EMU. The point estimate for the variable that captured the effect when both countries in the pair were EMU members was 0.207. This value suggests that countries joining the EMU increased their intra-EMU trade by 23%, (exp[0.207]-1)*100, at the expense of domestic sales.

EMU membership was also found to lead to greater openness toward non-EMU trading partners. The estimated coefficient was even larger (0.408), in line with the results in previous studies also using intranational trade flows (Larch et al., 2018; Esteve-Pérez et al., 2020a; and Felbermayr and Steininger, 2019). There are several possible explanations of this trade-enhancing effect of EMU with non-EMU countries. First, as suggested by Micco et al. (2003), the adoption of the euro may have prompted openness toward all countries. For example, Baldwin (2006, p. 59) argued that "the euro has acted more like a unilateral trade liberalization than a preferential trade liberalization." Second, the EMU may also have provided member countries with a vehicle to hedge exchange rate risk in their trade transactions with non-member countries. Using the euro as an invoicing currency provides additional stability that may boost trade with non-member countries because trade flows are subject to less exchange-rate volatility. Finally, other possible explanations include efficiency gains derived from larger production scale, greater export experience, growth of global supply chains, and more intermediate goods trade.[24]

[TABLE 1 AROUND HERE]

The use of consecutive-year followed the approach described by Egger et al. (2022). To make the results comparable to those of previous studies, we re-estimated the specification in Column 1 using time-interval data of bilateral trade flows and trade policy variables as a robustness check.[25] Using data at n-year

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[23] In a balanced panel data set with intranational trade flows comprising 69 countries over the period 1986 to 2016, the number of observations should be 147,591. In our data set, 7.4% of the observations were 0 (i.e., no trade flows in an exporter-importer-year). However, the reported number of observations is 147,487 due to singleton observations dropped by the ppmlhdfe estimation command in Stata.

[24] We thank a referee for providing this last set of possible explanations.

[25] For instance, Cheng and Wall (2005), Baier and Bergstrand (2007), Vicard (2009), Eicher and Henn (2011), Kohl (2014), Limão (2016), and Esteve-Pérez *et al.* (2020b) used data at five-year intervals, whereas Dai *et al.* (2014), Bergstrand *et al.* (2015), Anderson and Yotov (2016), and Gil-

intervals addresses the concern raised by Trefler (2004) and Cheng and Wall (2005) regarding the time required for the dependent and independent variables to adjust to trade policy fluctuations.[26] Like Olivero and Yotov (2012), we experimented with alternative time intervals. We considered intervals of two, three, and five years so that we could include both the first and the last year of the sample, thus covering the entire sample period. The results are reported in Columns 2 to 4. Interestingly, in all cases, the results for the estimates of the variables of interest were similar to those reported in Column 1.

The results for the other explanatory variables were broadly consistent with the estimations performed with all available data pooled over consecutive years. Therefore, the trade-enhancing effect of the euro was robust to the use of time-interval data.[27] Finally, with respect to the effect of the EMU reported by Esteve-Pérez *et al.* (2020a) for the period 1986 to 2006, the EMU effect nearly doubled when extending the sample period to include all years until 2016. We now discuss this observation in further detail.

The last column of Table 1 presents the results when the data were pooled over consecutive years but the sample period was divided into two subperiods from 1999 to 2007 and from 2008 to 2016. This division of the sample period confirmed that the EMU's trade-enhancing effect intensified over time.[28] The point estimate

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Pareja *et al.* (2014 and 2016) used intervals of four years. Alternatively, Trefler (2004) used three-year intervals, Olivero and Yotov (2012) experimented with alternative intervals, and Larch *et al.* (2018) and Esteve-Pérez *et al.* (2020a) performed robustness checks with data at two-year intervals.

[26] Some authors (e.g., Glick and Rose, 2016) have estimated the dynamic effects of joining the EMU using leads and lags, finding that the effects increased over time.

[27] We included a dummy variable for EU membership, as well as variables for a linear EU trend and a quadratic EU trend, to account for long-term trends in EU integration. Including these trends is important. As argued by Micco et al. (2003), Berger and Nitsch (2008), Bergin and Lin (2012), and Mika and Zymek (2018), the euro effect may be biased upward if the model does not account for long-term trends in European trade flows as a result of the ongoing economic integration among countries. In fact, the inclusion of these trends reduced the point estimates of the two main variables of interest (both in EMU and one in EMU). Without these trends, the point estimates were substantially larger (and always significant at the 1% level) than those reported in Table 1. This phenomenon was especially notable for the variable that captures the effect when both countries of the pair are EMU members. The estimated coefficients more than doubled with respect to those reported in Table 1. They lay in the interval 0.440 (with data for consecutive years) to 0.478 (with data at five-year intervals) when EU trend terms were not included. Point estimates for EMU trade with non-member countries were also larger than those reported in Table 1, but less so, ranging from 0.469 (for consecutive years) to 0.519 (at five-year intervals).

[28] We also estimated the gravity equation for each year of the EMU period and for each of three equal subperiods of the sample period. The results were consistent with those reported in Column 5 o. When we split the sample period into three equal subperiods (1999–2004, 2005–2010, and 2011–2016), the point estimates (standard errors in parentheses) were 0.109 (0.040), 0.294 (0.044), and

rose from 0.152 in the first subperiod to 0.390 in the second when both countries participated in EMU. Similarly, it rose from 0.300 to 0.528 when only one of the countries in the pair was an EMU member. The second subperiod spans the financial and debt crises of the euro. Despite these crises, the effect of the EMU was larger during the second subperiod than the first for trade between members and trade with non-member countries (relative to internal trade). Our results on the time pattern of the euro's trade effects, both between members and between members and non-members, are in line with those reported by Micco et al. (2003) for the early stage of the adoption of the euro. Our results are also consistent with those of Glick and Rose (2016), who found that the effect of EMU on exports varies depending on the end of the sample period. In their study, ending the sample period in 2005 instead of 2013 substantially reduced the estimated coefficient by more than half, regardless of whether the sample period began in 1948, 1985, or 1995.[29] Micco et al. (2003) indicated that a monetary union can influence trade in many ways (e.g., eliminating exchange rate volatility between EMU members and reducing volatility with non-member countries, reducing uncertainty, lowering transaction costs, increasing market transparency, and fostering competition among firms in different countries). From an economic standpoint, our results on the time pattern of the trade-boosting effect of the euro are relevant. They may be linked to the dynamic adjustment process of trade flows in response to the introduction of the euro. These dynamic effects may arise because firms need time to adjust to the new economic environment created by the common currency. Trade ties are sticky because of the costs of setting up distribution and service networks in the partner country (De Nardis and Vicarelli, 2003). Accordingly, firms that want to take advantage of the reduced costs of a single currency need time to reorganize. It is therefore reasonable to expect the effect of the EMU to increase over time.

The increase in the effect of the EMU on trade over time may also be linked to a major change in EMU institutions between 2008 and 2010. During this time, the European Central Bank (ECB) began to have specific responsibilities such as acting as a lender of last resort (LOLR).[30] The global financial crisis, which started

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0.445 (0.076), respectively, for the variable *BothEMU* and 0.253 (0.024), 0.429 (0.032), and 0.558 (0.044), respectively, for the variable *OneEMU*.

[29] For the two samples starting in 1985 (the year closest to the start of our sample period), Glick and Rose (2016) reported an estimated EMU coefficient of 0.44 (with a standard error of 0.02) when the sample ended in 2013 and an estimated EMU coefficient of 0.18 (0.03) when it ended in 2005.

[30] We thank a referee for raising this point and offering a thoughtful discussion. The role of central banks as LOLRs was first identified more than two centuries ago (Thornton, 1802). It was discussed at length 70 years later by Bagehot (1873), who reported that central banks should clarify that they stand ready to lend freely (i.e., without limit) to solvent but illiquid firms against good collateral at

after the fall of Lehman Brothers, and the sovereign debt crisis, which was especially severe in some European countries, led to changes in sovereign bailout guarantees such as the ECB's Securities Markets Programme (SMP, henceforth),[31] as well as the explicit commitment to save the euro "whatever it takes" (in the words of ECB President Mario Draghi in mid-2012).[32] Despite actions even before the SMP, the ECB President's statement marked the turning point in the upward trend of long-term interest rate spreads against German bonds that started with the 2008 crisis. This announcement and subsequent ECB actions reduced interest rates and spreads. Borrowing costs plunged, and uncertainty decreased in the euro area. This change in the role of the ECB could therefore reasonably have affected the bilateral market-specific investments required for trade between EMU members and between EMU members and non-member countries, given that expectations of trade credit costs and potential exit from the euro influence such investments.

