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Has the euro been fattening the European pig meat trade?

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Abstract: The introduction of the euro is one of the great achievements of the European integration process. We ask whether the creation of the euro led to a significant increase in pig meat trade in the eurozone. The pig meat industry is the most important in the European meat sector, and the EU is the world's second-biggest producer of pork and the leading supplier of pig meat to the global market. No study has yet been conducted in this respect for this sector. Our results suggest that pig meat trade was encouraged between countries sharing the euro, although the impact of EU single market was still greater. Trade creation was also observed, increasing pig meat exports from eurozone to non-eurozone countries. Also, non-eurozone EU exporters suffer from a diversion effect that benefits eurozone exporters.

Keywords: eurozone; gravity models; international trade; trade creation; trade diversion

The European Union (EU) is the world's second-biggest producer of pig meat after China, with 256 million slaughtered pig heads and annual production of nearly 23.7 million t of carcass weight in 2019. By country and slaughtered pigs in 2019, Germany was the first European producer accounting for 22% of the EU total followed by Spain with 19.5%. EU pork production accounted for just over 20% of global production during the period 2008–2013 and the figure remained the same figure in 2019. According to the Economic Accounts for Agriculture (Eurostat 2020a) in the EU, the pig meat value provided 23.4% of total EU animal output, while cattle accounted for 17.5%, excluding animal products such as milk, and poultry represented 12.2% of the annual data. The European slaughtering statistics for 2018 show that pig meat represented 50% of annual production in t of all meats [poultry meat (32%), bovine meat (17%)]. The EU became the world's first exporter of pig meat in 2011 with almost EUR 5 508 million exported to non-EU countries and EUR 9 913 million in 2019 (Figure 1) (EC 2020).

Under the Common Agricultural Policy (CAP), pork is covered by the Common Organization of the Markets. In times of serious and significant crisis, private storage schemes have been used to stabilize pig markets (EU regulation 1308/2013). Taste for pig meat is site-specific. That is, while in Spain pork loin is the most consumed pork part, in Germany, it is the pork knuckle, baby back ribs in the US, pig's ears in China, and in France, cooked ham. This diversification in pig meat consumption traditions has enhanced worldwide pig meat trade flows. The pig meat as good is produced and disassembled to be sold in a very large number of different markets.

Tinbergen (1962) adapted Newton's gravity equation to economics, the theory being that countries with higher GDP and at a closer distance to each other have a greater volume of trade between them. Since seminal article of Rose (2000), the importance of currency unions [the agreement between two or more states creating a single currency area (Mundell 1961)] in the improvement of trade has been a widely debated question in aca-

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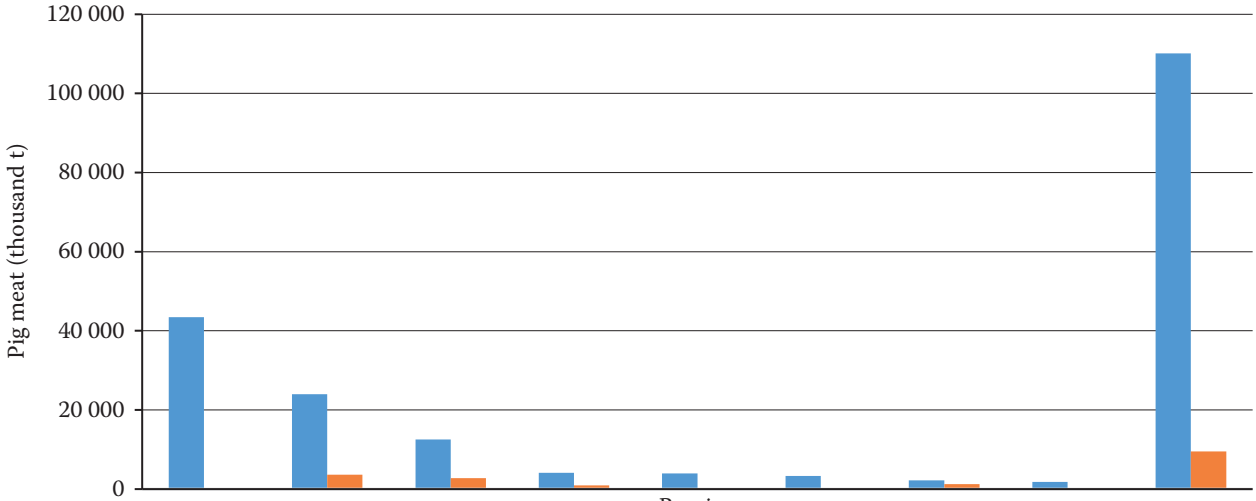

	China	EU	USA	Brazil	Russian Federation	Vietnam	Canada	Philippines	World
Production	43 481	23 954	12 536	4 126	3 937	3 329	2 175	1 841	11 0095
Exports	83	3 643	2 748	950	97	27	1 295	2	9 553

Figure 1. Pig meat production and exports in 2019 (thousand t)

Source: Authors' own elaboration based on FAO (2021)

demic research. A completely new stream of literature emerged and thrived around this topic, using gravity models to estimate trade flows (Anderson and van Wincoop 2003). Since then, a large number of studies have raised the question of the impact of common currency adoption on trade flows using the gravity equation (Santos Silva and Tenreyro 2010; Head and Mayer 2014).

