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EMU and trade: A PPML re-assessment with intra-national trade flows

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1 | INTRODUCTION

Since Rose's (2000) path-breaking study, a lot of studies have been carried out on the effect of currency unions on trade. Both Rose's striking finding that sharing a currency union more than triples trade between countries and the creation of the euro have propelled an intense debate on this issue and, in particular, about the effect of the Economic and Monetary Union (EMU) on trade.[1] More than 50 papers have examined the effect of EMU on bilateral trade flows given that it is, by far, the most important monetary union.[2] However, so far the results vary greatly across studies and even the most recent articles provide mixed results. Whereas Glick and Rose (2016) and Larch, Wanner, and Yotov (2018) find a positive EMU effect on trade, Mika and Zymek (2018) and Larch, Wanner, Yotov, and Zylkin (2019) provide no evidence of a positive effect on trade. Therefore, the debate is still ongoing.

[1]See Santos Silva and Tenreyro (2010) for a comprehensive review of the earlier empirical literature on the effect of currency unions on trade. More recent papers on this area include Eicher and Henn (2011a), De Souza (2012), Campbell (2013), Roy (2014), Glick and Rose (2016), Campbell and Chentsov (2017) and Larch el al. (2019). Rose (2017) reviews the impact of EMU on trade.

[2]EMU refers to the process of harmonising the economic and monetary policies of EU Member States with the aim to create the euro. EMU was accomplished in three stages. In this paper, EMU refers to the third stage of the process that came into effect on 1 January 1999 for the eleven early joiners of the euro. The third stage involved the irrevocable fixing of exchange rates and introduction of the single currency on the foreign exchange markets and for electronic payments.

Furthermore, the literature of the EMU effect on trade up to date, with a few exceptions (see, e.g., Aristotelous, 2006; Baldwin & Di Nino, 2006; Faruqee, 2004; Gil-Pareja, Llorca-Vivero, & Martinez-Serrano, 2003; Hashemi, 2016; Micco, Stein, & Ordonez, 2003), focuses on the overall EMU effect without examining whether there are significant differences across the individual EMU members. Besides, a caveat of all previous studies on the EMU effect on trade with the exception of Larch et al. (2018) is that they rely on international trade flows only (omitting intra-national trade flows), which prevents a proper assessment of both trade creation effects of the EMU among its members and unilateral effects with third countries.

The contribution of this paper to the literature is threefold. First, this paper examines the EMU impact on bilateral trade for the eleven early joiners (i.e., the countries that joined the EMU in 1999) plus Greece relying, for the first time, on international and intra-national trade flows in line with the microfoundations of the gravity equation of trade. Second, we properly assess the impact of EMU on trade both with other EMU members and with third countries for each individual member country, using also the latest developments in the empirical structural gravity literature. Finally, we analyse the EMU impact across countries taking into account the direction of the trade flows (exports versus imports).[3] We further discuss these points in turn.

On the one hand, the inclusion of intra-national trade flows allows us to capture the possibility of trade creation, that is, the replacement of domestic sales with trade with other EMU countries. As noted by Larch et al. (2018), such possibility cannot be accounted for in studies that only employ international trade flows.[4] Additionally, the introduction of intra-national trade flows also enables us to identify country-specific EMU effects on trade between EMU members and non-member countries. All previous studies that try to estimate the EMU effect on trade with third countries cannot account properly for multilateral resistance terms. This is because when relying only on international trade flows, a multicollinearity problem precludes the estimation of the unilateral EMU membership effects in the presence of the full set of exporter-time and importer-time fixed effects (the usual way to account for multilateral resistance terms in panel data sets).[5]

On the other hand, this paper accounts for heterogeneity of EMU effects across member countries. The importance of heterogeneity across country members and within country pairs of a currency union has been pointed out by the theoretical and empirical literature on integration processes (Chen & Novy, 2018). Heterogeneity across EMU members (even among the "early joiners") is significant, something that has undoubtedly raised important challenges during the 2008 crisis. The empirical evidence suggests the existence of heterogeneity along several dimensions, such as the degree of development of the economies (Santos Silva & Tenreyro, 2010), the size of the countries (Baldwin, 2006), the degree of product differentiation (Flam & Nordström, 2006, 2007) and the size and productivity of the firms (Berthou & Fontagné, 2008; Hashemi, 2016).

[3]Previous studies of the EMU effect on trade across countries estimate atheoretical log-linear versions of the gravity equation ignoring multilateral resistance price terms (Anderson & van Wincoop, 2003). In addition to the potential bias derived from the omission of multilateral resistance terms, these studies do not account for other potential sources of bias derived from the heteroscedasticity of the residuals, the existence of zeros in bilateral trade flows and the omission of intra-national trade flows. This paper deals with all these issues simultaneously.

[4]Yotov (2012), Dai, Yotov, and Zylkin (2014), Bergstrand, Larch, and Yotov (2015), Anderson and Yotov (2016), Borchert and Yotov (2017), Matoo, Mulabdic, and Ruta (2017), Heid, Larch, and Yotov (2017), Beverelli, Alexander, Larch, and Yotov (2018) and Baier, Kerr, & Yotov (2019) also highlight the importance of taking into account the intra-national trade flows in the estimation of the gravity equation of international trade.

[5]See Heid et al. (2017) and Beverelli et al. (2018) for a more formal discussion of the collinearity issues with country-specific variables in structural panel gravity regressions.

Egger and Pfaffermayr (2013) have found that integration-induced core–periphery and intra-periphery trade expands faster than intra-core trade during the whole integration process. Aristotelous (2006) points out that, from a theoretical point of view, the potential differences across countries in the EMU effect on trade may arise from different trade compositions, different levels of development and integration or different degrees of trade openness among EMU countries. Finally, Timini (2018), in his historical analysis of the Latin Monetary Union, shows strong heterogeneous effects on trade, which may have occurred for a number of reasons, ranging from the structure of trade itself to finance and politics. Hence, a study of the impact of EMU across countries may be particularly interesting for both academic scholars and policymakers.

This paper benefits from the computational development brought about by Correia, Guimãraes, & Zylkin (2019) to estimate the overall EMU effect on trade and the individual effect for each member country using the Poisson pseudo-maximum likelihood (PPML, hereafter) estimator with three types of (high-dimensional) fixed effects (exporter time, importer time and country pair). This is the current "state-of-the-art" estimator to obtain unbiased and theory-consistent estimates of the gravity equation.

We apply these methods to two data sets. First, we employ the data used by Glick and Rose (2016) and Larch et al. (2019), which is a large data set that includes trade flows between more than 200 countries and territories during the period 1948–2013, but that does not include intra-national trade flows. Second, we employ a data set constructed by Thomas Zylkin that comprises consistently constructed international and intra-national trade flow data covering the aggregate manufacturing sector of 69 countries over the period 1986–2006.

To preview our results, we find no overall positive EMU effect when we use international trade flows only. This result is robust to alternative samples of countries and periods as well as to the use of data for consecutive years or at five-year intervals. However, once we include intra-national trade flows, the overall EMU effect becomes positive both for trade between member countries and for trade between EMU members vis-à-vis non-member countries. Moreover, the average results mask remarkable heterogeneity across member countries. We find robust evidence of a positive effect of EMU on bilateral trade with other EMU countries for Ireland, Belgium–Luxembourg, Spain, Portugal and Austria. For Finland, France, Germany, Italy and the Netherlands, there is no evidence of a positive impact, whereas Greece faces a negative impact. With regard to trade with non-EMU members, the EMU has enhanced trade in 11 out of the 12 countries analysed. Greece is the only exception. Moreover, the four countries with the largest impact in trade with third countries (Belgium–Luxembourg, Austria, Ireland and Spain) are also four out of five countries that show a positive effect in trade with other EMU members. Finally, the analysis of the potential asymmetries according to the direction of the trade flows does not reveal significant differences in any country.

The rest of the paper is organised as follows. Section 2 includes a brief review of the recent literature on the EMU effect on trade. Section 3 presents the methodology, and Section 4 describes the data used in the empirical analysis. Section 5 presents and discusses the results. Finally, Section 6 concludes.