We analyzed whether the "confidence fairy" effect due to changes in institutional insurance from the ECB's actions influenced bilateral trade between member countries and between EMU members and non-member countries. First, we examined whether the fall in EMU countries' long-term interest rate spreads against German 10-year government bonds following Mario Draghi's statement had a greater positive impact on the bilateral trade flows of the EMU members that benefited most from this fall. We re-estimated the gravity equation (1) by dividing the EMU period into two subperiods (1999–2011 and 2012–2016) and adding two interactive variables to the regression. These interactive variables resulted from multiplying the EMU variables (*both in* and *one in*) for the subperiod 2012 to 2016 by a variable that took the value 1 for countries that experienced a larger fall in

a high rate of interest (Tucker, 2014). See Tucker (2014) for a detailed discussion of the role of central banks as LOLRs.

[31] In May 2010, the ECB expanded its monetary policy outright portfolio through secondary market purchases from credit institutions in euro area public and private debt securities markets under the SMP. Subject to that program, the ECB purchased sovereign bonds in the secondary market issued by the distressed euro area member states of Greece, Ireland, Portugal, Italy, and Spain. Between 2010 and 2012, the 10-year government bond spreads versus Germany went up and down repeatedly, but the average spread rose continuously. At the beginning of 2012, weak growth and news of fiscal slippages in several countries strained financial markets once more, leading to a widening in the cost of funding for several stressed euro area countries (Hobelsberger, Kok and Mongelli, 2022).

[32] On 26 July 2012, the ECB President Mario Draghi delivered a speech in London assuring that "Within our mandate, the ECB is ready to do whatever it takes to preserve the euro. And believe me, it will be enough." This speech is widely credited with calming markets. Shortly afterwards, the ECB's Governing Council announced its Outright Monetary Transactions (OMTs) program. This program consisted of purchasing sovereign bonds in secondary markets under strict conditions with the aim of "safeguarding an appropriate monetary policy transmission and the singleness of the monetary policy." The immediate effect of this announcement was to start contracting sovereign bond spreads (Altavilla et al., 2016).

the spread (*i.e.*, EMU countries above the median fall) three years after Draghi's statement. Countries in this group were those that faced financial panic in 2011 and 2012 such as Italy, Portugal, and Spain. However, countries in this group also saw that panic subsided after the ECB's actions. The estimated coefficients of both interactive variables were positive. However, these coefficients were not significant at conventional levels, suggesting that the EMU effect in 2012 to 2016 was no greater in countries with larger falls in spreads (i.e., the countries that benefited the most from the ECB's actions). For brevity, we do not report these results in full.[33]

We also explored the potential ECB-related confidence effects that might have boosted trade considering previous monetary policy actions. We assessed whether the SMP had a pro-trade effect. We re-estimated the gravity equation (1) by dividing the EMU period into two subperiods (1999–2009 and 2010–2016) and adding two interactive variables to the regression. These interactive variables resulted from multiplying the EMU variables for the 2010 to 2016 subperiod by a variable that took the value 1 for Greece, Ireland, Portugal, Italy, and Spain. The estimated coefficients for these interactive terms were negative and significant, suggesting that the EMU effect in that period was smaller for countries that benefited from the SMP than for the rest. For brevity, we do not report these results.[34]

To conclude the partial equilibrium analysis, we analyzed the results for each EMU member. This analysis accounted for the possibility of heterogeneous effects of the euro across member countries. We followed the strategy initially used by Micco *et al.* (2003) by estimating a separate gravity equation for each EMU country. The case of Austria was used to illustrate the procedure. In the regression for Austria (first row of Table 2), we split the EMU dummy (*BothEMU*) into two dummy variables. The first, *BothEMU(Austria)*, was a dummy that took the value

[33] The estimated coefficient for the interactive variable with *Both in EMU2012–2016* was 0.065 (with a standard error of 0.077), and that for the interaction with *One in EMU2012–2016* was 0.008 (0.062). We considered the fall in long-term interest spreads three years after Draghi's statement because the fall in spreads lasted until 2015 in countries such as Cyprus, Ireland, Italy, Portugal, and Spain. However, as a robustness check, we create an interactive dummy that takes the value 1 for countries with a fall in the spread against the German 10-year bond above the median fall one year and two years after Draghi's announcement. In these regressions, the estimated coefficients for the interactive variables were not statistically significant at conventional levels. The results are available from the authors upon request.

[34] We also examined the existence of a potential aggregate effect of monetary policy measures taken to fight the effects of the crisis since 2010 when the SMP was first introduced. We re-estimated the gravity equation (1) by splitting the EMU period into two subperiods (1999–2009 and 2010–2016) and adding two interactive variables to the regression. These interactive variables resulted from multiplying the two EMU variables for the 2010 to 2016 period by the annual average risk premia among EMU countries. We observed a small negative association between risk premia and trade. The results are available from the authors upon request.

1 for bilateral trade between Austria and any other EMU member for the years that both trading partners belonged to the EMU, and 0 otherwise. The second dummy, *BothEMU(-Austria)*, took the value 1 for all other pairs of EMU countries (i.e., excluding Austria) for the years that both partners belonged to the EMU, and 0 otherwise.

Similarly, we split the dummy *OneEMU* into two dummies. The first, *OneEMU(Austria)*, took the value 1 for pairs combining Austria and non-member countries since 1999, and 0 otherwise. The second, *OneEMU(-Austria)*, took the value 1 for pairs between the rest of the EMU countries and non-members from the year in which these euro members joined the EMU, and 0 otherwise. The rest of the regression variables were identical to those in the gravity equation (1).

[TABLE 2 AROUND HERE]

For the sake of brevity, we only report the estimated coefficients for the two main parameters of interest for each country. Following the example of Austria, we only report the estimated coefficients of the variables *BothEMU(Austria)* and *OneEMU(Austria)*. Columns 1 and 2 of Table 2 display the results using data pooled over consecutive years. The estimates indicate the existence of large differences in the effect of EMU on trade across member countries, in line with the findings in Esteve-Pérez *et al.* (2020a). However, in the present study, updating the sample period led to an increase in the number of countries where the euro had a positive impact on trade. Whereas Esteve-Pérez *et al.* (2020a) observed a positive and significant effect for Austria, Belgium-Luxembourg, Ireland, Portugal, and Spain, we also observed a trade-enhancing effect of the euro in France, Germany, and The Netherlands (three founding members of the EU) when both trade partners were EMU members. The negative and significant impact found for Greece for the period 1986 to 2006 vanished when the sample period was extended. Regarding trade with non-member countries, the effect was positive and significant, at least at the 5% level, in all cases except Finland, Greece, and Portugal. The remaining columns of Table 2 confirm the robustness of the results using data at time intervals of two, three, and five years.

4.2 General equilibrium experiments

This section presents the results of general equilibrium analysis for three counterfactual experiments. This analysis addressed three important questions. First, we assessed the overall welfare effect of the adoption of the euro on its member countries. Second, we examined whether gains from trade differed across countries by analyzing whether they differed for core and non-core EMU member countries.[35] Third, we further measured gains for EMU member countries by considering the effects of the creation of trade with countries outside the euro area.

Before discussing the results, a practical comment should be made. As noted earlier, the multilateral resistance terms were normalized by setting the multilateral resistance term of a given country to 1. Anderson *et al.* (2018) suggested two alternative strategies for choosing the country for the normalization procedure: (i) the country with the most reliable data and (ii) a country that presumably would be only slightly affected by the counterfactual shock. In line with the first strategy, we set the inward multilateral resistance for the United States to 1. In line with the second, we checked the robustness of the results by choosing Australia as the reference country.[36] The results did not change meaningfully.

Table 3 reports the results of the first counterfactual experiment (CFL1) estimating the GE effects of the euro. The columns report the percentage difference between the baseline values (with the euro) and the counterfactual scenario (without the euro) for each country in the sample.

[TABLE 3 AROUND HERE]

Column 1 of Table 3 suggests that, under the conditional GE scenario, all countries in the sample would have experienced a drop in exports in this alternative world (i.e., without the euro). EMU member countries experienced the largest fall in exports, ranging from -21% to -11% of total exports. These results suggest that the introduction of the EMU had a considerable trade creation effect both within the EMU and between EMU and non-EMU members.