Most studies have shown that the introduction of the euro had a positive and significant effect on trade among eurozone members (Cieślik et al. 2012; Camarero et al. 2014; Glick and Rose 2016; Kunroo et al. 2016; Larch et al. 2018; Esteve-Pérez et al. 2020). Meanwhile, Santana-Gallego et al. (2016) assess the positive impact of the euro on tourism flows. However, Bun and Klaassen (2007) show that the euro effect is not as great as one would conclude from the literature so far. And Mika and Zymek (2018) and Larch et al. (2019) provide no evidence of a positive euro effect on trade. Not only has the effect of the euro been studied but also Dumitru et al. (2014) reported a positive but decreasing effect of currency unions on international trade. Additionally, Baldwin et al. (2005) report that the impact of monetary union seems to differ substantially across sectors, with relatively strong effects for some sectors (i.e. electricity, gas and water supply), but no significant effect for commodities like farming and agricultural products. In particular, the application of the gravity approach to the agri-food sector has increased steadily during recent years. Garcia-Alvarez-Coque and Martí-Selva (2007) and Crescimanno et al. (2013) analyze the effects of Euro-Mediterranean agreements on fruit and vegetable trade and Italian agri-food exports towards Mediterranean countries. Dreyer et al. (2017) point out the positive effect of the euro on German beer exports, as this trade has increased more sharply in the eurozone than in other EU Member States (EU MS) or third countries. Kashiwagi et al. (2020) examine the factors that affect olive oil exports and imports in Mediterranean countries. Also, Ghodsi and Stehrer (2019) apply the gravity equation to analyze the effects on the European poultry market of being an EU MS. Additionally, Bakucs et al. (2019) show that belonging to the eurozone positively affects price transmission in the European dairy sector. Marquez-Ramos and Martinez-Gomez (2016) apply the gravity function on analyzing Morocco–EU trade in fruit and vegetables. Despite its importance, no study has yet been conducted in this respect for the pig meat sector. Our hypothesis is that the creation of the eurozone has encouraged pig meat exports between pairs of countries sharing the euro.

The EU single market is the main destination of pig meat exported by EU MS: approximately, 80% of the value of the total exported by EU MS is intra-EU trade; the rest goes to extra-EU. In fact, the value of pig meat exported from EU MS to both EU and non-EU countries has largely increased since the year 2000, when the eurozone was created. The value of EU exports to other

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EU countries doubled between 2000 and 2014 (from EUR 7 549 million to EUR 15 567 million). Additionally, the value of EU exports to third countries more than doubled (from EUR 2 521 million to EUR 5 508 million) between the same years [author's own calculations based on Eurostat (2018) database]. Using a common currency helps benefits outweigh the costs of trade integration (Baldwin et al. 2008).

However, the EU economies underwent a lengthy integration process (Berger and Nitsch 2008) before the adoption of the euro, and the cost-saving from adopting the single currency by these economies may have been very low. In addition, the food sectors and, in particular, the pig meat sector, presented a high level of integration among these economies that could have helped benefits of trade outweigh costs before using the euro (Barberis et al. 2020). But, 80% of the pig meat exported by them goes to other EU MS and prior to the euro almost all of them had a different currency. The adoption of the euro may have saved costs. The pig meat exports from eurozone countries have increased steadily since the year 2000, but these exports have increased to both eurozone and non-eurozone countries (Figure 2). For this reason, one of our objectives is to ascertain whether the creation of the currency union led to significant increases in the value of pig meat traded among eurozone countries in addition to the increase facilitated by the EU single market.

Additionally, the value of pig meat exports from the eurozone to non-eurozone EU MS increased from EUR 1 047 million to EUR 4 514 million, between 2000 and 2014. The value of pig meat exported from the eurozone to third countries also increased from EUR 1 099 million to EUR 3 688 million. The creation of the eurozone seems, in some sense, to have levelled out the playing field and has allowed eurozone firms and countries to experience an advantage enjoyed by their competitors, like the US, a large home market with a single currency. Therefore, we estimate whether the creation of the eurozone led to additional and significant increases in the value of pig meat exported (trade creation) to non-eurozone countries. Hence, we wish to ascertain whether, in addition to increasing pig meat exports between eurozone countries, the introduction of the euro has also resulted in trade creation or in trade diversion in terms of exports. Additionally, the likely increase in trade among eurozone countries may have been accompanied by a decrease in pig meat imports from non-eurozone EU countries. That is, we ask whether trade diversion has taken place in terms of imports.

