Readdressing the Trade Effect of the Euro: Allowing for Currency Misalignment

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Abstract

We know that euro-area member countries have absorbed asymmetric shocks in ways that are inconsistent with a common nominal anchor. Based on a reformulation of the gravity model that allows for such bilateral misalignment, we disentangle the conventional trade cost channel and trade effects deriving from "implicit currency misalignment". Econometric estimation reveals that the currency misalignment channel exerts a significant trade effect on bilateral exports. We retrieve country specific estimates of the euro effect on trade based on misalignment. This reveals asymmetric trade effects and heterogeneous outlooks across countries for the costs and benefits from adopting the euro.

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1 Introduction

The run-up to the Economic and Monetary Union (EMU) of the EU has been dominated by tension between a big aspiration and a big concern. The aspiration was that a common currency would reinvigorate the single market programme by establishing more cross-country transparency, wiping out all exchange rate uncertainty, and lowering administrative cost of intra-European trade. The concern was that some member countries might face problems in adjusting to a common nominal anchor. In order to allay fears of macroeconomic instability that would possibly result from such problems, ex ante macroeconomic convergence was installed as a prerequisite for membership in the currency union. The famous Maastricht entry criteria were supposed to guarantee, or at least foster, the ability of all member countries to live with a *stable* common nominal anchor ex post. In addition, the Stability and Growth Pact (SGP) has installed a rule of conduct, in order to ensure that the stability of this anchor would not be jeopardised from member countries' waning fiscal discipline.

Ten years on, we now have a wealth of evidence to judge whether the aspirations have been met and the concerns have been justified. On the macroeconomic side, the verdict seems split. On the one hand, the success of the Euro system in establishing lasting stability of the nominal anchor seems beyond doubt; see Wyplosz (2006). On the other hand, member countries' longer-term abilities to live with this anchor in some cases *are* in doubt, judged from the build-up of public sector imbalances, as well as from responses of nominal wage levels to country-specific shocks, which have lead to sizable misalignments of real exchange rates, as detailed in a recent report by the European Commission.[1]

On the single market aspirations, the verdict might draw on evidence of a trade-enhancing effect of the euro. While the famous tripling estimate which Rose (2000) found for pre-euro currency unions could never be reestablished for the euro area, the literature has produced a host of studies confirming positive effects on bilateral trade for the euro area as well. Early studies found effects around 15%, while more recent estimates based on refined econometric techniques reveal an effect barely above zero, if any at all; see Baldwin et al. (2008).

Setting overarching "European ambitions" such as the single market aspirations aside, a significant trade effect may seem like a necessary benefit to justify the cost

[1] See Volume 8 N° 1 (2009) of the Quarterly Report on the Euro Area.

of euro membership. After all, for several countries satisfying the relatively strong ex ante convergence criteria was quite costly, without any clear evidence of a lasting benefit, other than being part of the Euro; see Wyplosz (2006). Nor has the pain necessarily gone after entry. Member countries are subject to rigorous surveillance from Brussels and compliance with potentially painful fiscal rules under the Stability and Growth Pact. Furthermore, euro members delegate all monetary policy control to the European Central Bank, for the sake of a common nominal anchor that does not equally suit each individual member. Arguably, where countries are willing to pay such a price, there should also be a benefit. For most countries, a large enough boost in trade, due to higher transparency, lower uncertainty, and lower administrative cost, would conceivably be worth paying the price.[2]

In this paper, we argue that existing estimates of the trade effect of common currencies, particularly of the euro, suffer from ignoring what we call the currency misalignment channel. In most cases, the framework adopted involves estimation of the gravity model of bilateral trade, allowing for a common currency to affect bilateral trade through the so-called trade cost channel. This seems like an obvious approach, since it allows to conveniently control for determinants of bilateral trade other than a common currency, and to infer the magnitude of a trade effect, if any, from the coefficient estimate of a common currency dummy. However, such estimates contain very limited information and are fraught with a serious problem of interpretation, if the currency union suffers from internal real exchange rate misalignments. In the euro area, such misalignments have been building up in sizable magnitudes, due to tensions generated by a common nominal anchor in the presence of asymmetric shocks. We shall present some descriptive evidence on bilateral misalignments below. It is a safe guess that they have also had a profound impact on bilateral trade flows. Existing studies ignore this channel. What we need is an empirical framework that disentangles the *trade cost channel* and the *currency misalignment channel* as two conceptually different ways through which adopting a common currency affects bilateral trade. This paper proposes and implements such a framework.