2 | A BRIEF OVERVIEW OF THE RECENT LITERATURE

The empirical work on the EMU effect on trade relies on different specifications of the gravity equation of international trade. As previously discussed, the estimates of the EMU effect on trade vary enormously. In a recent paper, Rose (2017) asks why. Relying on both his meta-regression analysis of 45 papers on the EMU effect on trade and his empirical work using the data set of Glick and Rose (2016), Rose concludes that expanding the time span and especially increasing the number of countries analysed raises the estimated effect of EMU on trade.[6] Moreover, Rose points out that the hypothesis that EMU has no effect on trade does not seem to be consistent with the literature. In particular, he reports an export-enhancing effect of EMU of 54% that is obtained from OLS estimates of a log-linear version of the gravity equation with a full set of high-dimensional fixed effects (exporter time, importer time and country pair) on a data set that covers more than 200 countries over the period 1948–2013.[7]

Despite the fact that the empirical literature has progressively improved its theoretical foundations and the econometric specifications to account for potential sources of bias, almost all results of the EMU effect on trade rely on gravity equations with serious theoretical and econometric flaws. Glick and Rose (2016) properly accounted for unobserved bilateral heterogeneity (with country-pair fixed effects) and for changes in multilateral resistance terms (including exporter-time and importer-time fixed effects).[8] However, computational limitations prevent them from accounting for other two potential sources of bias, due to heteroscedasticity of the residuals and the presence of zeros in bilateral trade flows, through the estimation of the gravity equation with PPML. To date, only do few articles (Larch et al., 2018, 2019; Mika & Zymek, 2018) estimate the EMU effect on trade simultaneously accounting for the issues raised by heteroscedasticity and zeros, changes in multilateral resistance terms and unobserved bilateral heterogeneity.[9] Furthermore, to our knowledge, only one of them (Larch et al., 2018), using data for the period 2000–14, additionally accounts for intra-national trade flows, which more closely follows the analysis along the foundations of the structural gravity model of international trade.

Mika and Zymek (2018) overcome the computational problems derived from the estimation with PPML by restricting their sample to 153 countries over the period 1992–2013 and artificially balancing bilateral trade to include country-time fixed instead of both exporter-time and importer-time fixed effects. More interestingly, Larch et al. (2019) resume Glick and Rose (2016) investigation (using the same data set) by implementing an iterative PPML algorithm that specifically addresses the computational burden of the three types of (high-dimensional) fixed effects with PPML. In contrast to Glick and Rose (2016), Rose (2017) and Glick (2017) results, Mika and Zymek (2018) and Larch et al. (2019) find that the EMU effect on trade vanishes when one mitigates the risk of omitted

[6]Rose (2017) does not include a number of papers that also investigate the EMU effect on trade, such as Gil-Pareja et al. (2003), Esteve-Pérez, Gil-Pareja, Llorca-Vivero, and Martinez-Serrano (2011), Eicher and Henn (2011a), Olivero and Yotov (2012), Jagelka (2013), Campbell and Chentsov (2017) and Glick (2017), as well as the more recent papers on this issue by Mika and Zymek (2018), and Larch et al. (2018, 2019).

[7]This result was previously reported by Glick and Rose (2016).

[8]Previous work in international trade emphasises that trade policies should be treated as endogenous rather than exogenous determinants of trade. In particular, Baier and Bergstrand (2007) showed that ex-post estimation of the partial effects of free trade agreements (FTA) suffered from endogeneity bias, mainly due to self-selection of country pairs into agreements, and demonstrated that the most plausible estimates for the effect of an FTA on trade are obtained using panel data with bilateral fixed effects (or differenced panel data) and country-and-time fixed effects. Bilateral fixed effects have also been used to mitigate endogeneity concerns since early studies on the impact of the EMU on trade (see, e.g., Baldwin & Di Nino, 2006, and Baldwin & Taglioni, 2007; Gil *et al.*, 2003; Micco et al., 2003, among others).

[9]Baltagi, Egger, and Pfaffermayr (2003), Baier and Bergstrand (2007) and Baldwin and Taglioni (2007) motivated and included the three types of fixed effects (exporter time, importer time and country pair) in the estimation of log-linear gravity equations with ordinary least squares. This is the preferred specification in three recent papers: Glick and Rose (2016), Rose (2017) and Glick (2017). However, Santos Silva and Tenreyro (2006) showed that the traditional log-linearised version of the gravity equation leads to biased coefficients in the presence of heteroscedastic residuals and zeros in bilateral trade flows. Evidence on this for the effect of currency unions on trade has been documented in Santos Silva and Tenreyro (2010).

variable bias by using a full array of country-time and country-pair fixed effects in a PPML regression. Nevertheless, all these studies rely on data that include international trade flows only, omitting internal trade flows.

Recently, Larch et al. (2018) contribute to this literature by re-evaluating the EMU effect including both international and intra-national trade flows consistently with gravity theory. Importantly, the inclusion of intra-national trade flows enables them to capture potential trade creation and trade diversion effects of the EMU. Using data over 2000–14, these authors conclude that the adoption of the euro (for the "late joiners") has created trade not only with other EMU members but also between members and non-members.

This paper follows Larch et al. (2018) to evaluate the impact of euro on trade using data on 69 countries over the period 1986–2006, but with some noteworthy differences. First, unlike these authors, we can identify the overall EMU effect for the "early joiners" (i.e. the eleven original euro member countries plus Greece) accounting for trade creation and trade diversion effects. Second, we further examine the different impacts of euro across countries. Third, we analyse the potential differences across countries according to the direction of trade flows.

3 | METHODOLOGY

The goal of this paper is to estimate the overall impact of EMU membership as well as the impact across member countries. To that end, and similarly to the vast majority of previous studies on the trade effects of currency unions, we rely on the gravity equation, which has been used as a workhorse for analysing the determinants of bilateral trade flows for more than 50 years since it was introduced by Tinbergen (1962).

Following the works by Baltagi, Egger, and Pfaffermayr (2003), Baier and Bergstrand (2007) and Baldwin and Taglioni (2007), our econometric model includes three types of fixed effects (country-pair fixed effects, exporter-time fixed effects and importer-time fixed effects) in order to deal with two sources of omitted variable bias.[10] These authors point out that country-pair fixed effects should be included to control for the impact of any unobserved time-invariant determinant of bilateral trade that is correlated with the regressors, while country-year fixed effects (for both the exporter and importer countries) should be included to deal with the omission of the multilateral resistance (price) terms.[11]

Moreover, Santos-Silva and Tenreyro (2006) propose the use of the PPML estimator because it has two interesting properties when compared with the traditional log-linear gravity regression. First, it avoids the statistical problems that arise from the existence of zero bilateral trade flows. As it is well known, the gravity equation in its log-linear specification is not defined for zero trade flows and this problem results in a sample selection bias that can be particularly important in data sets with a large number of trade observations that are zero in levels. Second, and most importantly, the PPML estimator solves econometric problems of both efficiency and consistency that emerge in the likely presence of heteroscedastic residuals.

[10]Baldwin and Taglioni (2007) and Gil-Pareja, Llorca-Vivero, and Martinez-Serrano (2008) are among the first that recommend the inclusion of the three types of fixed effects precisely in the context of estimating the euro effect on exports.

[11]In their theoretical foundation of the gravity equation, Anderson and van Wincoop (2003) argue that bilateral trade flows depend not only on bilateral trade barriers between any two countries (distance, language, adjacency, etc.) but also on trade barriers of each country with the rest of the trading partners (i.e., the multilateral resistance to trade). Exporter-time and importer-time fixed effects also control for changes in GDPs as well as all other country-specific variables.

This paper follows the estimation strategy recently proposed by Correia, Guimaraes, and Zylkin (2019). The advantage of this approach is that it allows us estimating the gravity equation using PPML on a large data set requiring to compute the three types of high-dimensional fixed effects (exporter year, importer year and country pair) to avoid biased estimates and misleading inference.

Rather interestingly, similar to Larch et al. (2018) and unlike all other studies, we estimate the impact of EMU using both international and intra-national trade flows, which is in line with the suggestions of the microfoundations of the gravity model of trade. This allows us to capture more precisely both trade creation effects and unilateral effects of EMU membership as discussed by Larch et al. (2018). That is, joining the euro may promote trade between member countries at the expense of domestic sales, as well as it may affect trade between EMU member and non-member countries. In addition, this paper explicitly examines these effects by country as well as by the direction of trade flows.

In particular, we propose several econometric specifications of the theory-consistent gravity equation: first, a gravity equation with international trade flows only; second, a gravity equation with both inter- and intra-national trade flows, which allows capturing the bilateral and unilateral EMU effects; third, the previous specification separated by EMU member countries; and fourth, the previous specification but distinguishing by direction of trade flows.

In all equations, the dependent variable is the value of bilateral export flows (in levels) from a country i (exporter) to a country j (importer) at time t. While the estimation of Equation (1) includes data on international trade flows only (i.e. $i \neq j$), the estimations of Equations (2)-(4) include both inter- and intra-national trade flows (i.e. both $i \neq j$ and $i = j$). In addition, all specifications include a set of exporter-time fixed effects (χ_{it}), importer-time fixed effects (λ_{jt}) and country-pair fixed effects (η_{ij}). The first two sets of fixed effects account for country-specific characteristics of exporters and importers (either constant or time-variant, such as GDP), as well as for other time-varying country-specific unobservable factors that affect trade, including the theoretical multilateral resistance terms (Anderson & van Wincoop, 2003). The set of country-pair fixed effects controls for all time-invariant bilateral trade costs, such as distance and contiguity. Finally, ϵ_{ijt} denotes the error term. We present and explain all the specifications in turn.