The gravity models have been widely used to explain international trade flows (Anderson and van Wincoop 2003). Following Santos Silva and Tenreyro (2006), we estimated our gravity model using the Poisson pseudo-maximum likelihood (PPML) method with several sets of fixed effects (FE).

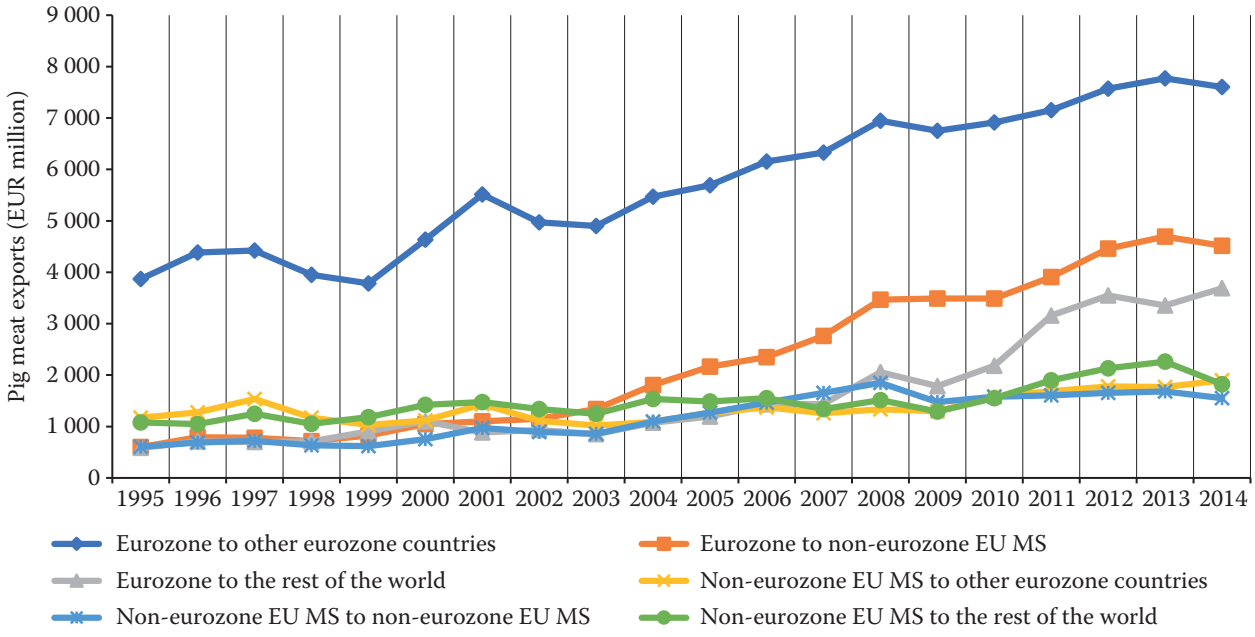

Figure 2. Evolution of pig meat exports from eurozone and non-eurozone EU countries in EUR million (1995–2014)

Source: Authors' own elaboration based on Eurostat (2018) database (1995–2014); each country has been included in its respective category, taking into account the evolution of the eurozone membership

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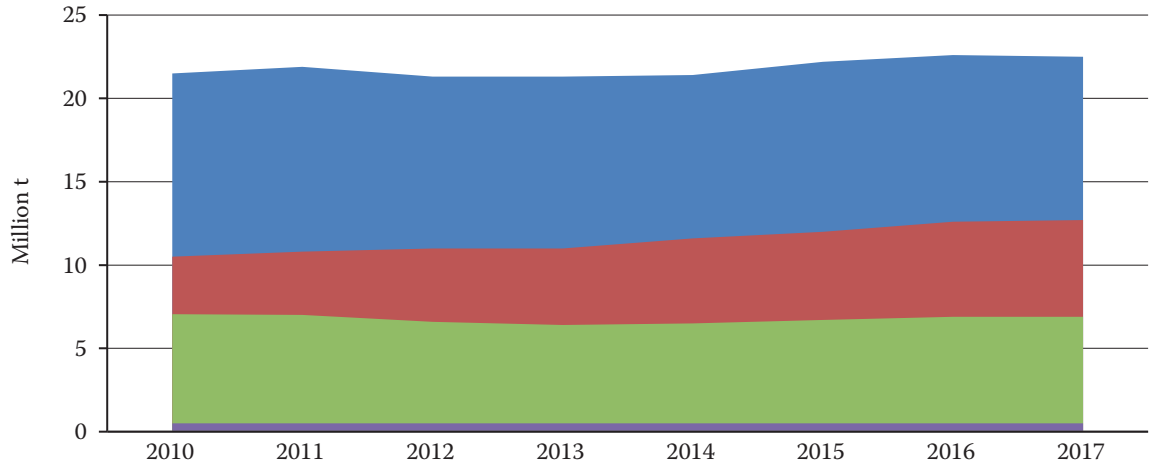
MATERIAL AND METHODS