The central contributions of this paper are as follows. First, we reformulate the

[2]It must be emphasised that easier and less costly trade generates sizable welfare gains, even if there is no associated increase in trade volumes. Indeed, alluding to the standard diagrammatical representation, the "rectangle gains'" on pre-existing trade volumes are likely to be larger than the "triangle gains" deriving from a trade volume effect. In a similar vein, Fontagné et al. (2009) argue that the euro has brought important firm-level gains that need not show up in enhanced aggregate trade.

gravity model of bilateral trade with nominal exchange rates and misalignments within currency unions brought to the fore. An equation of the usual form appears for what we call the “gravity norm”, i.e., a world that satisfies suitably defined bilateral purchasing power parities between all country pairs. Actual trade volumes then emerge as deviations from this norm that are caused by within union misalignments. Based on this model, we develop an empirical framework that allows us to address the trade cost channel affecting the “gravity norm” levels of bilateral trade, as well as the misalignment channel causing deviations from the norm. Secondly, within this framework, we analyse the bias that we must expect to be present in conventional estimates of trade effects from the euro where the currency misalignment channel is ignored. We show that these estimates may be interpreted as marginal effects from the trade cost channel for a hypothetical “sample mean country” that has no bilateral misalignment. While this seems reassuring for the existing literature, it masks potentially severe country heterogeneity. We argue that addressing country heterogeneity in terms of misalignments is very important, because deviations from the “gravity norm” have welfare implications akin to terms of trade effects. Thus, they are vastly different from those pertaining to changes in the “gravity norm”. Our third contribution, therefore, is to bring our framework to euro data, estimating a currency misalignment coefficient, alongside the conventional trade cost effect, and to portray a disaggregate picture of how different countries’ trade volumes have been affected by introducing the euro.

Our approach relies on state of the art estimation of a gravity equation on bilateral merchandise exports, with a common currency dummy capturing the trade cost channel. However, we additionally allow for a bilateral index of disparity in nominal unit wage costs to influence bilateral exports. The maintained hypothesis is that for country pairs that have separate currencies with a “reasonably flexible” nominal exchange rate, disparity in nominal wage levels should play no role, since nominal exchange rate adjustments may re-establish bilateral purchasing power. But for euro members, since such an adjustment is ruled out, nominal wage level disparity should exert a significant influence on bilateral trade. We estimate this effect through an interaction of wage disparity and a common currency dummy, a procedure that we justify through a suitable extension of the gravity model. Our results indicate that the currency misalignment effect is important and drastically changes conclusions drawn from conventional estimates in previous studies. In particular, our approach enables us to address cross-country heterogeneity in the trade effect of the euro. We decompose the euro effect on trade into the traditional trade cost effect, assumed to be common for all countries, and a country-specific misalignment impact.

The paper is structured as follows. In the next section we develop a our argument for why we should bother about the currency misalignment problem when estimating trade effects of a common currency in a gravity framework. Subsequently, section 3 further motivates our analysis by showing descriptive evidence on misalignments in the euro area. Section 4 then develops the extended gravity model where we explicitly determine nominal factor prices and allow for nominal wage level disparity to cause a deviation from the "gravity norm". The model serves as a basis for the subsequent empirical estimation. Section 5 introduces the empirical framework, specifying the estimation equation and describing the data. It also presents the results. Section 6 concludes the paper.

2 Why bother about currency misalignments?

Applying the gravity model in the present context amounts to exploiting cross-country as well as time-variation in exchange rate arrangements and bilateral trade volumes. This means attempting to see whether trade rises due to countries introducing a common currency, if all other determinants of trade are adequately controlled for. Correct identification of the true common currency effect using this approach hinges on the validity of the gravity model of trade and a correct empirical estimation strategy, as well as on successfully controlling for relevant country heterogeneity. Of course, what we are interested in is the trade effect of the euro, *other things equal*. The gravity approach tries to accomplish this by letting other gravity-type determinants "speak up" in the estimation, leaving for the common currency dummy to explain variation of bilateral trade across country pairs that other country characteristics cannot explain. Yet, the standard approach is liable to yield biased estimates in the presence of unobserved country (or country pair) heterogeneity, and also if euro membership itself is endogenous, even if all country heterogeneity is observed.[3]

Our concern can be framed in terms of country heterogeneity, but of a specific

[3]For a general discussion of these problems, see Baier and Bergstrand (2007). An alternative approach that does not hinge on the validity of the gravity approach to bilateral trade is to pursue propensity score matching, in order to ensure the "other things equal condition" when comparing trade across country pairs with and without a common currency; see Persson (2001). Frankel (2009) uses trade flows from African countries with currencies linked to, first, the French Franc and later the euro, in order to tackle the endogeneity issue. He confirms a positive trade effect of the euro.

type that we argue needs to be put into the foreground, rather than just somehow be controlled for. It has to do with the trade effects of what, after all, a common currency is all about, viz. establishing a common nominal anchor between different countries. In all likelihood this means different things for different countries, depending on the shocks, and shock absorption mechanisms, prevailing in different countries. We argue that the usual gravity-type controls do not capture heterogeneity in shock absorption in a satisfactory way.