First, Equation (1) takes the following form:

$$X_{ij,t} = \exp\left(\beta_1 BothEMU_t + \beta_2 nonEMU\_CU_t + \beta_3 RTA_t + \chi_{it} + \lambda_{jt} + \eta_{ij}\right) \times \epsilon_{ij,t}. \tag{1}$$

The main variable of interest is $BothEMU_t$, which is a bilateral indicator explanatory variable that takes value one if countries i and j are both EMU members at time t, and zero otherwise. Hence, this variable accounts for international trade between EMU members. The reference group in Equation (1) includes international trade between non-EMU members and international trade flows between EMU members and non-members. In addition, we include other bilateral indicator covariates to control for non-euro currency union ($nonEMU\_CU_t$) and regional trade agreement (RTA_t) participation of both countries i and j at time t.

Equation (2) adds two terms to Equation (1) in order to capture the bilateral and unilateral EMU effects when using data on both international and intra-national trade flows:

$$\begin{aligned} X_{ij,t} = \exp & \left[\beta_1 \left(BothEMU_t \times INTER_{ij}\right) + \beta_2 \left(OneEMU_t \times INTER_{ij}\right) + \beta_3 \left(nonEMU_{CU_t} \times INTER_{ij}\right)\right. \\ & \left. + \beta_4 \left(RTA_t \times INTER_{ij}\right) + \chi_{it} + \lambda_{jt} + \eta_{ij}\right] \times \varepsilon_{ij,t}. \end{aligned} \tag{2}$$

The main variables of interest in Equation (2) are $BothEMU_t$ x $INTER_{ij}$ and $OneEMU_t$ x $INTER_{ij}$. The former variable includes the product of two terms: (a) first, the bilateral indicator explanatory variable $BothEMU_t$ that takes value one if countries i and j are both EMU members at time t, and zero otherwise; (b) second, a dummy variable, $INTER_{ij}$, that takes value one for international trade flows, and zero otherwise. That is, it takes value one when the source and destination countries are different ($i \neq j$), and zero when they are the same country ($i = j$). Hence, $BothEMU_t$ x $INTER_{ij}$ takes value one for international trade flows between EMU members, and zero otherwise. Interestingly, the reference group includes intra-national trade flows, which allows capturing possible EMU trade creation effects that arise from replacement of domestic sales with trade with other EMU member countries.

The second variable of interest in specification (2) is the interaction term of two indicator variables: $OneEMU_t$ and $INTER_{ij}$. The dummy variable $OneEMU_t$ takes value one if either the importer or the exporter (but not both at once) is an EMU member at time t, while $INTER_{ij}$ is the previously indicator variable to account for international (versus intra-national) trade flows. It is worth noting that the estimate on $OneEMU_t$ x $INTER_{ij}$: (a) cannot be identified with data on international trade flows only due to perfect collinearity with the set of exporter and importer-time fixed effects, and (b) will help capture the unilateral (country-specific) EMU effects on trade between member and non-member countries. The remaining control variables are defined as in Equation (1), but now they are all interacted with the indicator variable $INTER_{ij}$.[12]

In order to examine the impact of the EMU distinguishing by member country and also across member countries according to the direction of trade flows, we further estimate specifications (3) and (4), respectively.

Expression (3) is similar to Equation (2) but comprises k different equations, one for each EMU member country included in the data, which are estimated separately.[13] In Equation (3), each one of the variables $BothEMU_t$ and $OneEMU_t$ is split into two variables. First, the dummy variable $BothEMU_t(k)$ takes value 1 when countries i and j are both EMU members at time t, being country k one of the two members. The dummy variable $BothEMU_t(-k)$ takes value 1 for any pair of EMU members other than k (i.e. all EMU member pairs including countries other than country k). Likewise, the dummy variable $OneEMU_t(k)$ takes value 1 if country k is an EMU member at time t and the other country in the dyad is not an EMU member, whereas $OneEMU_t$ $(-k)$ takes value 1 at time t when one country in the pair (but not both at once) is an EMU member (other than country k) at time t.

To clarify the notation in Equation (3), let us consider the particular equation for the case of Austria (i.e., $k =$ Austria). First, the dummy variable *BothEMU(Austria)* is equal to 1 for trade flows that take place between Austria and the rest of EMU members for the period in which both countries are EMU members (and zero otherwise). Second, the dummy *BothEMU(-Austria)* takes the value of 1 for all other pairs of EMU countries (i.e., excluding Austria) for the period in which both countries belong to the EMU (and zero otherwise). Similarly, we split the variable $OneEMU_t$ into two dummies. The first of these dummies takes the value of 1 for pairs combining Austria and non-EMU member countries (*OneEMU(Austria))* since 1999 (and zero otherwise). The second dummy variable, *OneEMU(-Austria)*, takes value 1 for pairs between the rest of EMU countries and third nations since these euro members joined the EMU (and zero otherwise):

[12]Note that while $OneEMU_t$ dummy is country-time specific and its impact cannot be identified in the presence of country-time fixed effects, the interaction term ($OneEMU_t$ 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.

[13]The list of EMU member countries in the data that include intra-national trade flows is as follows: Austria, Belgium–Luxembourg, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal and Spain.

$$X_{ij,t}=\exp\left[\beta_1\left(BothEMU\,(k)_t\times INTER_{ij}\right)+\beta_2\left(BothEMU\,(-k)_t\times INTER_{ij}\right)+\beta_3\left(OneEMU\,(k)_t\times INTER_{ij}\right)+\beta_4\left(OneEMU\,(-k)_t\times INTER_{ij}\right)+\beta_5\left(nonEMU\_CU_t\times INTER_{ij}\right)+\beta_6\left(EU_t\times INTER_{ij}\right)+\beta_7\left(nonEU\_RTA_t\times INTER_{ij}\right)+\chi_{it}+\lambda_{jt}+\eta_{ij}\right]\times\epsilon_{ij,t}. \tag{3}$$

For each $k \in EMU$.

Finally, expression (4) includes k separate equations distinguishing for each EMU member country as in Equation (3), but further distinguishing by the direction of trade flows. In this expression, the suffices X and M stand for exports and imports, respectively:[14]

$$X_{ij,t}=\exp\left[\beta_1\left(BothEMU_{X(\bar{k})_t}\times INTER_{ij}\right)+\beta_2\left(BothEMU_{M(\bar{k})_t}\times INTER_{ij}\right)+\beta_3\left(BothEMU_{X(-\bar{k})_t}\times INTER_{ij}\right)+\beta_4\left(BothEMU_{M(-\bar{k})_t}\times INTER_{ij}\right)+\beta_5\left(OneEMU\left(\bar{k}\right)_t\times INTER_{ij}\right)+\beta_6\left(OneEMU\left(-\bar{k}\right)_t\times INTER_{ij}\right)+\beta_7\left(nonEMU_{CU_t}\times INTER_{ij}\right)+\beta_8\left(EU_t\times INTER_{ij}\right)+\beta_9\left(nonEU_{RTA\,t}\times INTER_{ij}\right)+\chi_{it}+\lambda_{jt}+\eta_{ij}\right]\times\epsilon_{ij,t}. \tag{4}$$

For each $k \in EMU$.

In addition, in expressions (3) and (4) we also split the bilateral indicator accounting for participation in regional trade agreements (RTA_t) into two variables. First, the variable EU_t takes value 1 when countries i and j are both members of the European Union at time t. Second, the variable $nonEU\_RTA_t$ takes value 1 when countries i and j participate in a regional trade agreement (other than the European Union) at time t.

All the estimations have been carried out using the Poisson pseudo-maximum likelihood (PPML) estimator with the *ppmlhdfe* Stata command recently developed by Correia et al. (2019).

4 | DATA

This paper uses two data sets properly adapted to the aims of the article.[15] The first one is Glick and Rose (2016) data set, which comprises bilateral unidirectional trade flows of goods between more than 200 IMF country codes over a long time span (1948–2013) with gaps.[16] In particular, the bilateral

[14]Note that in Equation (4), we do not split into two the EMU dummies that capture the potential trade diversion effect of each country by direction of trade flows. As pointed out by Larch et al. (2018), while the inclusion of intra-national trade flows allows the identification of country-specific effects, due to collinearity issues it is not possible to identify directional (i.e., exporter versus importer) effects of country-specific variables in structural gravity regressions. See Beverelli et al. (2018) for a more formal discussion on this issue.

[15]We gratefully acknowledge Andrew Rose and Thomas Zylkin for making their data sets public.

[16]It is noteworthy that not all areas covered are countries in the conventional sense of the word. The data set also includes some territories (e.g. Gibraltar, Guam), and overseas departments (e.g. Guadeloupe).

exports flows in US dollars are gathered from *Direction of Trade* data set (International Monetary Fund). A shortcoming of this data set for the purposes of this paper is the lack of information on intra-national trade flows.