A similar pattern was observed for the full endowment case reported in Column 2, although with some differences. The full endowment GE effects were slightly larger (in absolute value), suggesting that producers would have captured some EMU trade-induced gains via higher prices. The results of the change in real GDP reported in Column 3 suggest sizable welfare effects of the EMU. The welfare

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[35] The core–periphery distinction is especially relevant for monetary policy. The country categorization used in this paper of core and periphery EMU countries was central to the European integration debate in the run-up to the formation of the EMU. Motivated by optimum currency area theory, some authors advocated a two-speed euro, with countries identified as peripheral starting later or even remaining outside. Other ways of categorizing countries might also affect the results. For example, Glick (2017) distinguished between early and late joiners of both the EU and the EMU. In case of the EMU, trade among old members rose by about 40%, while the effect for late joiners (i.e., post 2001) was null after controlling for their membership in the EU.

[36] These results are not reported for brevity. They are available from the authors upon request.

effects on real GDP in EMU countries ranged from 2% in Germany to 6% in Cyprus. In line with the theoretical predictions, smaller countries seemed to have benefited more from economic integration than larger countries. The correlation between the percentage change in the output from the counterfactual and the log GDP was 0.81. All other countries in this world would have seen their GDP fall by less than 1 percentage point.

Our results were several orders of magnitude higher than those reported by Felbermayr and Steininger (2019), who observed a decrease of 0.6% in Germany's real GDP. Interestingly, our results were closer to those in the cited study when we omitted the variable *OneEMU* from the baseline and counterfactual analysis, which led to a drop in Germany's GDP of approximately 1%. Using the cross-sectional estimate of the effect of the EMU slightly reduced the fall in GDP. Therefore, our results highlight the relevance of considering the dynamics and trade creation/deviation effects. These effects are discussed in detail with the results of the third counterfactual analysis (CFL3).

Columns 4 to 6 of Table 3 quantify the distributional effects of the EMU, distinguishing between consumers and producers. As expected, without the euro, countries would have faced higher inward multilateral resistances (IMRs), as shown in Column 4, translating into higher consumer prices. Countries would have also faced higher outward multilateral resistances (OMRs), as shown in Column 5, which would have translated into lower factory-gate prices for producers relative to the effects on consumers in the reference country (the United States). The combined effect of lower prices for producers and higher prices for consumers suggests that both would have been substantially worse off without adopting the euro.

Figure 2 summarizes our main findings graphically. It displays the average change for the world, EMU members, and non-euro EU members for the variables of interest. Panel a of Figure 2 depicts the scatter plot of the full endowment export growth shown in Column 2 in Table 3. The green squares represent EMU member countries, the red circles represent non-EMU countries, and the solid points represent EU members within these two categories. All countries lie below the 0 line, indicating that all countries would have had lower exports without the EMU, particularly because the global average export fall was -8.37%.[37] Furthermore, all EMU countries are clustered in the bottom-left area of the figure, indicating the higher gains from the EMU for members. The fall of their exports (-18.06%) was more than triple the rest-of-world average fall (-5.23%). Notably, for non-EMU EU countries, represented by the solid red circles, exports also fell substantially.

[37] These averages were calculated as the geometric mean of the changes for individual countries in each group, as a conservative way of calculating average percentages.

Countries in this group are among the non-EMU countries with the highest expected export loss (-10.04%).

[FIGURE 2 AROUND HERE]

The pattern described in Panel a of Figure 2 for exports is qualitatively similar to that for the rest of the variables of interest. The trade-induced GE gains due to the EMU differed across country groups. From highest to lowest gains, the ranking is as follows: EMU members, non-EMU EU members, and rest of the world. However, there are some quantitative differences. Panel b displays changes in real GDP. The overall impact of the euro was sizable. A world without the EMU would have meant a 1.02% lower world GDP. As expected, the EMU members would have been the most affected, given that they experienced the highest negative impact in our counterfactual (-4.15%). The following example illustrates the relevance of this result. Considering that the euro area's GDP growth was 1.9% in 2016, the non-existence of the EMU would have eliminated more than two years of total growth. Equivalently, the average yearly growth rate lost would have been approximately 0.25%. The real GDP variation for non-EMU EU members was -0.48%, more than double the real GDP change for the rest of the world (-0.21%).

The bottom panels of Figure 2 summarize the distributional effects for consumers (Panel c) and producers (Panel d). According to our results, the initial claims of the pro-inflationary effects of the adoption of the euro were overstated. Without the euro, consumer prices would have been 2.09% higher in the EMU and 0.11% higher in non-EMU EU member states. Therefore, the euro significantly reduced inflation for members due to cheaper imports. The effect on consumer prices in the rest of the world was practically null, suggesting that their income increase came from the supply side.

The change in producer prices shown in the bottom right part of Figure 2 (Panel d) was sizable. Without the EMU-induced export growth, producers would have sold their products domestically at lower prices (-2.14%). This effect was -0.37% for non-EMU EU member states. The level of change in producer prices was similar to the level of change in consumer prices, suggesting that consumers' and producers' gains from the EMU were relatively similar.

The results of the second counterfactual (CFL2) reported in Table 4 may cast some doubt on the EMU integration process. Interestingly, only the core countries experienced a fall in GDP. The summary of the results for CFL2 in Figure 3 can help with the interpretation of these findings by showing the clubbing effect of the EMU graphically. As seen in Panel a of Figure 3, the exports of peripheral EMU countries would have been most affected by paying with drachmas, pesetas, and liras. The other non-EMU EU members would have also experienced a large drop in exports. However, the core EMU members would have increased their exports by between 30% and 40%. The increase in the peripheral EMU GDP, 1.21%, reveals that the gain was higher in the peripheral countries and could ideally have compensated for the loss in the core countries. Furthermore, the increase in the real GDP of non-EMU EU countries was 0.57%, whereas the overall GDP increase for the EU was 0.33%. Therefore, these results suggest that, with an appropriate compensation scheme, the *two-speed* euro may be justified from a trade perspective.

[TABLE 4 AND FIGURE 3 AROUND HERE]

The bottom panels of Figure 3 shed some light on the political-economy mechanisms that prevented the creation of a *two-speed* euro. First, as shown in Panel c, consumers in all EMU members (except for Ireland) enjoyed lower prices. Second, whereas peripheral producers had higher prices than core producers, core manufacturers experienced a drop in factory-gate prices. Trade diversion from peripheral EMU members might explain this situation. Core EMU producers would have had incentives to support a two-speed euro. However, consumers in core EMU countries would have lost out due to higher prices. Therefore, the lobbying power of peripheral producers and tax-payers' reluctance to transfer rents to manufacturers in core EMU countries would have prevented this alternative timeline of higher overall growth.

[TABLE 5 AND FIGURE 4 AROUND HERE]

As highlighted in the results in Table 5 for the EMU in the third counterfactual (CFL3), trade creation effects outside the EMU dominated the GE effects of the EMU. CFL1 showed -18.06% lower exports for EMU members overall, as reflected in Panel a of Figure 2. This percentage was explained by a loss in both within- and outside-EMU exports of EMU member countries. Panel a in Figure 4 reveals that most EMU-led export growth came from trade creation outside the EMU of -14.06%. A similar result was observed for GDP growth and consumer and producer prices. For example, the GDP loss related to EMU trade creation was -3.34%, while the overall effect in CFL1 was -4.15%.

The results of this third experiment suggest that the growth effects of the EMU were mainly driven by common exchange rate stability and macroeconomic predictability rather than the cohesiveness of the euro area as an optimum currency area, in line with the arguments of Lane (2006). This result echoes previous evidence suggesting that real exchange rate uncertainty negatively affects export growth (Grier et al., 2007). The argument is that the primary driver of the welfare increase associated with the EMU is not a reduction of trade costs within the euro area but rather trade creation with non-member countries. The strict Maastricht criteria to join the euro, which impose fiscal and macroeconomic discipline on EMU members, signal institutional commitment. Our results are compatible with the interpretation that this signal to the rest of the world has had significant welfare-enhancing effects.

5. Conclusions

This paper examines the effect of the euro on trade using structural gravity. It also examines trade-induced welfare effects using the general equilibrium framework of GEPPML. The paper provides policy-relevant insights into the euro's effect on trade and welfare. The analysis uses a new data set covering the period 1986 to 2016, extending the data set used by Zylkin. The structural gravity estimates reveal that the effect of the euro on trade was more intense in the most recent decade, despite the trade collapse of 2009. The GE analysis uncovers several interesting findings regarding welfare analysis and the effects of the EMU. Methodologically, the results suggest that trade creation/deviation and reduced-form dynamics are essential to quantify the trade-induced effects of economic integration on welfare.