We focus on studying the trade flows of a single economic sector, the EU pork industry which has accounted for approximately the 9% of the value of the EU agricultural output and the 20% of the value of animal output in the last two decades (Table 1). Pigs are the largest livestock category, accounting for half of all meat produced from slaughterhouses (Figure 3). Our intuition is that the introduction of the euro would facilitate trade in the pig meat market among eurozone countries. To test if our intuition would hold, we used the gravity methodology. Our dependent variable is the value in euros of the tons of pig meat exported by each of the 28 EU countries. Our database includes yearly observations, between 1995 and 2014, of the value of pig meat exported from the 28 countries that were EU MS on 1 January 2014, for a set of 45 countries that together account for 98% of the value of the total pig meat exported from EU countries during those years. These 45 countries include the remaining 27 EU MS and 18 additional non-EU countries that concentrated more than 90% of the value of the EU pig meat exported to third countries. These countries are China, Russia,

Table 1. Evolution of EU value of agricultural output, animal output and pigs

	EU-15	EU-27	EU-28					
	1995	2000	2005	2009	2014	2016	2017	2019
Agricultural output (EUR million)	266 842.30	315 829.05	323 944.87	332 099.02	406 450.56	392 308.36	417 593.31	430 964.00
Animal output (EUR million)	115 034.19	132 970.13	137 216.30	138 049.53	172 794.51	160 634.81	177 690.54	177 769.53
Pigs (EUR million)	23 558.26	29 002.31	29 958.99	31 795.70	35 927.78	35 733.46	39 891.02	41 532.88
Pig/animal output (%)	20.5	21.8	21.8	23.0	20.8	22.2	22.4	23.4
Pig/agricultural output (%)	8.8	9.2	9.2	9.6	8.8	9.1	9.6	9.6

Source: Eurostat (2020a); economic accounts for agriculture (aact_eaa01)



	2010	2011	2012	2013	2014	2015	2016	2017
Pigs	21.5	21.9	21.3	21.3	21.4	22.2	22.6	22.5
Poultry	10.5	10.8	11.0	11.0	11.6	12.0	12.6	12.7
Bovine animals	7.1	7.0	6.6	6.4	6.5	6.7	6.9	6.9
Sheep and goats	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Figure 3. Production of meat from slaughterhouses by species, EU-27, 2010–2017 (million t of carcass weight)

Source: Eurostat (2020b); statistics explained; agricultural production–livestock and meat

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Japan, Canada, US, Switzerland, Angola, Hong Kong, South Korea, Philippines, Singapore, Belarus, Ukraine, Australia, Taiwan, New Zealand, Montenegro and Serbia. Our data set takes into account the evolution of the status of each country as a EU MS, from EU-15 in 1995 to EU-28 in 2014. During those years, Germany and Spain increased their exports, becoming the biggest exporters in the EU. Simultaneously, Denmark, the Netherlands and Belgium maintained or improved their already large volume of exports. Additionally, we can also see that the countries that joined the EU in 2004 have greatly increased the value of their exports since then. The value of pig meat exports from each of the EU MS, with the exception of Cyprus and Malta, has grown since the year of the creation of the euro [Table S1 in electronic supplementary material (ESM); for the ESM see the electronic version]. Our data were obtained from the Eurostat (2018) database. Our interest is to focus on the impact of the euro in the first years of its implementation. Following De Sousa (2012), we contrasted the influence of the euro on a year-by-year basis and its impact almost disappeared after 15 years (Figure S1 in ESM; for the ESM see the electronic version). Therefore, we considered only the first 15 years after its implementation. Our database includes 24 930 observations. We use the value of exports as a dependent variable because very few tons of pig meat are imported in the EU market from third countries. For instance, in 2014, the EU exported nearly 3 million t of pig meat of carcass weight to non-EU countries and imported 35 245 t of carcass weight from them (EC 2019).

Nineteen EU countries were members of the eurozone, not all of them joined simultaneously. The currency was introduced in non-physical form (traveller's cheques, electronic and banking transfers, among others) on 1 January 1999.

To test whether trade relationships between country-pairs with the euro were more intense than the trade relationship between country-pairs where at least one of them did not belong to the monetary union, we introduced the variable $DEuro_{ijt}$ (which takes the value 1 when both exporting country i and importing country j have the euro as their currency during period t, and 0 otherwise). Additionally, when a monetary union is created a trade diversion or trade creation effects may occur. We estimated whether there was trade creation in terms of exports, that is, whether both pig meat exports from eurozone countries to the eurozone and to non-eurozone countries have increased, or conversely, whether pig meat exports were diverted from non-eurozone to eurozone countries. We also estimated whether exports from non-eurozone EU MS to eurozone countries have increased or decreased with the creation of the single currency, that is, whether the euro has resulted in trade creation or in trade diversion in terms of imports.