The second data set is a balanced panel data set, assembled and provided by Thomas Zylkin, which includes consistently constructed international and intra-national trade flow data covering aggregate manufacturing trade for 69 countries over the period 1986–2006.[17] The time span of this data set is determined by the availability of intra-national trade flows. In this data set, following the standard procedure, domestic sales have been worked out as the difference between total production and total exports (apparent consumption) of manufacturing products. It is worth noting that in order to ensure consistency between international trade flows and intra-national trade flows, *gross* production values are used to construct intra-national trade.[18]

In the set of explanatory variables, we include dummy variables for currency unions and regional trade agreements. Glick and Rose (2016) construct currency union series from the IMF's *Schedule of Par Values* and issues of the IMF's *Annual Report one Exchange Rate Arrangements and Exchange Restrictions*, supplemented with information from the *Statesman's Yearbook*. Following Glick and Rose (2016), we use a transitive definition of currency union. That is, if dyads *x-y* and *x-z* are in currency unions, then *y-z* is a currency union. Data on regional trade agreements are taken from the World Trade Organization's website.

5 | EMPIRICAL RESULTS

As suggested by the structural gravity theory of international trade, the proper evaluation of the EMU effect on trade requires data not only on international trade flows but also on intra-national trade flows (Larch et al., 2018). However, as a starting point, we begin by providing estimations of the overall EMU effect on trade using an extensive data set in terms of countries and years that only include international trade flows (Glick & Rose, 2016). It is worth pointing out that we estimate the gravity Equation (1), with the dependent variable in levels, using the PPML estimator and including exporter and importer-time fixed effects as well as country-pair time-invariant fixed effects. It is considered the best estimator and specification to obtain unbiased and theory-consistent estimates in the absence of data on intra-national trade flows.[19] In order to check the robustness of the results, we use data for different samples (of countries and periods) and consider two frequencies of the data (data for consecutive years and at five-year intervals).

Estimation results for the gravity Equation (1) considering the world sample of countries (213) over the full sample period (1948–2013) appear in column (1) of Table 1. In line with Larch et al. (2019)

[17]The sample comprises the following countries: Argentina, Australia, Austria, Belgium–Luxembourg, Bolivia, Brazil, Bulgaria, Cameroon, Canada, Chile, China, Colombia, Costa Rica, Cyprus, Denmark, Ecuador, Egypt, Finland, France, Germany, Greece, Hong Kong (China), Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Japan, Jordan, Kenya, Kuwait, Macao (China), Malaysia, Malta, Mauritius, Malawi, Mexico, Morocco, Myanmar, the Netherlands, Nepal, Niger, Nigeria, Norway, Panama, the Philippines, Poland, Portugal, Qatar, Romania, Senegal, Singapore, South Africa, the Republic of Korea, Spain, Sri Lanka, Sweden, Switzerland, Tanzania, Thailand, Trinidad and Tobago, Tunisia, Turkey, Uruguay, the United Kingdom and the United States.

[18]See Baier et al. (2019) for a detailed explanation of the construction of the data.

[19]We have run regression equation specification error test (RESET) obtaining that we cannot reject the null hypothesis that the models are correctly specified when we use Glick and Rose's data set. Yet, when using the data set with intra-national trade flows (Zylkin's data set), the results of these tests are not conclusive. In particular, the tests reject the null in our most complete specifications. This is in line with the results in Baier et al. (2018).

TABLE 1 EMU effect on trade: PPML estimation using international trade flows only

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Both in EMU	−0.002	−0.075	−0.017	0.015	−0.060	0.012	0.019	0.048
	(0.039)	(0.046)	(0.031)	(0.041)	(0.054)	(0.036)	(0.046)	(0.056)
All non-EMU CUs	0.795	1.373	0.022	0.840	1.317	−0.010	0.836	0.857
	(0.112)***	(0.181)***	(0.056)	(0.114)***	(0.179)***	(0.072)	(0.112)***	(0.108)***
RTAs	0.199	0.330	0.011	0.185	0.282	0.045	0.242	0.275
	(0.037)***	(0.041)***	(0.038)	(0.035)***	(0.043)***	(0.034)	(0.044)***	(0.050)***
Sample period	1948–2013	1948–2013	1983–2013	1948–2013	1948–2013	1983–2013	1948–2013	1948–2013
Sample	World	OECD + EU	World	World	OECD + EU	World	World	World
Year intervals	consec.	consec.	consec.	5-year	5-year	5-year	5-year	5-year
Lags	No	No	No	No	No	No	1	2
RESET	0.310	0.125	0.242	0.594	0.110	0.188	0.190	0.653
No. of observations	729,932	69,363	522,595	152,406	14,800	114,235	149,603	146,410

Notes: The regressand is the value of bilateral exports, measured by dyad-year. Robust standard errors, clustered by dyad, are in parentheses. *** $p < .01$, ** $p < .05$, * $p < .1$. All regressions include country-pair fixed effects, and exporter- and importer-year fixed effects.

Fixed effects are not reported for brevity. p-value of the Ramsey-RESET reported.

Glick and Rose (2016) dataset, including data on more than 200 countries over the period 1948–2013.

Reported coefficients in columns (7) and (8) include the contemporaneous and the lagged effects.

and Mika and Zymek (2018), the point estimate for the *Both in EMU* dummy is very close to zero and it is not statistically significant at conventional levels. With regard to the estimated coefficients for the rest of currency unions (*nonEMU_CU*) and regional trade agreements (*RTA*), we find in both cases a positive and statistically significant coefficient at the 1% of significance, which is again in line with Larch et al. (2019). Columns (2) and (3) show the robustness of the result of no EMU effect using an alternative country sample (EU + OECD) and period of investigation (1983–2013), respectively.[20]

Columns (4) to (6) of Table 1 replicate the estimations reported in columns (1) to (3) with data at five-year intervals spanning 14 years (1948, 1953, …, 2013). Considering data at intervals is usual in the gravity equation literature of international trade to address the concern raised by Cheng and Wall (2005, p. 52) who noted that "Fixed-effects estimation is sometimes criticized when applied to data pooled over consecutive years on the grounds that dependent and independent variables cannot fully adjust in a single year's time".[21] As we can see, the results remain unaltered.

Finally, since terms-of-trade changes tend to have lagged effects on trade volumes, columns (7) and (8) present the results for the full period and sample of countries including one and two lags of the dummy variables *Both in EMU*, *nonEMU_CU* and *RTA*, respectively. For these specifications, the reported coefficients include the sum of the contemporaneous and the lagged values. The estimated coefficient for regional trade agreements raises from 0.185 without lags (column (4)) to 0.242 (with one lag) and 0.275 (with two lags). The economic interpretation of the cumulative estimated coefficient with two lags is that after 10 years (we use data at five-year intervals), formation of a regional trade agreement increases the level of trade by [exp(0.275)-1]*100 = 31.7 per cent. In addition to lagged effects of terms-of-trade changes on trade volumes, this result can be explained by the fact that virtually every trade agreement is "phased-in", typically over 10 years (Baier & Bergstrand, 2007). However, for currency unions the results do not change in any significant way with the inclusion of lags. In particular, the point estimate for the *Both in EMU* remains close to zero and non-statistically significant at conventional levels.

The above results, which rely on data that only include international trade flows, suggest that there is no evidence of an EMU effect on trade flows. However, as noted before, all microfoundations of the gravity model of trade stress the importance of including intra-national trade flows. To deal with this issue, we use a balanced panel data set, assembled and provided by Thomas Zylkin, which includes consistently constructed international and intra-national trade flow data covering 69 countries over the period 1986–2006.[22] The results with this data set are reported in Table 2. For comparison purposes, columns (1) and (2) depict the results without intra-national trade flows over the same period

[20]Similarly to Glick and Rose (2016) and Larch et al. (2019), we have considered other alternative country samples and periods of analysis (not reported for brevity). Like in Larch et al. (2019), no single subsample leads to a positive and significant effect for the EMU. We have also considered alternative frequencies for the data (three-year and four-year intervals) and, although the comparison groups change with the alternative subsamples, the results remain qualitatively unaltered. These results are available from the authors upon request.

[21]As we do here, Cheng and Wall (2005), Baier and Bergstrand (2007), Vicard (2009), Eicher and Henn (2011a, 2011b), Behar and Cirera-i-Crecillé (2013), Kohl (2014), Limão (2016) and Esteve-Pérez, Gil-Pareja, and Llorca-Vivero (2020) use data at five-year intervals in this way. Dai et al. (2014), Bergstrand et al. (2015), Anderson and Yotov (2016) and Gil-Pareja, Llorca-Vivero, and Martinez-Serrano (2014, 2016) use intervals of 4 years. Trefler (2004) and Olivero and Yotov (2012) employ data at three-year intervals, while Larch et al. (2018) check the robustness of their results using two-year time intervals instead of consecutive years.

[22]As noted before, the inclusion of country-pair fixed effects has been used to control for endogeneity in previous studies on the EMU impact. While pair dummies do not completely eliminate the scope for endogeneity, keeping the sample period relatively short mitigates this concern. In section 5 of this paper, we address this concern by carrying out robustness checks for shorter sample periods (1992–2002 and 1992–2006).