Our results have some policy implications. For instance, this study indicates that the euro has promoted economic growth and has had positive welfare effects on consumers and producers within and outside the euro area. The main policy implication is that the euro has been successful in exports and economic growth, inside and outside the euro area. However, the analysis indicates that a more optimal design or phasing of the euro, such as the two-speed euro, would have led to higher growth. Nevertheless, critical differences in the effect to consumers and producers within countries (i.e., distributional effects) might have triggered political and economic forces that would have prevented this scenario. Finally, trade creation outside the EMU appears to be the primary driver of the GE euro effects. However, the question of whether the euro is effective at creating cohesive European economic integration requires further research.

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Appendix A

The underlying theoretical model consists of N different trading partners, each producing a variety of differentiated goods by place of origin, following the approach of Armington (1969). Consumer preferences are assumed to follow a constant elasticity of substitution (CES) utility function with a common elasticity of substitution σ and a CES preference parameter $\gamma > 0$. The budget constraint of utility maximization is $\sum_i p_{ij}\, c_{ij} = E_j$, where p_{ij} denotes prices of goods paid by consumers in country *j* for goods imported from country *i*, c_{ij} is the quantity consumed in country *j* from country *i*, and E_j is the total expenditure in country *j*. From this setup, it can be demonstrated that the following trade equation holds:

$$X_{ij} = \left(\frac{\gamma_i p_{ij}}{P_j}\right)^{1-\sigma} E_j$$

where X are the trade flows (value of goods from country *i* consumed in *j*), and P_j is the CES consumer price index given by $P_j = \left[\sum_i \left(\gamma_i p_{ij}\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$.

Assuming that each country is endowed with a fixed amount of Q_i, the total nominal income in country *i* is represented by $Y_i = p_i Q_i$, where p_i is producer price (or factory-gate price). Producer and consumer prices are linked by transfer prices of $p_{ij} = t_{ij} p_i$, where $t_{ij} \geq 1$ are iceberg transport costs.

Imposing the market clearing condition, total production is equal to total consumption $Y_i = \sum_j X_{ij}$. Using the expression for X_{ij}, we can solve for $\gamma_i p_i$, obtaining the following system of equations:

$$X_{ij} = \left(\frac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma} Y_i E_j$$

$$P_j^{1-\sigma} = \sum_i \left(\frac{t_{ij}}{\Pi_i}\right)^{1-\sigma} Y_i$$

$$\Pi_i^{1-\sigma} = \sum_j \left(\frac{t_{ij}}{P_j}\right)^{1-\sigma} E_j$$

$$p_j = \frac{Y_j^{\frac{1}{1-\sigma}}}{\gamma_j \Pi_j}.$$

The GEPPML procedure of Anderson et al. (2018) relies on this system of equations and the following useful property of PPML described by Fally (2015): PPML estimates of the gravity equation with fixed effects are perfectly consistent with the multilateral resistance terms $P_j^{1-\sigma}$ and $\Pi_i^{1-\sigma}$. By dropping the fixed effect for one importer and the constant in the gravity equation estimation, the multilateral resistance terms can be computed from the fixed effects as follows:

$$\widetilde{\Pi_i^{1-\sigma}} = E_0 Y_i\, exp(-\widetilde{\pi_i})$$

and

$$\widetilde{P_j^{1-\sigma}} = \frac{E_j}{E_0} exp\left(-\widetilde{\chi_j}\right)$$

where $\widetilde{\pi_i}$ and $\widetilde{\chi_j}$ are the estimated fixed effects from the gravity equation X_{ij}, and E_0 is the numéraire expenditure.

The GEPPML counterfactuals operate by changing the trade cost vectors and obtaining counterfactual values for trade flows, $\widetilde{X_{ij}^c}$, output, $Y_i^c = (p_i^c/p_i)Y_i$, and expenditures, $E_i^c = (p_i^c/p_i)E_i$. We report results as the percentage changes between baseline and counterfactual values: $Output\% = (Y_i^c - Y_i)/Y_i \times 100$. As in Anderson et al (2018), we assume a value of 7 for the elasticity of substitution.

These counterfactuals are inherently static as they operate on a cross-section of the data. As discussed in the main text, we partially resolve this limitation by estimating the parameters of the cost vector on a panel. However, the GEPPML procedure does not incorporate the elements of a fully dynamic model (e.g., Olivero & Yotov, 2012).

Table 1. EMU effect on trade: PPML using intranational trade. Sample period 1986–2016

	(1) Consecutive years	(2) 2-year intervals	(3) 3-year intervals	(4) 5-year intervals	(5) Consecutive years
Both in EMU	0.207	0.206	0.195	0.238	
	(0.045)***	(0.045)***	(0.047)***	(0.047)***	
One in EMU	0.408	0.411	0.406	0.457	
	(0.032)***	(0.032)***	(0.034)***	(0.033)***	
Both in EMU 1999-2007					0.152
					(0.038)***
Both in EMU 2008-2016					0.390
					(0.063)***
One in EMU 1999-2007					0.300
					(0.025)***
One in EMU 2000-2016					0.528
					(0.041)***
All non-EMU CUs	0.168	0.172	0.231	0.045	0.155
	(0.108)	(0.107)	(0.094)**	(0.115)	(0.113)
EU	0.721	0.685	0.749	0.817	0.679
	(0.104)***	(0.103)***	(0.106)***	(0.102)***	(0.103)***
All non-EU RTAs	0.451	0.442	0.450	0.473	0.447
	(0.069)***	(0.069)***	(0.072)***	(0.073)***	(0.069)***
EU trend	0.001	0.002	0.008	0.003	0.015
	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)**
EU trend squared	0.000	0.000	0.000	0.000	0.000
	(0.000)**	(0.000)**	(0.000)	(0.000)**	(0.000)
Number of observations	147487	76042	52234	33198	147487

Notes: Robust standard errors clustered by dyad are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the value of bilateral exports, measured by dyad-year. All regressions include country-pair fixed effects, and exporter- and importer-year fixed effects. Fixed effects are not reported for brevity. The data set includes balanced (annual) panel data covering the aggregate manufacturing sector across 69 countries over the period 1986–2016.

Table 2. EMU effect by country: main results. Sample period 1986–2016

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Consecutive years		2-year intervals		3-year intervals		5-year intervals	
	Both in EMU	One in EMU	Both in EMU	One in EMU	Both in EMU	One in EMU	Both in EMU	One in EMU
Austria	0.187	0.481	0.192	0.486	0.216	0.494	0.288	0.596
	(0.051)***	(0.081)***	(0.052)***	(0.083)***	(0.051)***	(0.085)***	(0.051)***	(0.085)***
Belgium	0.358	0.603	0.356	0.609	0.264	0.501	0.292	0.581
	(0.055)***	(0.051)***	(0.055)***	(0.052)***	(0.059)***	(0.056)***	(0.059)***	(0.055)***
Finland	-0.081	-0.009	-0.087	-0.005	-0.085	-0.021	-0.026	0.017
	(0.055)	(0.083)	(0.058)	(0.083)	(0.062)	(0.082)	(0.060)	(0.082)
France	0.171	0.338	0.175	0.348	0.150	0.333	0.208	0.397
	(0.055)***	(0.050)***	(0.055)***	(0.051)***	(0.055)***	(0.056)***	(0.056)***	(0.046)***
Germany	0.198	0.443	0.193	0.443	0.195	0.448	0.231	0.493
	(0.052)***	(0.055)***	(0.052)***	(0.055)***	(0.055)***	(0.057)***	(0.053)***	(0.057)***
Greece	-0.123	0.075	-0.102	0.075	-0.132	0.135	-0.081	0.096
	(0.098)	(0.072)	(0.100)	(0.073)	(0.100)	(0.088)	(0.109)	(0.097)
Ireland	0.348	0.371	0.304	0.343	0.226	0.288	0.367	0.403
	(0.162)**	(0.171)**	(0.166)*	(0.171)**	(0.147)	(0.172)*	(0.147)**	(0.191)**
Italy	-0.017	0.172	-0.012	0.181	-0.004	0.184	0.029	0.212
	(0.054)	(0.056)***	(0.054)	(0.057)***	(0.055)	(0.057)***	(0.055)	(0.057)***
Netherlands	0.375	0.668	0.367	0.662	0.467	0.776	0.413	0.751
	(0.049)***	(0.071)***	(0.049)***	(0.072)***	(0.051)***	(0.074)***	(0.051)***	(0.077)***
Portugal	0.245	0.116	0.256	0.152	0.210	0.111	0.354	0.264
	(0.100)**	(0.094)	(0.101)**	(0.088)*	(0.102)**	(0.092)	(0.105)***	(0.090)***
Spain	0.384	0.515	0.378	0.507	0.373	0.509	0.454	0.583
	(0.055)***	(0.065)***	(0.056)***	(0.065)***	(0.056)***	(0.067)***	(0.059)***	(0.068)***
Malta	0.296	0.444	0.180	0.402	0.222	0.328	0.301	0.426
	(0.342)	(0.208)**	(0.274)	(0.179)**	(0.345)	(0.212)	(0.313)	(0.191)**
Cyprus	1.121	0.521	1.265	0.597	0.950	0.446	1.331	0.581
	(0.150)***	(0.102)***	(0.165)***	(0.113)***	(0.162)***	(0.116)***	(0.203)***	(0.128)***
Number of observations	147,487		76,042		52,234		33,198	