To ascertain these effects, we distinguish between four different types of country-pair relationships: if both countries belong to the eurozone, if the exporter belongs to the eurozone but the importer does not, if the importer belongs to the eurozone but the exporter does not and, finally, if neither of them belongs to the eurozone. To identify the differences and similarities between these four types of country-pair relationships we have defined two dummy variables additional to $DEuro_{ijt}$: *i*) $DEuro\_Exp\_noImp_{ijt}$, which takes the value 1 when exporting country i has adopted the euro as its currency in period t but importing country j has not, and is 0 in all other cases, and *ii*) $DEuro\_noExp\_Imp_{ijt}$, which takes the value 1, when exporting country i is an EU MS that has not adopted the euro as its currency in period t but importing country j has, and is 0 in all other cases.

A positive and significant value of $DEuro\_Exp\_noImp_{ijt}$, together with a positive value of $DEuro_{ijt}$ would indicate that the single currency has had a trade creation effect. Conversely, a negative coefficient of $DEuro\_Exp\_noImp_{ijt}$ would reveal an export diversion effect. Furthermore, there are two types of non-eurozone importers in our sample, EU MS that do not have the euro as their currency, and second, non-EU countries. To test whether or not the coefficients differ between EU MS and non-EU countries, we constructed two additional dummy variables, $ExEuro\_ImEUnoEuro_{ijt}$ (takes the value 1 when exporting country i has the euro and importing j is a non-euro EU MS in t, and 0 otherwise) and $ExEuro\_ImnoEU_{ijt}$ (takes the value 1 when exporting country i has the euro and importing j is a non-EU MS in t, and 0 otherwise). Finally, the variable $DEuro\_noExp\_Imp_{ijt}$ singles out country-pairs where the exporter is an EU MS that does not belong to the eurozone but the importer does. A negative and significant coefficient of $DEuro\_noExp\_Imp_{ijt}$ would suggest that there has been a diversion effect in terms of imports. That is, eurozone countries have substituted the pig meat imports from non-eurozone EU MS with imports from other eurozone countries.

To distinguish the impact of the euro from the impact of EU membership we isolate the effects of EU membership, introducing DEU_{ijt} (that takes the value 1 when both exporting country i and importing country j are

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full EU MS in period *t*, and 0 otherwise), which allows us to estimate the effects of becoming EU MS and enjoying the benefits of the single market.

The gravity equation postulates that the volume of trade between two countries is directly related to their economic importance. To represent the economic size of the exporting country's pork industry, we define $ExpProd_{it}$ as the value in EUR million of the pig meat produced by exporting country *i* in period *t*, which coefficient we expect to be positive and statistically significant, meaning that the higher a country's production, the higher we expect its exports to be. We use GDP to measure the economic importance of the importing country. A country's expenditure on any particular good tends to be greater the higher its GDP, either because it has a bigger population or because its inhabitants have greater purchasing power. Variable $ImpGDP_{jt}$ is the value of GDP in EUR million of importing country *j* in period *t*, obtained from the International Monetary Fund (IMF 2017) database. We expect the estimated $ImpGDP_{jt}$ coefficient to be positive and statistically significant since we expect that the larger the importing country, the higher the value of its pig meat imports. Furthermore, this estimated parameter is the elasticity value of pig meat exports X_{ijt} from country *i* in respect to the GDP of importing country *j*, and should be construed as how much more country *j* would import from country *i* following a one per cent increase in its GDP. Also, gravity models often explain bilateral trade as a function of transport costs represented by distance. We included the variable $Distance_{ij}$ defined as the distance in km between the capitals of exporting country *i* and importing country *j* that approximates transport cost. We expect its coefficient to be negative and significant. Trade relationships with remote countries are considered to be more difficult, these difficulties are not necessarily due only to transport costs but to cultural and ancestral differences. We also include the variable $DBorder_{ij}$, which takes the value 1 when exporting country *i* and importing country *j* have common borders and 0 otherwise. We introduce this variable, even if technically there are no borders in the EU because we expect that countries that historically have had neighbourly relationships maintain a larger volume of trade than others. We expect its estimated coefficient to be positive and statistically significant.