TABLE 2 EMU effect on trade: PPML using intra-national trade flows (sample period: 1986–2006)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Both in EMU	−0.095	−0.101	0.179	0.182	0.175	0.174	0.243	0.243	0.088	0.088
	(0.027)***	(0.033)***	(0.041)***	(0.040)***	(0.042)***	(0.042)***	(0.038)***	(0.038)***	(0.039)**	(0.039)**
One in EMU							0.319	0.320	0.276	0.276
							(0.023)***	(0.023)***	(0.025)***	(0.025)***
All non-EMU CUs	0.009	−0.089	−0.004	0.058	−0.004	−0.004	−0.003	−0.002	−0.003	−0.003
	(0.065)	(0.052)*	(0.053)	(0.048)	(0.053)	(0.054)	(0.055)	(0.055)	(0.055)	(0.055)
RTAs	−0.019	−0.105	0.328	0.326						
	(0.033)	(0.050)**	(0.062)***	(0.062)***						
EU					0.402	0.402	0.289	0.289	0.077	0.077
					(0.057)***	(0.057)***	(0.050)***	(0.050)***	(0.062)	(0.062)
EU trend									0.016	0.016
									(0.003)***	(0.003)***
All non-EU RTAs					0.300	0.299	0.266	0.264	0.279	0.278
					(0.080)***	(0.080)***	(0.082)***	(0.083)***	(0.082)***	(0.082)***
Dataset	Glick & Rose	Zylkin	Zylkin	Zylkin	Zylkin	Zylkin	Zylkin	Zylkin	Zylkin	Zylkin
Sample (# countries)	213	69	69	69	69	69	69	69	69	69
Year intervals	consec.	consec.	consec.	2-year	consec	consec	consec.	consec	consec	consec
Positive trade flows only	Yes	Yes	No	No	No	Yes	No	Yes	No	Yes
Intra-national trade flows	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RESET	0.030	0.213	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
No. of observations	338,909	90,040	99,708	52,107	99,708	91,489	99,708	91,489	99,708	91,489

Notes: The regressand is the value of bilateral exports, measured by dyad-year. Robust standard errors, clustered by dyad, are in parentheses. *** $p < .01$, ** $p < .05$, * $p < .1$.

All regressions include country-pair fixed effects, and exporter- and importer-year fixed effects. Fixed effects are not reported for brevity. p-value of the Ramsey-RESET reported.

Column (1) reports the estimates using Glick and Rose (2016) dataset for the period 1986–2006. Zylkin dataset includes a balanced (annual) panel data covering aggregate manufacturing sector of 69 countries over the period 1986–2006 assembled and provided by Thomas Zylkin.

(1986–2006) using both Glick and Rose and Zylkin data sets, which comprise 213 and 69 countries, respectively.[23] At first glance, the results with both data sets are very similar despite the difference in the number of countries considered in each case. In particular, we find a negative and significant effect for the EMU (−9 per cent) in both cases. This odd result is fully in line with that reported by Larch et al. (2019) for the three subsamples ending in 2005 that they considered (1948–2005, 1985–2005 and 1995–2005).[24]

Interestingly, the picture that emerges substantially changes when we estimate a fully grounded-in-theory gravity model including internal trade (Equation (2)). Only has Larch et al. (2018) previously estimated the EMU effect with intra-national trade flows. Yet, these authors use a sample of 43 countries over the period 2000–2014.[25] Therefore, our paper is the first that analyses the overall EMU effect on trade for the early joiners of the euro using both international and intra-national trade flows, as the structural gravity theory of international trade suggests. Column (3) shows that, once intra-national trade flows are introduced, we obtain a positive (0.179) and highly statistically (SE 0.041) estimate of the partial trade effect of joining the EMU. This result is very similar to the point estimate (0.182) and the standard error (0.041) reported by Larch et al. (2018), despite the fact that in their paper, the EMU effect is only identified off the variation introduced by new EMU members. These results suggest that joining the EMU has led to an increase in international trade flows among members and that EMU estimates that only use international trade flows are biased downwards. With regard to the estimates for the other explanatory variables, the point estimate for regional trade agreements is positive and highly statistically significant in line with previous studies whereas that for non-EMU currency unions is both economically and statistically insignificant.[26]

The next three columns of Table 2 report estimates from alternative specifications: column (4) uses data at two-year intervals instead of data for consecutive years; column (5) controls for EU membership;[27] and column (6) includes positive trade flows only. The estimates confirm the findings in column (3): (a) the point estimates for the EMU fall in a small interval that goes from 0.174 to 0.182, with standard errors around 0.041; (b) the non-EMU currency union effect is always statistically insignificant; and (c) the regional trade agreement effect is always economically and statistically significant.

As previously discussed, the inclusion of intra-national trade flows provides a second advantage. It enables us to identify, in the framework of a theoretically founded specification of the gravity equation,

[23]A limitation of Zylkin's data set for comparison purposes with Glick and Rose's data set is that the former includes manufacturing exports only. This may also be important when assessing the impact of EMU on trade given that we miss its potential impact on trade for non-manufacturing goods. We thank one referee for pointing this out.

[24]Evidence of a negative impact of the EMU on trade is also reported by Mika and Zymek (2018) in several specifications using the PPML estimator and data that only include international trade flows over the period 1992–2013.

[25]As Larch et al. (2018) note, due to the inclusion of bilateral fixed effects in their estimations, the identification of the EMU effect relies on countries that joined the euro in the data period: Greece (2001), Slovenia (2007), Malta (2008), Cyprus (2008), Slovakia (2009), Estonia (2011) and Latvia (2014).

[26]The result for non-EMU currency unions is consistent with Mika and Zymek (2018) for the periods 1992–2002 and 1992–2013, as well as with Larch et al. (2019) for samples beginning in 1985 or 1995. It can be explained because, as Larch et al. (2019) pointed out, subsamples without observations prior to 1985 include only very few observations of country pairs leaving or joining non-EMU currency unions.

[27]So far, we have controlled for membership of countries in regional trade agreements with a single dummy variable that captures the average effect of all regional trade agreements (RTAs). From now on, we separate out the effect of the European Union (*EU*), since members of the EMU are also members of the European Union. To this end, we include in the regressions an EU-specific dummy and a dummy for the rest of regional trade agreements (*All non-EU RTAs*).

TABLE 3 EMU effect by country using intra-country trade flows (PPML): Main results

	Both in EMU	One in EMU
Austria	0.177	0.452
	(0.039)***	(0.055)***
Belgium-Luxembourg	0.373	0.632
	(0.049)***	(0.039)***
Finland	−0.015	0.118
	(0.041)	(0.063)*
France	0.052	0.216
	(0.049)	(0.030)***
Germany	0.054	0.277
	(0.047)	(0.046)***
Greece	−0.289	−0.001
	(0.064)***	(0.056)
Ireland	0.408	0.416
	(0.149)***	(0.135)***
Italy	−0.072	0.115
	(0.044)	(0.041)***
The Netherlands	−0.072	0.201
	(0.051)	(0.056)***
Portugal	0.215	0.114
	(0.078)***	(0.069)*
Spain	0.296	0.364
	(0.042)***	(0.051)***
Dataset	Zylkin	
Sample period	1986–2006	
Sample (# countries)	69	
Positive trade flows only	No	
Intra-national trade flows	Yes	
EU trend	Yes	
No. of observations	99,708	

Notes: The estimates reported in each column are obtained from separate regressions (one for each row) for each EMU member country. The regressand 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 rest of countries' euro effect in each case, a dummy for the EU, a linear EU 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 of exposition, we only report the EMU estimates for each country. The estimates of the coefficients on all other covariates are available upon request. p-values of Ramsey-RESET tests are equal to .000 in all regressions. Zylkin dataset includes a balanced (annual) panel data on aggregate manufacturing sector of 69 countries over 1986–2006. Robust standard errors, clustered by dyad, are in parentheses. $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$.

the trade effects of joining the EMU for trade flows between members and non-member countries. These unilateral country-specific EMU effects on trade between members and non-members allow us to check whether the trade enhancing euro effect when both countries participate in the EMU comes at the expense of trade diversion away from trade between EMU members and non-EMU countries. Therefore, columns (7) and (8) of Table 2 report the results when we add a new dummy to the specifications in columns (5) and (6), respectively, that takes the value one when only one of the countries involved in dyad uses the euro (*One in EMU*).[28] A couple of things are worth noting. First, we find that EMU has stimulated trade not only between members but also with third countries. Second, consistent with this finding, the EMU point estimate when both countries participate in EMU raises (up to 0.243) once we account for unilateral EMU effects. The intuition for this result is that given that the EMU effect between members and non-members is positive, removing pairs of countries combining EMU and non-EMU members from the reference category, as it is done in columns (7) and (8), must lead to a higher estimate of the effect when both trading partners participate in EMU. These results are in line with those found by Larch et al. (2018) for late joiners to the EMU.