Notes: Robust standard errors clustered by dyad are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The estimates reported in each column are obtained from separate regressions (one for each row) for each EMU member country. The dependent variable in each regression is the value of bilateral exports, measured by dyad-year. The list of independent variables in each regression includes, in addition to two dummies to capture the euro effect for that particular country (Both in EMU and One in EMU), two dummies for the euro effect in other countries in each case, a dummy for the EU, a linear EU trend, a quadratic EMU trend, a dummy for other regional trade agreements, a dummy for other currency unions, and dummies for exporter- and importer-year fixed effects and country-pair fixed effects. For brevity and clarity, we only report the EMU estimates for each country. The estimates of the coefficients of all other covariates are available upon request.

Table 3: Counterfactual CF1: No EURO

	Conditional GE	Full endowment general equilibrium				
Country	% Δ exports	%Δ exports	%Δ real GDP	%Δ IMR	%Δ OMR	%Δ Factory-gate price
Cyprus	-12.63	-14.90	-6.42	3.38	3.94	-3.26
Malta	-19.27	-20.20	-5.58	3.92	2.24	-1.88
Austria	-13.64	-14.98	-5.47	3.01	3.15	-2.62
Portugal	-15.09	-16.33	-5.27	2.98	2.92	-2.44
Greece	-19.60	-20.61	-4.99	3.11	2.44	-2.04
Finland	-20.99	-21.83	-4.09	2.34	2.21	-1.85
Netherlands	-14.67	-15.70	-4.04	1.91	2.63	-2.20
France	-17.98	-18.80	-3.65	2.00	2.04	-1.72
Spain	-19.27	-20.01	-3.27	1.68	1.95	-1.64
Ireland	-15.72	-16.99	-3.14	0.49	3.20	-2.67
Belgium-Luxembourg	-16.61	-17.45	-3.05	1.40	2.01	-1.69
Italy	-19.07	-19.81	-2.67	1.00	2.02	-1.70
Germany	-15.93	-16.78	-2.16	0.08	2.48	-2.08
Tunisia	-8.36	-8.81	-0.80	0.28	0.60	-0.52
Switzerland	-13.85	-14.52	-0.71	-0.05	0.90	-0.77
Denmark	-10.90	-11.45	-0.68	0.12	0.66	-0.56
Niger	-4.91	-5.30	-0.64	0.21	0.50	-0.43
Iceland	-6.42	-6.80	-0.60	0.20	0.47	-0.40
Bulgaria	-6.75	-7.14	-0.55	0.16	0.46	-0.39
Hungary	-9.02	-9.48	-0.52	0.10	0.49	-0.42
Poland	-11.08	-11.61	-0.51	0.07	0.52	-0.44
Morocco	-7.65	-8.09	-0.49	0.01	0.57	-0.49
Senegal	-5.98	-6.30	-0.49	0.20	0.34	-0.29
Norway	-8.01	-8.45	-0.48	0.05	0.50	-0.43
Romania	-7.45	-7.86	-0.46	0.10	0.42	-0.36
Cameroon	-5.17	-5.52	-0.45	0.10	0.41	-0.35
Tanzania	-4.53	-4.86	-0.45	0.12	0.39	-0.33
Sweden	-8.65	-9.10	-0.38	0.06	0.38	-0.33
Jordan	-5.82	-6.17	-0.36	0.10	0.31	-0.26
Egypt	-6.62	-7.00	-0.32	0.07	0.30	-0.26
Kenya, Rep. of	-5.04	-5.36	-0.30	0.06	0.28	-0.24

Mauritius	-4.72	-5.03	-0.29	0.05	0.28	-0.24
Bolivia	-3.17	-3.43	-0.28	0.06	0.26	-0.22
United Kingdom	-12.88	-13.50	-0.25	0.16	0.10	-0.09
Turkey	-7.86	-8.30	-0.25	0.03	0.26	-0.22
Nepal	-2.49	-2.77	-0.24	-0.02	0.31	-0.27
Panama	-4.19	-4.45	-0.24	0.09	0.17	-0.14
Nigeria	-6.23	-6.60	-0.23	0.03	0.23	-0.20
Israel	-6.45	-6.84	-0.21	0.01	0.23	-0.20
Sri Lanka	-3.61	-3.90	-0.20	-0.02	0.26	-0.22
Uruguay	-3.61	-3.88	-0.19	0.02	0.20	-0.17
Ecuador	-3.95	-4.22	-0.18	0.03	0.18	-0.16
Costa Rica	-3.69	-3.95	-0.17	-0.00	0.21	-0.18
South Africa	-5.42	-5.78	-0.17	-0.02	0.23	-0.19
Colombia	-3.97	-4.24	-0.16	0.03	0.16	-0.14
Trinidad and Tobago	-4.71	-5.03	-0.15	-0.03	0.22	-0.18
Chile	-4.37	-4.67	-0.15	-0.00	0.17	-0.15
Qatar	-4.96	-5.32	-0.14	-0.11	0.29	-0.25
Iran	-5.58	-5.96	-0.14	-0.04	0.21	-0.18
Kuwait	-5.89	-6.28	-0.13	0.01	0.15	-0.13
Myanmar	-2.20	-2.45	-0.13	-0.08	0.25	-0.21
Canada	-3.03	-3.24	-0.12	0.02	0.11	-0.10
Philippines	-2.90	-3.17	-0.10	-0.08	0.22	-0.19
Mexico	-2.90	-3.12	-0.10	0.01	0.10	-0.09
Brazil	-5.01	-5.37	-0.08	-0.04	0.15	-0.13
Indonesia	-3.16	-3.44	-0.08	-0.09	0.20	-0.17
Malaysia	-2.62	-2.88	-0.08	-0.09	0.20	-0.17
India	-3.66	-3.98	-0.08	-0.10	0.21	-0.18
Australia	-3.80	-4.11	-0.07	-0.05	0.14	-0.12
Thailand	-3.02	-3.31	-0.06	-0.11	0.20	-0.17
Korea	-2.94	-3.25	-0.04	-0.16	0.23	-0.19
United States	-5.35	-5.77	-0.04	0.00	0.04	-0.04

Japan	-3.38	-3.71	-0.03	-0.15	0.21	-0.18
China	-3.56	-3.92	-0.02	-0.16	0.20	-0.17
Singapore	-3.42	-3.77	-0.01	-0.04	0.07	-0.06
Hong Kong (China)	-2.89	-3.21	-0.01	-0.07	0.09	-0.08
Malawi	-4.19	-7.91	0.61	-0.41	-0.23	0.20

Notes: See Table A1 for the list of countries. IMR and OMR stand for inward and outward multilateral resistance, respectively.