Consider, first, the question of a selection effect. It is all too obvious from the Maastricht entry criteria that euro members are no random selection of otherwise similar countries. The hope was that Maastricht-type convergence ex ante would somehow guarantee that member countries would eventually establish mechanisms of shock absorption that are in line with a *stable* common nominal anchor ex post. Note that there is some irony here: The very fact that this hope has turned out illusive can now be argued to question any Maastricht-type selection effect, which should strengthen the general validity of the gravity estimates of the trade effect. This is of interest when looking at euro area experience from a broader perspective of currency union effects, but our concern is a different one.

Suppose, then, that there is no selection effect. What remains is that the trade effect of euro membership, estimated in the aforementioned way, confounds two fundamentally different channels. One is the conventional *trade cost channel*, which the gravity approach seems tailored to pick up, and which typically underlies interpretations of the results obtained in the literature. Importantly, this channel operates *symmetrically* across all countries. The other is the *currency misalignment channel* which – almost by definition – operates *asymmetrically*. It arises, if some countries of the union – for whatever reason – experience, or actively pursue, shock absorption that is inconsistent with the common nominal anchor. In the present context, perhaps the most important dimension of shock absorption is nominal wage levels.

But why should confounding these two channels cause problems? After all, the gravity model does not explicitly specify any role of *nominal* exchange rates or international currency arrangements. Although researchers typically allude to trade costs, the approach actually leaves open what it is, exactly, that makes countries trade more with each other if they share a common currency, compared to a situation in which they don't.[4] At first sight, this may seem like an advantage in that the

[4]The same applies, if one attempts to identify differential trade effects of a richer classification of currency arrangements that includes varying degrees of exchange rate flexibility. For a study that implements a classification of 12 degrees of exchange rate flexibility, see Egger (2008).

approach allows us to pick up *any* effect that one can possibly imagine.

But for the same reason, a correct interpretation of the estimated effects seems very hard, or impossible, if both the trade cost and the currency misalignment channels are operative in the sample. Consider, for instance, the welfare gains. Arguably, these should provide the ultimate rationale for enhanced trade. Clearly, enhanced trade that emerges from the trade cost channel and trade effects that derive from real exchange rate misalignments have different welfare implications. Trade cost reductions generate the usual "rectangle" and "triangle" gains, symmetrically for all countries.[5] By way of contrast, misalignment-induced trade generates welfare effects akin to terms of trade effects, which are clearly asymmetric in nature. In view of the mercantilistic tone that often prevails in popular arguments related to trade effects of the euro, it is perhaps worth pointing out that an increase in exports due to a real exchange rate depreciation involves a term of trade deterioration. This seems a long shot from welfare gains from trade expansion. To summarise this point, any given trade effect of a common currency will mean very different things, depending on the presence (or not) of a currency misalignment effect behind trade.

One might argue that, since any currency misalignment by definition is a bilateral affair of over- and undervaluation, misalignment effects should cancel out in the overall picture. Accordingly, they should not harm aggregate estimates of the trade cost effects too much. One might question this argument on empirical grounds, since misalignment effects should still be expected to affect aggregate trade, if countries are of unequal size, or if bilateral trade is unbalanced. We shall demonstrate below that within our empirical framework – somewhat surprisingly – the conventional procedure does indeed generate unbiased estimates of the marginal trade-cost effect of a common currency for a hypothetical "sample mean country". However, it seems difficult to imagine that one would be satisfied knowing the aggregate trade cost effect, recognizing that it masks significant country heterogeneity from multiple misalignments within the currency union. There is no way to avoid the conclusion

[5] Note that even pure trade cost channel effects are but an incomplete measure of the welfare effects from euro-enhanced trade. Specifically, the bulk of gains arise on inframarginal trade. Invoking a simple partial equilibrium diagram, the estimated trade effect, combined with an estimate of the price elasticity of trade, would allow us to infer a "price-equivalent effect" of the trade cost channel effect on trade volumes. It is then straightforward from the usual partial equilibrium exposition to calculate the "triangular" welfare increase from trade expansion. But more importantly, the "rectangle" gains then follow from the price-equivalent effect and the pre-existing, inframarginal volume of trade. In addition to the traditional effects, there are variety and scale effects suggested by new trade theory, as well as productivity effects from firm heterogeneity stressed by the "new new" trade theory.

that the currency misalignment channel needs appropriate attention in the empirical analysis. Therefore, we now proceed to a suitable reformulation of the gravity approach leading to an empirical framework that allows us to do so, and to implement this framework towards a disaggregate, country-specific view on the trade effects of the euro.