Finally, we show how the results are affected when we add an EU-specific linear trend in the gravity equations including and excluding zeros (columns (9) and (10)). The introduction of a EU trend is important because, as argued by Micco et al. (2003), Berger and Nitsch (2008), Bergin and Lin (2012) and Mika and Zymek (2018), among others, the euro effect may be biased upwards when we do not account for long-term trends in European trade flows as a result of the ongoing economic integration among these countries. As we can see, the effect for common membership in the EMU remarkably falls although it remains statistically significant at the 5% level. Other authors, such as Berger and Nitsch (2008) and Mika and Zymek (2018), even report that the euro's impact on trade disappears when the positive trend in the institutional integration is controlled for. Instead, the positive effect of the EMU on trade with third countries do not significantly vary, which suggests as previously noted by Baldwin (2006) that the euro may have acted more like a unilateral trade liberalisation than a preferential trade liberalisation.[29]

Next, we turn to the analysis of the EMU effect by country since, as discussed in the introduction, there are several reasons to believe that the EMU impact may be different across countries and, therefore, our previous estimates of the overall impact of the EMU may be masking heterogeneous effects at the country level. The few studies that have investigated the EMU effect on trade of each EMU country separately (Aristotelous, 2006; Faruqee, 2004; Gil-Pareja et al., 2003; Hashemi, 2016; and Micco et al., 2003) estimate an atheoretical log-linear version of the gravity equation ignoring multilateral resistance price terms (Anderson & van Wincoop, 2003) and, therefore, face a potential omitted variable bias. Moreover, in addition to this bias, these studies do not account for other potential sources of bias derived from the heteroscedasticity of the residuals, the existence of zeros in bilateral trade flows and the lack of intra-national trade flows.

This paper overcomes the previous shortcomings and examines the impact of euro adoption by country with the estimation of the gravity model for each country that shares the euro (Equation (3)).[30] Let us consider the case of Austria to illustrate the procedure. In the regressions for this country, we

[28]Other articles relying only on international trade flows have also included in the gravity equation a second euro indicator variable to capture trade effects with non-members (see, e.g., Faruqee, 2004; Flam & Nordström, 2006; or Gil-Pareja, Llorca-Vivero, & Martinez-Serrano, 2007; Micco et al., 2003). However, all such estimates are based on gravity specifications that do not include exporter-time and importer-time fixed effects because there is a problem of perfect multicollinearity between these fixed effects and the cited indicator variable.

[29]It is worth noting that the results reported in Table 1 and column (1) of Table 2 using Glick and Rose's data set remain unaltered when we include a specific EU dummy and an EU trend as in columns (9) and (10) of Table 2, which is our preferred specification using data on intra-national trade flows.

[30]We use the strategy followed by Micco et al. (2003) in their table 8 for the analysis of the EMU effect by country. As noted by these authors, one advantage of this procedure is that we can test whether the individual country EMU effect is significantly different from the effect in the rest of EMU countries.

TABLE 4 EMU effect by country using intra-country trade flows (PPML): Robustness checks

	(1)		(2)		(3)		(4)		(5)		(6)	
	Both in EMU	One in EMU	Both in EMU	One in EMU	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	0.198	0.458	0.153	0.466	0.134	0.305	0.142	0.331	0.170	0.374	0.141	0.378
	(0.041)***	(0.055)***	(0.042)***	(0.060)***	(0.032)***	(0.039)***	(0.031)***	(0.041)***	(0.028)***	(0.043)***	(0.028)***	(0.046)***
Belgium-Luxembourg	0.391	0.639	0.367	0.628	0.337	0.553	0.347	0.566	0.231	0.421	0.217	0.425
	(0.047)***	(0.037)***	(0.046)***	(0.045)***	(0.042)***	(0.031)***	(0.042)***	(0.034)***	(0.045)***	(0.033)***	(0.044)***	(0.038)***
Finland	0.008	0.127	−0.032	0.078	0.054	0.085	0.065	0.072	−0.019	0.049	−0.043	0.003
	(0.043)	(0.062)**	(0.045)	(0.059)	(0.032)*	(0.034)**	(0.031)**	(0.025)***	(0.028)	(0.048)	(0.027)	(0.038)
France	0.070	0.221	0.046	0.218	0.006	0.116	0.016	0.150	0.022	0.168	0.009	0.171
	(0.051)	(0.030)***	(0.050)	(0.031)***	(0.043)	(0.022)***	(0.043)	(0.023)***	(0.035)	(0.026)***	(0.033)	(0.027)***
Germany	0.071	0.282	0.046	0.276	−0.014	0.112	−0.003	0.139	0.029	0.200	0.015	0.200
	(0.049)	(0.045)***	(0.047)	(0.048)***	(0.037)	(0.033)***	(0.037)	(0.036)***	(0.035)	(0.035)***	(0.033)	(0.036)***
Greece	−0.261	0.001	−0.285	−0.003	−0.308	−0.094	−0.294	−0.095	−0.299	−0.068	−0.311	−0.070
	(0.063)***	(0.056)	(0.064)***	(0.063)	(0.061)***	(0.041)**	(0.062)***	(0.043)**	(0.049)***	(0.041)*	(0.050)***	(0.045)
Ireland	0.430	0.426	0.411	0.406	0.272	0.333	0.290	0.347	0.310	0.324	0.304	0.317
	(0.148)***	(0.133)***	(0.147)***	(0.143)***	(0.092)***	(0.089)***	(0.092)***	(0.092)***	(0.128)**	(0.114)***	(0.128)**	(0.121)***
Italy	−0.053	0.120	−0.078	0.135	−0.034	0.077	−0.025	0.123	−0.033	0.115	−0.048	0.134
	(0.044)	(0.041)***	(0.042)*	(0.048)***	(0.039)	(0.027)***	(0.039)	(0.029)***	(0.036)	(0.031)***	(0.035)	(0.037)***
The Netherlands	−0.054	0.208	−0.080	0.169	−0.117	0.067	−0.106	0.082	−0.098	0.119	−0.113	0.098
	(0.052)	(0.055)***	(0.050)	(0.061)***	(0.052)**	(0.032)**	(0.052)**	(0.036)**	(0.038)**	(0.048)**	(0.036)***	(0.053)*
Portugal	0.236	0.123	0.212	0.082	0.184	0.105	0.193	0.115	0.176	0.117	0.160	0.086
	(0.078)***	(0.067)*	(0.076)***	(0.074)	(0.056)***	(0.052)**	(0.056)***	(0.058)**	(0.065)***	(0.066)*	(0.064)**	(0.072)
Spain	0.316	0.371	0.293	0.355	0.173	0.212	0.182	0.237	0.196	0.299	0.183	0.301
	(0.041)***	(0.051)***	(0.039)***	(0.058)***	(0.036)***	(0.032)***	(0.036)***	(0.040)***	(0.035)***	(0.040)***	(0.034)***	(0.047)***
Sample period	1986–2006		1986–2006		1992–2002		1992–2002		1992–2006		1992–2006	

(Continues)

TABLE 4 (Continued)

	(1)		(2)		(3)		(4)		(5)		(6)	
	Both in EMU	**One in EMU**	**Both in EMU**	**One in EMU**	**Both in EMU**	**One in EMU**	**Both in EMU**	**One in EMU**	**Both in EMU**	**One in EMU**	**Both in EMU**	**One in EMU**
Sample (Zylkin dataset)	Full (69 countries)		EU + OECD		Full (69 countries)		EU + OECD		Full (69 countries)		EU + OECD	
No. of observations	99,708		21,504		52,030		11,264		71,175		15,360	

Notes: The estimates reported in each column are obtained from separate regressions (one for each row) for each EMU member country. The regressand 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 rest of countries' euro effect in each case, an EU dummy, a linear EU trend, a quadratic EU 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 of exposition, we only report the EMU estimates. The estimates of the coefficients on all other covariates are available upon request. Robust standard errors, clustered by dyad, are in parentheses. p-values of Ramsey-RESET tests are equal to .000 in all regressions. *** $p < .01$, ** $p < .05$, * $p < .1$. Zylkin dataset includes a balanced (annual) panel data covering aggregate manufacturing sector of 69 countries over the period 1986–2006.

split the EMU dummy (*BothEMU*), when both countries participate in the EMU, into two dummy variables. The first one is a dummy, *BothEMU(Austria)*, that is equal to one for trade between Austria and the rest of EMU members for the years that both trading partners belong to the EMU (and zero otherwise). The second dummy *BothEMU(-Austria)* takes the value of one for all other pairs of EMU countries (i.e., excluding Austria) for the years that both partners belong to the EMU (and zero otherwise). In a similar way, we split the EMU dummy when only one country participates in EMU, into two dummies. The first of these dummies takes the value of one for pairs combining Austria and non-member countries (*OneEMU(Austria))* since 1999 (and zero otherwise). The second dummy takes the value unity for pairs between the rest of EMU countries and third nations (*OneEMU(-Austria))* since these euro members joined the EMU (and zero otherwise).