Table 4: Counterfactual CF2: EURO only CORE

	Conditional GE	Full endowment general equilibrium				
Country	% Δ exports	%Δ exports	%Δ real GDP	%Δ IMR	%Δ OMR	%Δ Factory-gate price
Netherlands	34.22	30.46	-2.41	-2.99	6.60	-5.33
Austria	41.48	36.72	-2.30	-2.92	6.37	-5.15
Belgium-Luxembourg	31.82	28.82	-1.89	-3.31	6.34	-5.13
France	39.58	36.33	-1.61	-3.33	6.01	-4.88
Germany	36.35	33.50	-0.99	-4.12	6.26	-5.07
Finland	37.77	33.77	-0.94	-3.71	5.68	-4.62
Hong Kong (China)	-2.70	-2.88	0.02	0.10	-0.14	0.12
Singapore	-3.36	-3.61	0.02	0.07	-0.11	0.09
China	-5.19	-5.52	0.02	0.22	-0.28	0.24
Japan	-4.84	-5.10	0.04	0.20	-0.28	0.24
Korea	-4.46	-4.62	0.05	0.20	-0.29	0.25
United States	-5.41	-5.86	0.05	0.00	-0.06	0.05
Thailand	-4.37	-4.52	0.08	0.14	-0.25	0.22
India	-5.06	-5.25	0.10	0.12	-0.26	0.22
Australia	-4.63	-4.86	0.10	0.05	-0.18	0.15
Malaysia	-3.99	-4.06	0.10	0.10	-0.24	0.20
Indonesia	-4.49	-4.62	0.11	0.10	-0.24	0.20
Brazil	-6.22	-6.57	0.11	0.04	-0.18	0.15
Philippines	-4.33	-4.39	0.13	0.09	-0.25	0.22
Mexico	-3.78	-3.94	0.13	-0.03	-0.11	0.10
Canada	-4.02	-4.17	0.15	-0.05	-0.12	0.10
Myanmar	-3.90	-3.83	0.15	0.09	-0.28	0.24
Qatar	-7.48	-7.68	0.17	0.11	-0.32	0.28
Iran	-7.19	-7.51	0.17	0.02	-0.23	0.20
Kuwait	-6.76	-7.13	0.18	-0.05	-0.15	0.13
Trinidad and Tobago	-6.60	-6.81	0.19	0.01	-0.23	0.20

Chile	-5.75	-5.96	0.19	-0.03	-0.18	0.16
Costa Rica	-5.59	-5.68	0.21	-0.03	-0.21	0.18
Colombia	-5.34	-5.51	0.21	-0.07	-0.16	0.14
South Africa	-7.22	-7.48	0.22	-0.01	-0.24	0.21
Ecuador	-5.51	-5.65	0.23	-0.07	-0.19	0.16
Sri Lanka	-5.61	-5.63	0.23	0.00	-0.27	0.24
Uruguay	-5.35	-5.44	0.24	-0.06	-0.21	0.18
Nepal	-5.00	-4.81	0.27	0.02	-0.33	0.28
Israel	-8.46	-8.77	0.27	-0.07	-0.23	0.20
Nigeria	-8.05	-8.31	0.30	-0.10	-0.23	0.20
Panama	-5.60	-5.74	0.30	-0.17	-0.16	0.14
United Kingdom	-11.56	-12.47	0.31	-0.30	-0.01	0.01
Turkey	-10.16	-10.52	0.33	-0.10	-0.27	0.23
Bolivia	-5.62	-5.55	0.33	-0.11	-0.26	0.22
Mauritius	-6.99	-7.06	0.35	-0.11	-0.27	0.23
Kenya, Rep. of	-7.44	-7.51	0.36	-0.12	-0.28	0.24
Sweden	-11.28	-11.62	0.38	-0.13	-0.28	0.24
Egypt	-9.22	-9.41	0.41	-0.15	-0.29	0.25
Poland	-13.30	-13.79	0.43	-0.22	-0.25	0.21
Norway	-11.91	-11.99	0.45	-0.13	-0.37	0.32
Jordan	-8.62	-8.71	0.45	-0.20	-0.29	0.25
Denmark	-13.96	-14.25	0.50	-0.27	-0.27	0.23
Tanzania	-8.18	-8.02	0.52	-0.19	-0.38	0.32
Romania	-10.93	-11.03	0.52	-0.20	-0.36	0.31
Cameroon	-9.11	-8.96	0.53	-0.18	-0.40	0.34
Hungary	-12.87	-12.97	0.57	-0.21	-0.42	0.36
Morocco	-13.15	-12.98	0.57	-0.06	-0.60	0.52
Senegal	-8.92	-8.92	0.60	-0.33	-0.32	0.27
Switzerland	-18.68	-18.89	0.60	-0.07	-0.62	0.53
Iceland	-10.50	-10.35	0.65	-0.30	-0.40	0.34
Bulgaria	-11.37	-11.27	0.66	-0.27	-0.45	0.39
Niger	-9.99	-9.62	0.73	-0.31	-0.49	0.42
Italy	-20.58	-21.09	0.74	0.02	-0.88	0.76

Spain	-21.02	-21.37	0.95	-0.17	-0.90	0.78
Tunisia	-13.77	-13.54	0.96	-0.45	-0.58	0.50
Ireland	-27.75	-27.51	1.18	0.40	-1.82	1.58
Malawi	-8.79	-11.46	1.75	-0.78	-1.10	0.95
Portugal	-24.05	-23.87	1.92	-0.76	-1.32	1.15
Malta	-23.44	-23.40	2.27	-1.38	-0.99	0.86
Greece	-26.19	-26.00	2.42	-1.24	-1.33	1.15
Cyprus	-31.46	-30.44	3.63	-1.51	-2.35	2.06

Note: See Table A1 for the list of countries. IMR and OMR stand for inward and outward multilateral resistance, respectively.

Table 5: Counterfactual CF3: No EURO ONE

	Conditional GE	Full endowment general equilibrium				
Country	% Δ exports	%Δ exports	%Δ real GDP	%Δ IMR	%Δ OMR	%Δ Factory-gate price
Cyprus	-11.58	-13.61	-5.41	2.72	3.42	-2.84
Malta	-15.56	-16.48	-4.54	2.98	2.01	-1.69
Austria	-9.00	-10.27	-4.26	2.15	2.64	-2.20
Portugal	-11.47	-12.65	-4.20	2.21	2.49	-2.08
Greece	-16.95	-17.93	-4.17	2.43	2.19	-1.84
Finland	-18.40	-19.22	-3.45	1.83	2.00	-1.68
Netherlands	-8.58	-9.60	-3.09	1.27	2.21	-1.86
France	-11.99	-12.82	-2.83	1.36	1.79	-1.51
Spain	-14.93	-15.67	-2.62	1.20	1.72	-1.45
Ireland	-13.69	-14.85	-2.59	0.31	2.74	-2.29
Belgium-Luxembourg	-9.84	-10.69	-2.32	0.88	1.74	-1.47
Italy	-14.99	-15.72	-2.15	0.69	1.75	-1.47
Germany	-11.88	-12.70	-1.72	-0.01	2.05	-1.72
Tunisia	-8.57	-9.06	-0.93	0.34	0.70	-0.60
Switzerland	-14.31	-14.98	-0.82	-0.05	1.03	-0.87
Denmark	-11.30	-11.83	-0.77	0.18	0.70	-0.59
Niger	-4.93	-5.38	-0.75	0.25	0.59	-0.50
Iceland	-6.58	-6.99	-0.71	0.24	0.54	-0.46
Bulgaria	-6.93	-7.35	-0.65	0.19	0.54	-0.46
Hungary	-9.39	-9.85	-0.63	0.14	0.58	-0.49
Poland	-11.55	-12.06	-0.59	0.12	0.55	-0.47
Senegal	-6.19	-6.53	-0.58	0.25	0.39	-0.33
Morocco	-7.82	-8.30	-0.58	0.00	0.67	-0.57
Norway	-8.26	-8.71	-0.56	0.07	0.57	-0.49
Romania	-7.72	-8.14	-0.54	0.13	0.48	-0.41
Cameroon	-5.28	-5.66	-0.53	0.13	0.48	-0.41
Tanzania	-4.61	-4.97	-0.53	0.14	0.45	-0.39
Sweden	-9.02	-9.45	-0.45	0.08	0.44	-0.37
Jordan	-6.04	-6.40	-0.43	0.13	0.36	-0.31
Egypt	-6.90	-7.27	-0.39	0.09	0.35	-0.30
Kenya, Rep. of	-5.23	-5.55	-0.35	0.07	0.33	-0.28