We followed Rose and van Wincoop (2001) as a benchmark to estimate the euro effects on the pig meat trade. We specified the functional form for and we obtained the generalized gravity model in linearized form for the value of pig meat trade from country *i* to *j* as:

$$\begin{aligned}\ln X_{ijt} = {} & \beta_0 + \beta_1 \ln ExpProd_{it} + \beta_2 \ln ImpGDP_{jt} + \\ & + \beta_3 lnDistance_{ij} + \beta_4 DBorder_{ij} + \\ & + \beta_5 DEU_{ijt} + \beta_6 DEuro_{ijt} + \\ & + \beta_7 DEuro\_Exp\_noImp_{ijt} + \\ & + \beta_8 DEuro\_noExp\_Imp_{ijt} + u_{ijt}\end{aligned} \quad (1)$$

where: X_{ijt} – value of the pig meat exported by each of the 28 EU countries; $ExpProd_{it}$ – value of the pig meat produced by exporting country; $ImpGDP_{jt}$ – value of GDP of importing country; $Distance_{ij}$ – distance between the capitals of exporting country and importing country; $DBorder_{ij}$ – takes the value 1 when exporting country and importing country have common borders, and 0 otherwise; DEU_{ijt} – takes the value 1 when both exporting country and importing country are full EU MS, and 0 otherwise; $DEuro_{ijt}$ – takes the value 1 when both exporting country and importing country have the euro as their currency, and 0 otherwise; $DEuro\_Exp\_noImp_{ijt}$ – takes the value 1 when an exporting country has adopted the euro as its currency but importing country has not, and is 0 in all other cases; $DEuro\_noExp\_Imp_{ijt}$ – takes the value 1 when exporting country is an EU MS that has not adopted the euro as its currency but importing country has, and is 0 in all other cases; u_{ijt} – error term; *i* – exporting country; *j* – importing country; *t* – period.

Anderson and van Wincoop (2003), showed that the volume of trade between two countries (having taken their economic weight into account) depends not only on their bilateral trade barriers but also on the relative importance of trade barriers with and between third countries, i.e. the multilateral trade resistance terms. Not introducing these multilateral resistance terms as explanatory variables in the regression model could create a problem of omitted variables that could lead to biased and inefficient estimates. Following Santos Silva and Tenreyro (2006), we estimated our model using the PPML method with FE. It addresses the omitted variable bias due to the unaccounted for multilateral resistance terms with the use of FE and is consistent in the presence of heteroskedasticity when the gravity equation is log-linearized. Also, Santos Silva and Tenreyro (2011) showed that PPML solves the sample selection bias problem due to non-random zero trade distribution in the dependent variable. Hence, the PPML with FE solves the main estimation problems that we face.

The dependent variable follows a Poisson distribution with a conditional mean $E(X_{ijt})$ that is an exponential function of the explanatory variables:

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$$E\left(X_{ijt}\right) = e^{\left(\begin{array}{l}\beta_0 + \beta_1 \ln ExpProd_{it} + \beta_2 \ln ImpGDP_{jt} + \\ + \beta_3 \ln Distance_{ij} + \beta_4 DBorder_{ij} + \beta_5 DEU_{ijt} + \\ + \beta_6 DEuro_{ijt} + \beta_7\ DEuro\_Exp\_noImp_{ijt} + \\ + \beta_8 DEuro\_noExp\_Imp_{ijt}\end{array}\right)} \quad (2)$$

where: e – Euler's number

We estimate a model with exporting country, importing country, time and country-pair FE. Exporting and importing country FE allows controlling for the average differences across exporting countries and across importing countries. The presence of a time FE absorbs the bias caused by excluding unobserved variables that change over time but are constant over country-pairs. That is, this model allows eliminating bias from unobservables that change over time but are constant across countries and it controls for factors that differ across countries but are constant over time. However, specific bilateral characteristics of trading partners may influence trade, and we include country-pair FE to control for these characteristics. It eliminates bias from unobservable characteristics of country pairs. It captures the time-invariant pair characteristics that could be correlated with the likelihood of belonging to the eurozone.

Gravity models often explain bilateral trade as a function of some observable characteristics such as *Distance* and *DBorder* that are constant between pairs of countries. However, to include these variables in our estimations we have to drop country-pair FE because these FE account for all unobserved variables that are time-invariant characteristics of a country-pair including *Distance* and *DBorder*. In our second model, we included variables *Distance* and *DBorder* and dropped country-pair FE. Finally, however, note that with this specification we could have left out some relevant unobserved time-invariant variables due to the lack of data. If this was the case, this model estimated parameters would have a higher likelihood of being biased. To account for all unobserved variables is important for the estimation because we avoid the problems related to omitted variables (Wooldridge 2009). The software used for our estimations was Stata 16.

RESULTS AND DISCUSSION

We now present our estimations in Table 2. In our models, all standard errors are estimated, clustered by country pair. The estimated coefficients of any of the independent variables introduced as logarithm in the PPML regression can be interpreted as elasticities, and those introduced in levels as ratios, if we calculate their exponential values. We consider the differences between parameters significant with a *P*-value of < 0.05.

The estimated coefficient of *DEU* is positive and significant. Its estimated value oscillates between 1.299 and 1.417, between our two models. We interpret these results in incidence rate ratios, that is, the rate at which events occur. For example, we exponentiate it and obtain $e^{1.299}$ = 3.665 (similarly $e^{1.417}$ = 4.124). That is, country-pairs, where both countries are EU MS are expected to have an export rate 3.665 (or 4.124) times higher than the rest of the country-pairs. Our results confirm that joining the EU facilitates pig meat trade among EU countries and that the integration of EU pig meat trade began taking place before the introduction of the euro.