The results of the EMU effect for the 11 early joiners of the EMU (Belgium and Luxembourg are jointly considered) and Greece using our preferred specification appear in Table 3. To save on space, we only report the estimated coefficients for the two main parameters of interest.[31] The estimates point out the existence of remarkable differences in the EMU impact across EMU member countries. We find a positive and statistically significant estimated coefficient, at the 1% level, for Austria (0.177), Belgium–Luxembourg (0.373), Ireland (0.408), Portugal (0.215) and Spain (0.296), while Greece shows a negative and statistically significant coefficient (−0.289). In the six regressions, the individual EMU coefficients are statistically different from those of the rest of EMU countries. Furthermore, the EMU effect with third countries is also positive and statistically significant in all countries except for Greece (column (2)). Therefore, with the exception of the particular case of Greece, we can conclude that the EMU has had a positive effect on trade because although the positive effect of the EMU on bilateral exports to other EMU countries appears in only half of the countries, the positive effect of the EMU in trade with third countries is pervasive. In particular, the point estimates for the "One in EMU" variable are above the overall effect found in column (9) of Table 2 (0.276) for Austria (0.452), Belgium–Luxembourg (0.632), Ireland (0.416) and Spain (0.364) and slightly above it in the case of Germany (0.277). Instead, Finland (0.118), France (0.216), Italy (0.115), the Netherlands (0.201) and Portugal (0.114) show positive estimated coefficients below the overall impact, but statistically significant at least at the 10% level of significance in all cases.

Next, Table 4 depicts the results from a number of robustness checks. In particular, we test whether the results are robust: to the inclusion of an EU-specific quadratic trend in bilateral trade flows; to changes in the sample of countries; to variations in the sample period; and to changes in the sample in both dimensions simultaneously (countries and periods).

Column (1) of Table 4 displays the results when we add an EU-specific quadratic trend. Two comments are in order. First, the quadratic EU trend is negative and statistically significant at conventional levels in all the regressions. Second, the results of Table 3 still hold. The EMU impact, when both countries share the euro, remains consistently positive and statistically significant at the 1% level for Austria, Belgium–Luxembourg, Ireland, Portugal and Spain, whereas it is again negative in the case of Greece, in a very similar order of magnitude in all cases. For the remaining countries, there is no evidence of a positive effect of euro adoption between EMU members. Moreover, in trade with third countries, the results confirm the positive impact in all EMU members with the exception of Greece, and the ranking of countries according to the magnitude to the estimated effect remains unchanged.

[31]The list of independent variables in each regression includes, in addition to the two dummies that capture the euro effect for each particular country, the corresponding dummies for the rest of countries' euro effect, a dummy for the EU, a linear EU trend, a dummy for other regional trade agreements and a dummy for other currency unions, as well as dummies for exporter and importer-year fixed effects and country-pair fixed effects. We estimate the gravity equations with PPML including zeros.

TABLE 5 EMU effect by country and direction of trade using intra-national trade flows (PPML)

	(1)		(2)		(3)		(4)		(5)		(6)	
	Both in EMU	**One in EMU**	**Both in EMU**	**One in EMU**	**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_X	0.101		0.056		0.080		0.088		0.085		0.058	
	(0.071)	0.450	(0.075)	0.460	(0.058)	0.302	(0.060)	0.329	(0.051)*	0.368	(0.053)	0.373
Austria_M	0.287	(0.051)***	0.241	(0.056)***	0.183	(0.038)***	0.191	(0.039)***	0.247	(0.039)***	0.216	(0.041)***
	(0.069)***		(0.075)***		(0.052)***		(0.055)***		(0.049)***		(0.052)***	
Belgium-Luxembourg_X	0.395		0.374		0.344		0.351		0.241		0.229	
	(0.059)***	0.639	(0.062)***	0.628	(0.049)***	0.553	(0.051)***	0.566	(0.051)***	0.422	(0.052)***	0.425
Belgium-Luxembourg_M	0.387	(0.038)***	0.360	(0.045)***	0.330	(0.031)***	0.342	(0.034)***	0.220	(0.033)***	0.205	(0.038)***
	(0.082)***		(0.087)***		(0.061)***		(0.064)***		(0.076)***		(0.079)***	
Finland_X	0.018		−0.007		0.042		0.063		−0.017		−0.041	
	(0.081)	0.128	(0.081)	0.080	(0.054)	0.084	(0.050)	0.072	(0.061)	0.049	(0.054)	0.004
Finland_M	−0.004	(0.061)**	−0.058	(0.057)	0.068	(0.032)***	0.067	(0.025)***	−0.021	(0.048)	−0.045	(0.037)
	(0.079)		(0.078)		(0.047)		(0.043)		(0.058)		(0.050)	
France_X	0.059		0.032		−0.008		−0.004		0.016		0.004	
	(0.079)	0.220	(0.081)	0.218	(0.067)	0.115	(0.068)	0.149	(0.053)	0.168	(0.054)	0.171
France_M	0.080	(0.030)***	0.059	(0.031)***	0.019	(0.022)***	0.036	(0.023)***	0.028	(0.025)***	0.013	(0.027)***
	(0.071)		(0.073)		(0.058)		(0.060)		(0.050)		(0.051)	
Germany_X	0.062		0.054		−0.009		0.012		0.029		0.030	
	(0.080)	0.281	(0.082)	0.276	(0.061)	0.113	(0.063)	0.140	(0.059)	0.200	(0.060)	0.202
Germany_M	0.080	(0.046)***	0.037	(0.049)***	−0.019	(0.033)***	−0.018	(0.036)***	0.028	(0.035)***	−0.002	(0.037)***
	(0.082)		(0.084)		(0.061)		(0.063)		(0.059)		(0.059)	
Greece_X	−0.405		−0.446		−0.403		−0.405		−0.407		−0.434	
	(0.092)***	0.018	(0.103)***	0.017	(0.088)***	−0.086	(0.094)***	−0.086	(0.073)***	−0.055	(0.080)***	−0.055
Greece_M	−0.180	(0.054)	−0.188	(0.060)	−0.258	(0.040)**	−0.232	(0.042)**	−0.237	(0.036)	−0.237	(0.040)
	(0.101)*		(0.111)*		(0.087)***		(0.094)**		(0.072)***		(0.078)***	

(Continues)

TABLE 5 (Continued)

	(1)		(2)		(3)		(4)		(5)		(6)	
	Both in EMU	One in EMU	Both in EMU	One in EMU	Both in EMU	One in EMU	Both in EMU	One in EMU	Both in EMU	One in EMU	Both in EMU	One in EMU
Ireland_X	0.446		0.434		0.249		0.281		0.298		0.309	
	(0.250)*	0.427	(0.254)*	0.407	(0.152)	0.332	(0.153)*	0.347	(0.216)	0.324	(0.218)	0.317
Ireland_M	0.399	(0.130)***	0.368	(0.139)***	0.316	(0.087)***	0.306	(0.090)***	0.332	(0.112)***	0.296	(0.118)***
	(0.146)***		(0.155)**		(0.116)***		(0.119)**		(0.126)***		(0.132)**	
Italy_X	−0.098		−0.116		−0.065		−0.054		−0.059		−0.080	
	(0.071)	0.115	(0.075)	0.131	(0.060)	0.074	(0.061)	0.119	(0.059)	0.111	(0.061)	0.130
Italy_M	−0.009	(0.042)***	−0.040	(0.049)***	−0.004	(0.027)***	0.004	(0.029)***	−0.008	(0.032)***	−0.016	(0.038)***
	(0.071)		(0.075)		(0.055)		(0.057)		(0.054)		(0.058)	
The Netherlands_X	0.041		−0.023		−0.050		−0.056		−0.039		−0.084	
	(0.067)	0.201	(0.073)	0.167	(0.055)	0.061	(0.059)	0.079	(0.053)	0.115	(0.058)	0.097
The Netherlands_M	−0.158	(0.050)***	−0.141	(0.056)***	−0.191	(0.029)**	−0.161	(0.033)**	−0.163	(0.044)***	−0.144	(0.051)*
	(0.097)		(0.101)		(0.092)**		(0.095)*		(0.077)**		(0.080)*	
Portugal_X	0.197		0.195		0.166		0.187		0.130		0.144	
	(0.114)*	0.123	(0.119)*	0.081	(0.087)*	0.106	(0.091)**	0.115	(0.107)	0.117	(0.112)	0.086
Portugal_M	0.271	(0.066)*	0.226	(0.073)	0.201	(0.051)**	0.199	(0.058)**	0.216	(0.065)*	0.175	(0.071)
	(0.132)**		(0.136)*		(0.092)**		(0.097)**		(0.109)**		(0.113)	
Spain_X	0.302		0.250		0.141		0.143		0.181		0.145	
	(0.075)***	0.371	(0.079)***	0.358	(0.059)**	0.214	(0.064)**	0.239	(0.062)***	0.299	(0.065)**	0.303
Spain_M	0.328	(0.050)***	0.331	(0.057)***	0.201	(0.031)***	0.219	(0.039)***	0.209	(0.039)***	0.218	(0.045)***
	(0.066)***		(0.071)***		(0.049)***		(0.054)***		(0.051)***		(0.056)***	
Sample period	1986–2006		1986–2006		1992–2002		1992–2002		1992–2006		1992–2006	
Sample (Zylkin dataset)	Full (69 countries)		EU + OECD		Full (69 countries)		EU + OECD		Full (69 countries)		EU + OECD	