Mauritius	-4.89	-5.21	-0.34	0.06	0.32	-0.28
Bolivia	-3.23	-3.51	-0.33	0.08	0.30	-0.26
United Kingdom	-13.75	-14.30	-0.29	0.21	0.09	-0.08
Turkey	-8.26	-8.68	-0.29	0.04	0.30	-0.26
Nepal	-2.51	-2.82	-0.28	-0.03	0.37	-0.31
Panama	-4.38	-4.64	-0.28	0.12	0.20	-0.17
Nigeria	-6.53	-6.88	-0.28	0.04	0.27	-0.23
Israel	-6.75	-7.13	-0.25	0.02	0.27	-0.23
Sri Lanka	-3.73	-4.03	-0.24	-0.03	0.31	-0.26
Uruguay	-3.75	-4.02	-0.23	0.03	0.24	-0.20
Ecuador	-4.12	-4.39	-0.22	0.04	0.21	-0.18
Costa Rica	-3.82	-4.08	-0.21	0.00	0.24	-0.20
South Africa	-5.67	-6.01	-0.20	-0.02	0.27	-0.23
Colombia	-4.15	-4.42	-0.20	0.04	0.19	-0.16
Trinidad and Tobago	-4.90	-5.21	-0.18	-0.03	0.25	-0.22
Chile	-4.58	-4.87	-0.18	0.00	0.20	-0.17
Qatar	-5.13	-5.49	-0.17	-0.13	0.35	-0.30
Iran	-5.85	-6.21	-0.16	-0.05	0.25	-0.21
Kuwait	-6.22	-6.59	-0.16	0.01	0.17	-0.15
Myanmar	-2.24	-2.52	-0.16	-0.10	0.30	-0.25
Canada	-3.17	-3.38	-0.14	0.03	0.13	-0.11
Philippines	-3.00	-3.28	-0.12	-0.10	0.26	-0.22
Mexico	-3.05	-3.26	-0.11	0.01	0.12	-0.10
Brazil	-5.26	-5.60	-0.10	-0.05	0.18	-0.15
Indonesia	-3.28	-3.57	-0.10	-0.10	0.23	-0.20
Malaysia	-2.71	-2.97	-0.10	-0.11	0.24	-0.20
India	-3.82	-4.14	-0.09	-0.12	0.25	-0.21
Australia	-3.99	-4.30	-0.09	-0.06	0.17	-0.15
Thailand	-3.13	-3.43	-0.07	-0.13	0.24	-0.21
Korea	-3.04	-3.35	-0.05	-0.19	0.27	-0.23
United States	-5.69	-6.09	-0.04	0.00	0.05	-0.04

Japan	-3.51	-3.84	-0.03	-0.18	0.25	-0.21
China	-3.70	-4.03	-0.02	-0.19	0.24	-0.21
Singapore	-3.65	-3.99	-0.02	-0.06	0.09	-0.07
Hong Kong (China)	-3.09	-3.41	-0.01	-0.08	0.11	-0.10
Malawi	-4.19	-7.98	0.52	-0.38	-0.16	0.14

Note: See Table A1 for the list of countries. IMR and OMR stand for inward and outward multilateral resistance, respectively.

Figure 1: Share of aggregate domestic and international trade of EMU members

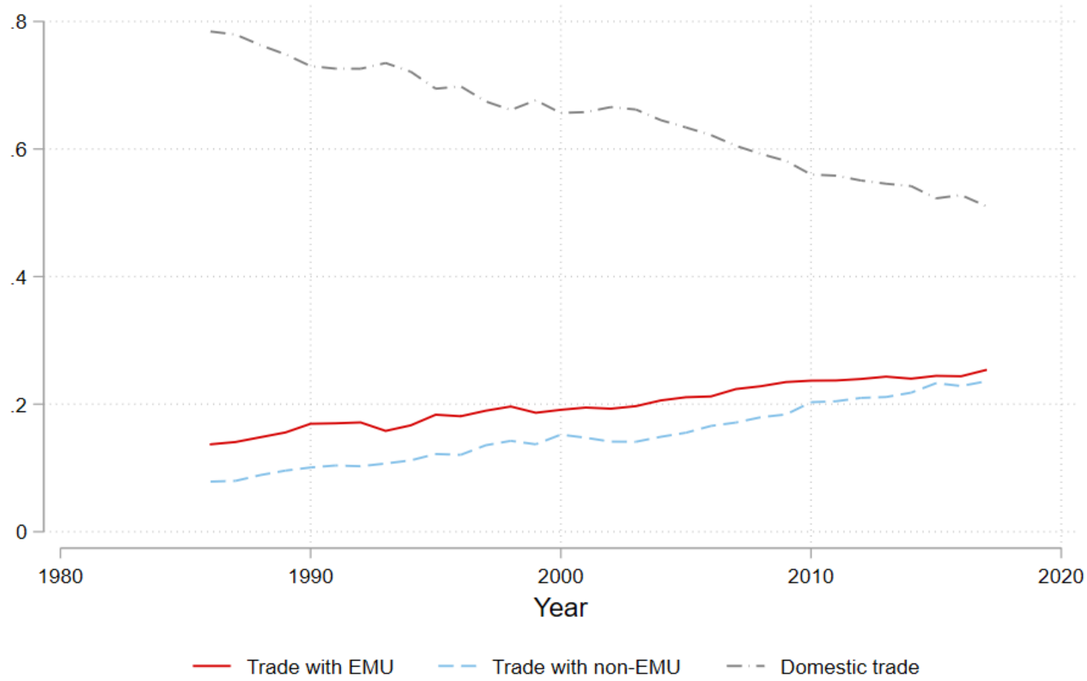
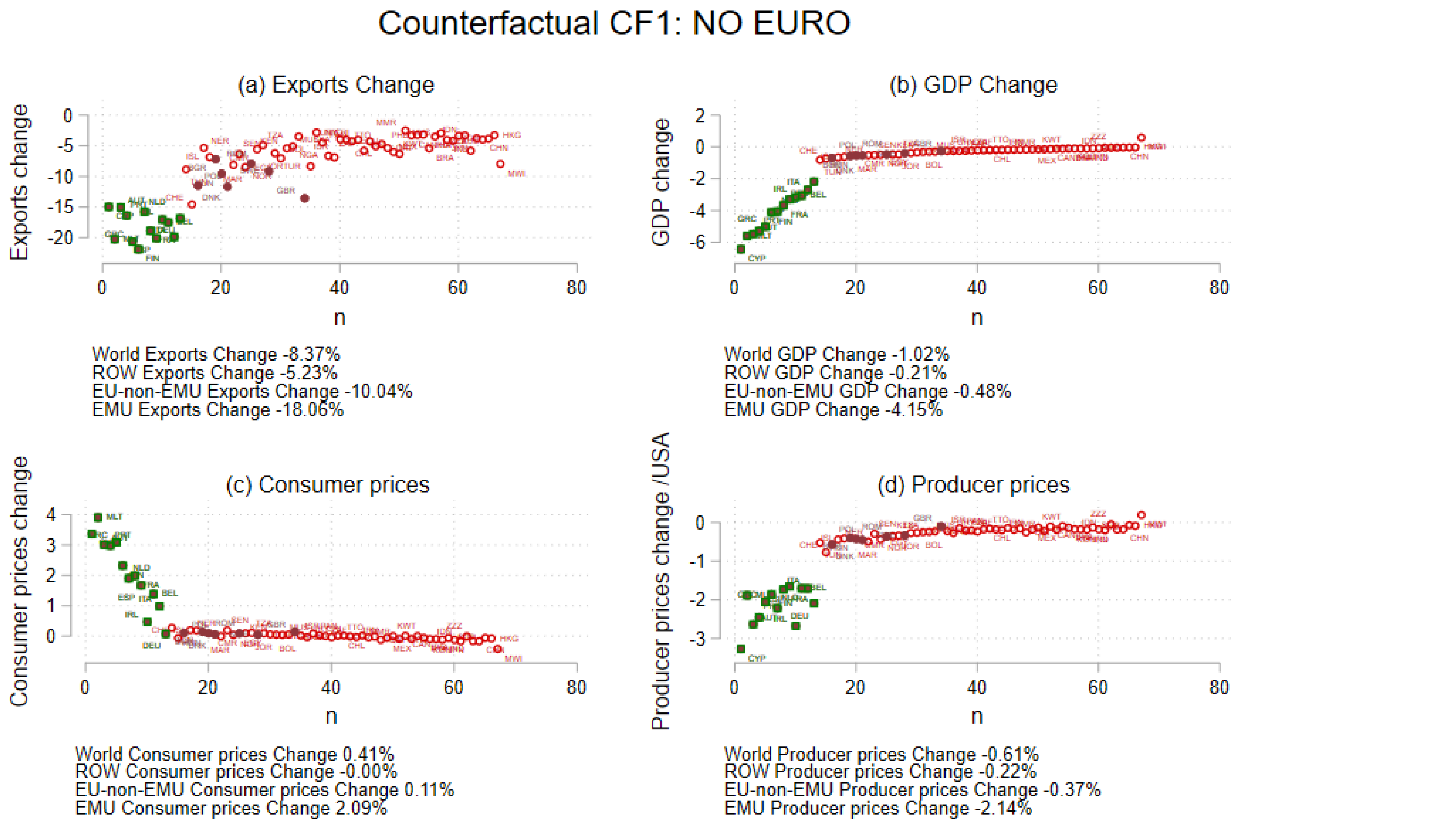
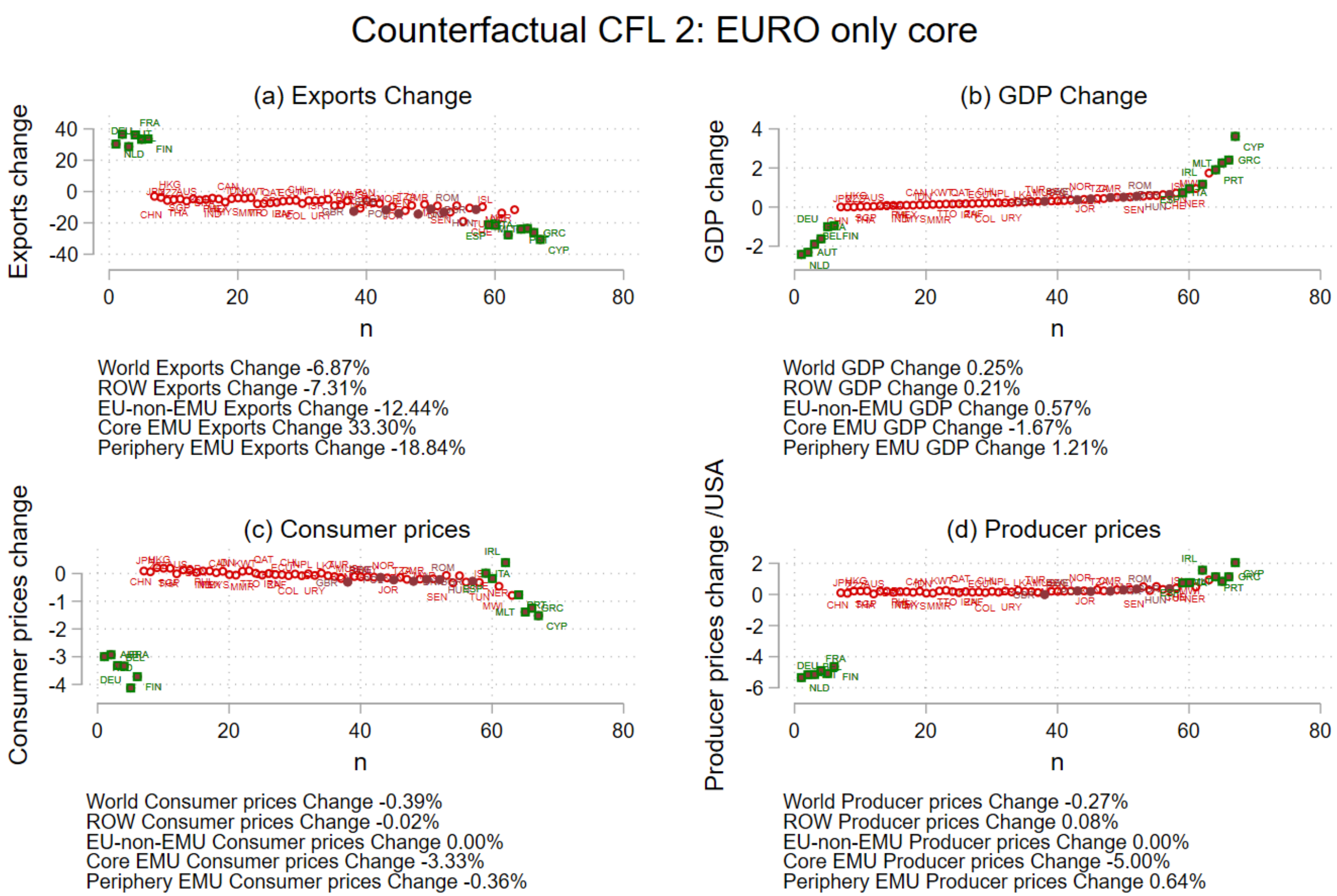