To better explore the role of the euro we consider all the possible country-pair relationships. The control group includes only country-pairs where neither exporting country nor importing country belongs to the eurozone. The positive and significant coefficient of *DEuro*, in both regressions (0.292 and 0.360, respectively), means that the value of meat exported between country-pairs where both countries belong to the eurozone is significantly higher than the value of meat exported between country-pairs where neither belongs to it. Therefore, the creation of the eurozone increased the pig meat trade significantly between its members. Note, however, that the absolute value of the estimated parameter of *DEuro* is always smaller than the estimated parameter of *DEU*, which suggests that joining the EU has had a greater impact on the pig meat trade than the creation of the currency union. One possible explanation for this result could be that there was a lengthy euro convergence process that ended when national currencies entered the euro. The euro effect started before the creation of the common currency. Thus, *DEU* may partially accounts for the effects of this convergence process.

Our results further reveal that the parameter value of *DEuro_Exp_noImp* in the country-pair FE model is also positive and significant (0.698), which together with the positive value of the *DEuro* coefficient suggests that some export creation has occurred. In the model without country-pair FE, the variable *DEuro_Exp_noImp* is positive but not significant. This loss of significance level reduces evidence of the export creation effect from eurozone countries to countries that do not belong to the eurozone. However, we may still conclude that the introduction of the common currency led to an export trade creation effect, in the sense that the joint

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Table 2. PPML estimated regression of the value of pig meat exports from EU MS: Determination of trade creation or trade diversion

Variable	Without export differences to non-euro EU *vs.* to non-EU countries		With export differences to non-euro EU *vs.* to non-EU countries	
	With country-pair FE	Without country-pair FE	With country-pair FE	Without country-pair FE
ExpProd	0.745*** (0.000)	0.826*** (0.000)	0.747*** (0.000)	0.826*** (0.000)
ImpGDP	0.509*** (0.000)	0.618*** (0.000)	0.507*** (0.000)	0.619*** (0.000)
Distance	–	–0.599*** (0.000)	–	–0.593*** (0.000)
DBorder	–	1.093*** (0.000)	–	1.092*** (0.000)
DEU	1.299*** (0.000)	1.417*** (0.000)	1.381*** (0.000)	1.358*** (0.000)
DEuro	0.292* (0.014)	0.360* (0.027)	0.290* (0.014)	0.360* (0.027)
DEuro_Exp_noImp	0.698*** (0.000)	0.0700 (0.570)	–	–
DEuro_noExp_Imp	–0.144 (0.344)	–0.917*** (0.000)	–0.144*** (0.344)	–0.912*** (0.000)
ExEuro_ImEUnoEuro	–	–	0.640*** (0.000)	0.133 (0.385)
ExEuro_ImnoEU	–	–	0.806*** (0.000)	–0.011 (0.961)
Number of observations	19 127	19 127	19 127	19 127
Pseudo R^2	0.949	0.832	0.949	0.8324

***, **, *Significance at $P < 0.001$, $P < 0.01$ and $P < 0.05$ levels, respectively; PPML – Poisson pseudo-maximum likelihood; EU MS – European Union Member States; FE – fixed effects; *ExpProd* – value of pig meat in EUR million produced by the exporting country during a given period; *ImpGDP* – GDP in EUR million of importing country; *Distance* – distance in km between the capitals of exporting country and importing country; *DBorder* – takes the value 1 when exporting country and importing country have common borders, and 0 otherwise; *DEU* – takes the value 1 if both exporting and importing country are EU MS in *t* and 0 otherwise; *DEuro* – takes the value 1 if both exporting and importing country have the euro and 0 otherwise; *DEuro_Exp_noImp* – takes the value 1 if exporting country has adopted the euro but importing country has not, and 0 otherwise; *DEuro_noExp_Imp* – takes the value 1 if exporting country is an EU MS that has not adopted the euro but importing country *j* has, and 0 otherwise; *ExEuro_ImEUnoEuro* – takes the value 1 if exporting country has adopted the euro and importing country is a non-euro EU MS, and 0 otherwise; *ExEuro_ImnoEU* – takes the value 1 if exporting country has adopted the euro and importing country does not belong to the EU, and 0 otherwise
Source: Authors' own calculations based on data provided by Eurostat (2018) and IMF (2017) databases (1995–2014)

effect of the exports from the eurozone to other eurozone countries and from the eurozone to non-eurozone countries is positive [among others, this interpretation is used by Shanping and Martínez-Zarzoso (2014)]. Pig meat exports from eurozone countries increased. Exports were not diverted, and the introduction of the euro has resulted in trade creation for the countries that adopted it. Let us recall that there are two types of importers that do not belong to the eurozone. First, EU MS that do not have the euro as their currency, and second, non-EU countries. To test whether or not the exports from eurozone countries has increased similarly to both non-euro EU MS and to non-EU countries, we test if there was a significant difference between the coefficients of variables, *ExEuro_ImEUnoEuro* and *ExEuro_ImnoEU*. We used a Wald test and could not reject the null hypothesis with a *P*-value of 0.303. Therefore, we conclude that the intensity of exports from eurozone countries has increased similarly to both non-euro EU MS and to non-EU countries.