(Continues)

TABLE 5 (Continued)

	(1)		(2)		(3)		(4)		(5)		(6)	
	Both in EMU	One in EMU	Both in EMU	One in EMU	Both in EMU	One in EMU	Both in EMU	One in EMU	Both in EMU	One in EMU	Both in EMU	One in EMU
No. of observations	99,708		21,504		52,030		11,264		71,175		15,360	

Notes: The estimates reported in each column are obtained from separate regressions (one for each row) for each EMU member country. The regressand 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 three dummies to capture the euro effect for that particular country (*Both in EMU_X*, *Both in EMU_M* and *One in EMU*), two dummies for the rest of countries' euro effect in each case, a dummy for the EU, an EU dummy, a linear EU trend, a quadratic EU 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 of exposition, we only report the EMU estimates for each country and direction of trade. For Both in EMU columns, the suffixes X and M refer country's exports and imports, respectively. For One in EMU columns, it is not possible to disentangle the importer- versus exporter-specific effects. The estimates of the coefficients on all other covariates are available upon request. Robust standard errors, clustered by dyad, are in parentheses. *p*-values of Ramsey-RESET tests are equal to .000 in all regressions. *** $p < .01$, ** $p < .05$, * $p < .1$. Zylkin dataset includes a balanced (annual) panel data covering aggregate manufacturing sector of 69 countries over the period 1986–2006.

To illustrate whether our estimates of the EMU effect by country are sensitive to the sample of countries, column (2) presents the results when we restrict the sample to EU plus OECD countries. At first glance, the point estimates for the EMU are only marginally affected using this sample of countries. Again, we find that the EMU has boosted trade with other EMU countries for the same five countries whereas the opposite occurs for Greece.[32] Furthermore, except for Finland, Greece and Portugal, the EMU has also enhanced trade with third countries.

Finally, we analyse the sensitivity of the results to two alternative sample subperiods: 1992–2002 (columns (3) and (4)) and 1992–2006 (columns (5) and (6)). On the one hand, we choose the first subperiod because it corresponds with the time span initially considered by Mika and Zymek (2018), a subperiod that allows them to compare their estimates with the findings from earlier studies (which only use data up to 2002). We choose the second subperiod because it includes seven years before and after the euro creation in 1999. For the two subperiods, we provide the results both for the full sample of countries and for the sample of EU + OECD countries. The results remain qualitatively unaltered, but two comments are in order. First, the size of the point estimates falls when we drop out the initial years of the sample period, particularly for Spain and Ireland. This may be due to the fact that when we drop out the initial years (1986–1991), we remove observations in the comparison group that correspond to years in which economic integration with other EMU member countries is relatively less strong leading to a smaller impact of EMU membership. Second, the only remarkable difference in the results is that the coefficient for the Netherlands in trade with other EMU members, which was negative but not statistically significant so far, turns out to be statistically significant in all four cases.

As pointed out in the introduction section, the differential EMU effect across countries may arise from several reasons including differences in terms of composition of trade, the level of economic development, the level of integration, the size of countries, the size and productivity of the firms or even the degree of trade openness. Unfortunately, we cannot explain the significant cross-country heterogeneity of the EMU impact on trade when both trading partners share the euro relying on such differences. For instance, Greece and Portugal have similar trade composition, level of development, distribution of firm size, economic size or even similar population levels but the impact of EMU sharply differs. Whereas we always find a positive impact for Portugal, we systematically report the opposite effect for Greece. Similarly, there are also many resemblances between Spain and Italy. Yet, while for Spain we find robust evidence of a positive EMU impact, the point estimate for Italy is never positive and statistically significant. In contrast, despite the large differences along most of the listed countries' characteristics among Austria, Belgium–Luxembourg, Ireland, Portugal and Spain, we find a positive impact of the EMU in all of them. Moreover, even splitting the countries according to the usual EU/EMU classifications (i.e., core versus periphery, severely hit versus non-affected by the currency turmoil of the early 1990s; by the intensity of the 2010 debt crisis), we cannot find homogeneous patterns of the EMU impact. Therefore, beneath the heterogeneity in the results across countries there may be other factors that merit a deeper theoretical and empirical research. However, this goes beyond the scope of this paper.

Finally, we go a step further by examining the potential differential impact of the EMU by country according to the direction of the trade flows (Equation (4). To this end, let us consider the case of Austria to illustrate the procedure. In Equation (4), the dummy variable that captures the EMU effect for Austria when the partner shares the common currency is split into two dummies: *BothEMU_X(Austria)* that takes value one for Austrian exports to other EMU members, and zero otherwise, and *BothEMU_M(Austria)* that is equal to one for Austrian imports from other EMU members, and zero otherwise). Table 5 presents the results for the same set of sampling periods and countries

[32]In this subsample of countries, in addition to Greece, Italy also shows a negative coefficient but it is statistically significant at the 10% level only.

offered in Table 4. To save on space, we only report the estimated coefficients of the parameters of interest. Several comments are in order. First, with the exception of Austria, the positive impact of EMU on trade with other EMU members arises for both exports and imports. In Austria, the positive impact of EMU on trade with other EMU only appears for this country's imports. Second, the negative impact for Greece arises from both export and import flows. Third, in all cases the difference between the estimated coefficient for exports and imports is not statistically significant at conventional levels. Finally, the results are robust to the alternative samples of countries and periods considered.

6 | CONCLUSIONS

Over the past decade and a half, much work has been written about the EMU effect on trade. Unlike the vast majority of previous research, two recent papers (Mika & Zymek, 2018 and Larch et al., 2019) conclude that there is no evidence of a positive effect of the euro adoption once the empirical specification deals simultaneously with four well-known potential sources of bias in the estimation of the gravity equation: unobserved bilateral heterogeneity, changes in multilateral resistance terms, zeros in bilateral trade flows and heteroscedastic residuals. However, neither of these papers consider intra-national trade flows as all microfoundations of the gravity model of trade suggest. Larch et al. (2018) address this issue for new joiners of the EMU turning the EMU effect on trade into positive and statistically significant.

In this paper, we also rely on the "state of art" in the gravity equation literature and estimate the EMU effect on trade including international and intra-national trade flows. We make several contributions to the specialised literature. First, we estimate, for the first time to the best of our knowledge, the overall EMU effect on trade for the eleven early joiners of the EMU and Greece not only among its members but also among EMU members and non-members, using a fully theory-grounded gravity model. Second, we use this analytical framework to estimate the EMU effect separately for each member country, which allows us to obtain unbiased and theory-consistent estimated coefficients of the impacts across EMU members. Finally, we also examine the potential differential effect of the EMU on trade depending on the direction of the trade flows for each country.

Our results confirm that ignoring intra-national trade flows leads to a downward bias in the estimation of the overall EMU effect on trade. Using the extensive data set in Glick and Rose (2016) or the data set provided by Zylkin (but relying only on international trade flows), we find no evidence of a positive EMU trade effect. This finding is robust to alternative samples of countries and periods, as well as to the use of data for consecutive years or at year intervals. However, when we add intra-national trade flows we find a positive and statistically significant impact on trade between EMU members. Interestingly, euroland's trade with third countries is also promoted by the single currency. Indeed, the evidence of a positive impact is even larger for trade with them, suggesting that the EU has acted like a unilateral trade liberalisation.

Importantly, we further unravel that the overall results mask substantial heterogeneous effects across member countries. The analysis by country shows robust evidence of a positive effect of EMU on bilateral trade with other EMU countries for the following countries (in descending order of magnitude of the impact): Ireland, Belgium–Luxembourg, Spain, Portugal and Austria. For Finland and, interestingly, for four out of the six founding members of the European Economic Community in 1957 (France, Germany, Italy and the Netherlands), there is no evidence of a positive impact. With regard to trade with non-EMU members, the EMU has enhanced trade in 11 out of the 12 countries analysed. Moreover, the four countries with the largest impact in trade with third countries (Belgium–Luxembourg, Austria, Ireland and Spain) are among the group of five countries that show a positive effect in trade with other EMU members.

Greece clearly turns out to be a particular case. According to our results, it is the only country for which we find robust evidence that the euro has had a negative impact on trade with other EMU members and, additionally, it is the only country for which the EMU has not boosted trade with third countries. Rather tentatively, this result may be related to the geographical isolation of the country from the rest of EMU countries, but also to institutional and historical factors. However, to dig deeper into the factors driving the remarkable heterogeneity of the EMU effect across member countries as well as the particular impact for each country, further theoretical and empirical research is required.

Finally, the analysis of the potential asymmetric EMU effect for each country according to the direction of the trade flows does not reveal significant differences in any case.

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