Figure 2: Counterfactual CF1: No EURO



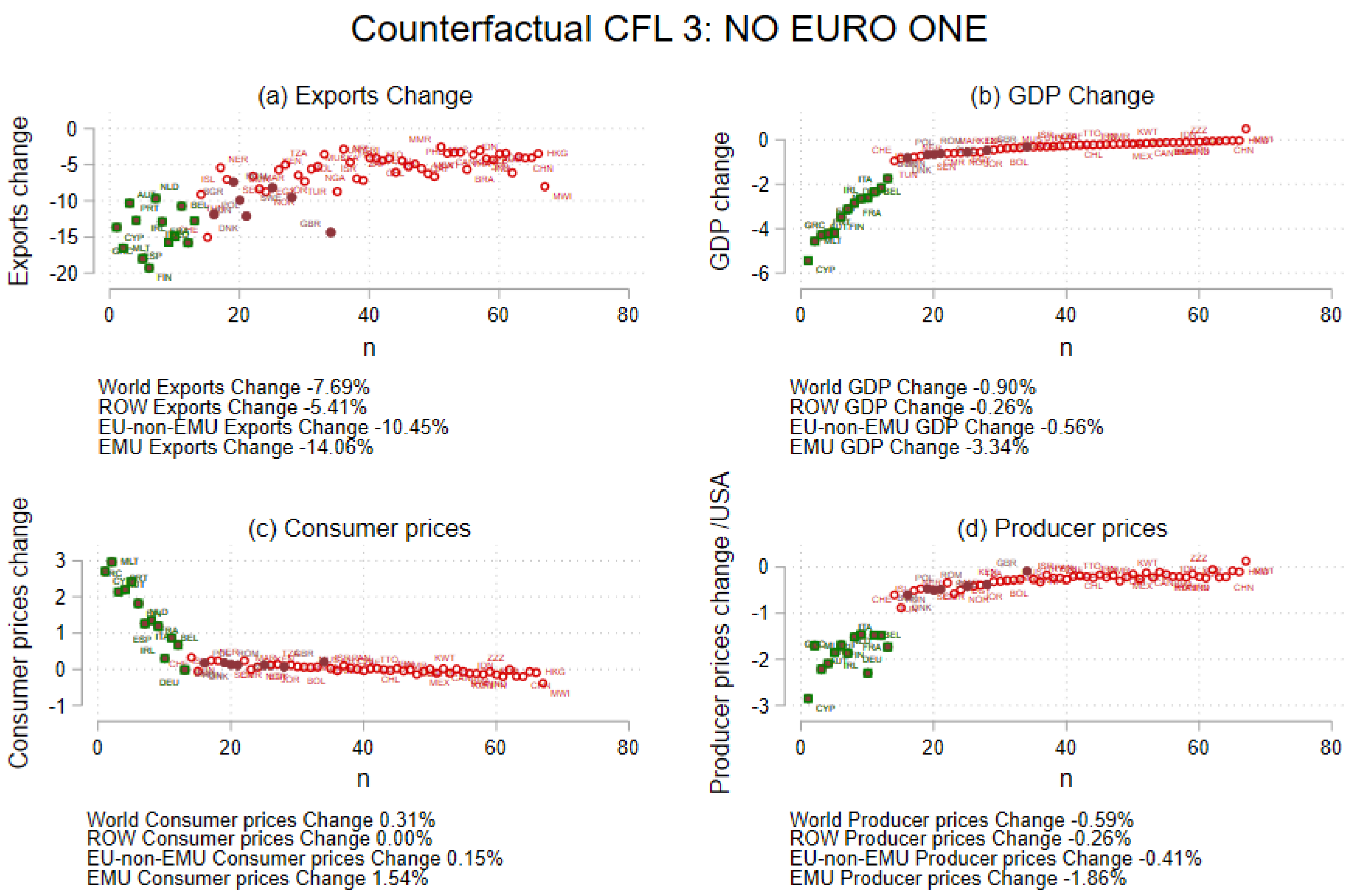
Notes: See Table A1 for the list of countries. Countries ordered by the percentage change in GDP (denoted as n on the x-axis). ROW = rest of world.

Figure 3: Counterfactual CF2 EURO only core



Note: See Table A1 for the list of countries. Countries ordered by the percentage change in GDP (denoted as n on the x-axis). ROW = rest of world.

Figure 4: Counterfactual CF3: No EURO ONE



Note: See Table A1 for the list of countries. Countries ordered by the percentage change in GDP (denoted as n in the x-axis). ROW = rest of world.