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Additionally, the negative parameters of *DEuro_noExp_Imp* (–0.144 and –0.917) suggest that after the introduction of the common currency, trade diversion in terms of imports has emerged. This variable represents the set of country-pairs where only the importer belongs to the eurozone. Its negative value suggests that an increase in exports among eurozone countries (positive and significant variable *DEuro*) is accompanied by a reduction in the imports of eurozone countries from non-eurozone EU countries (negative parameter of *DEuro_noExp_Imp*). EU pig meat exporting countries have an advantage when exporting to eurozone countries if they have the euro as their currency. The EU MS that do not belong to the eurozone have found a non-level playing field for selling pig meat to eurozone members. With the introduction of the euro, EU pig meat exporters that do not belong to the eurozone have suffered from a 'euro facilitation effect' that benefits exporters that belong to the eurozone and results in trade diversion from non-eurozone EU countries.

The coefficients of the rest of the explanatory variables were as expected. $ExpProd_{it}$ is positive and significant, and it highlights that the larger the value of pig meat produced by a country, the greater the economic magnitude of its exports. When the $ImpGDP_{jt}$ estimated coefficient is positive and statistically significant, the higher the GDP, the larger its pig meat imports. The estimated coefficient of the variable *Distance* is negative and significant. Our results ratify the hypothesis that most authors have considered, that transport costs have a negative impact on exports. Furthermore, the estimated coefficient of the variable *DBorder* is positive and significant, as expected. Sharing borders increases the volume of trade between countries.

CONCLUSION

Our estimated results (the positive and significant value of the *DEuro* coefficient) show that, *ceteris paribus*, pig meat exports from eurozone countries have increased towards other eurozone countries in addition to the intensification already achieved with the creation of the EU single market. However, it may be difficult to distinguish the effects of these two integration steps, that is, the creation of the EU single market and the monetary union. The positive and the significant coefficient of the variable *DEU* suggest that for pig meat trade the convergence process that countries had to undergo when entering this single market had already enabled them to engage and strengthen the international pig meat trade. The introduction of the euro as a currency and the previous creation of the EU single market have allowed countries to benefit from a cross-country sales integration process. Firms or other economic agents in EU exporting countries may have anticipated the effects of the introduction of the common currency and adjusted their behavior accordingly. Both effects together have enabled countries and firms engaged in international trade from eurozone countries to grow.

Moreover, we can conclude that the introduction of the euro resulted in trade creation for adopting countries, as the joint effect of exports from eurozone countries to other eurozone countries and from the eurozone to non-eurozone countries is positive. The variable *DEuro_Exp_noImp* presents a positive coefficient in both estimated models but loses its significance when we drop country-pair FE. The positive coefficient indicates that exports were not diverted from non-eurozone importers to eurozone importers, on the contrary, there was trade creation, as both pig meat exports to the eurozone and to non-eurozone importers have increased or remain equal.

Additionally, the negative value of the estimated parameters of *DEuro_noExp_Imp* (–0.144 and –0.917) suggest that after the introduction of the common currency, some trade diversion in terms of imports has emerged. Imports from EU MS that do not belong to the eurozone seem to be replaced by imports from EU MS that belong to the eurozone. The EU MS that do not belong to the eurozone have found a non-level playing field for selling pig meat to eurozone members because the eurozone countries enjoy easier access to the market.

The experience of years of trade in the EU has allowed the development of an industry able to take advantage of economies of scale and experience in European markets to access and compete successfully in the global market. The establishment of the eurozone reduced transaction costs, enhancing global trade and resulting in trade creation. Moreover, the single currency may also have favored the expansion of extra-EU trade in this sector. Factors such as the consolidation of the euro as a second world currency may have contributed to facilitating exports.

The good performance of this sector during these euro adoption years shows that sectors that have never been excessively protected by the CAP are able to compete with little regulatory aid and become highly competitive in the global markets. Thus, it would seem possible to affirm that the results of this study corroborate that the benefits of the euro have outweighed its

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costs for the European pig meat sector. Trying to measure and isolate the impacts of the monetary union in the European pig meat sector is not an easy task, since it is difficult to separate its impact from other important international changes such as globalization, changes in consumer tastes, and health concerns, among others. Possibly the worst enemy for EU pig meat exporting countries will not come from competing countries but from the shift in consumer tastes.

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