3 Descriptive evidence on misalignment

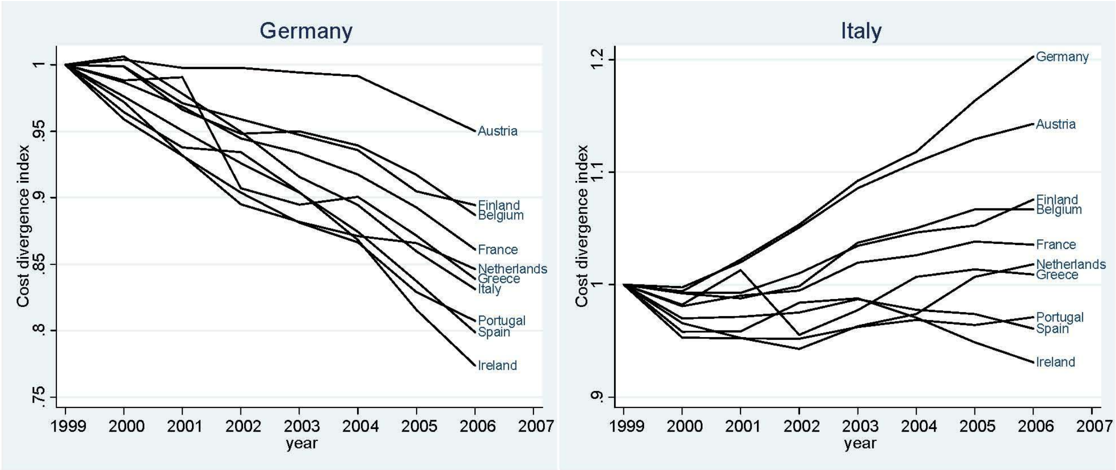
Before we proceed with a refinement of gravity-modeling and estimation, we take a quick look at the data in order to see whether we are talking about a phenomenon of empirical importance. In terms of the model developed in the next section, we calculate bilateral measures of cost divergence as $\bar{m}_{ijt} = c(\mathbf{w}_{it})/c(\mathbf{w}_{jt})$, where $\mathbf{w}_{.t}$ denotes a vector of nominal factor prices (e.g., wages) prevailing in euro area countries i and j, respectively, at time t, and $c(\cdot)$ denotes a minimum unit-cost function for aggregate output.[6] Considering that within the euro area nominal exchange rate adjustments are no longer possible, any long-run upward or downward trend in $\bar{m}_{ijt}$ must be seen as an implicit intra-euro "currency misalignment" in the sense discussed above and identified precisely in the next section.

We focus on unit labor costs, relying on data from the Organisation for Economic Cooperation and Development (OECD). These measures, representing the average cost of labor per unit of output, can be seen as a reflection of a country's cost competitiveness.[7] Germany and Italy are good cases in point. Figure 1 shows the values of $\bar{m}_{ijt}$, where the left-hand panel sets i = Germany and the right-hand panel sets i = Italy, with j indicating other euro members in either case. We set the index base-year to 1999, thus assuming that the euro entry exchange rates at the start were roughly in line with bilateral purchasing power. The figure clearly shows that the currency misalignment was not a "dead channel" for trade between the two countries and the other euro area members. Germany has experienced significant real depreciation vis à vis all other countries, indicating substantial gains in relative competitiveness. For Italy, the picture is a little less clear cut, but in

[6] For ease of exposition, we assume $c(\cdot)$ to be the same for each country. Our empirical strategy in no way relies on this assumption.

[7] Note that competitiveness here is not to be interpreted as fully comprehensive. Changes in the cost of capital may be considered as well when assessing the overall competitiveness of a country. However, in the euro area interest rates are set by the ECB for all members while labor market policies remain within the realm of national governments.

Figure 1: **Unit labor cost relative to other euro-area countries**



the majority of cases it has experienced a sizable real appreciation and a loss in relative competitiveness. In a bilateral trade context, we would then expect exports from Germany to Italy to rise above, while those from Italy to Germany would fall, relative to what we will subsequently call the "gravity norm" level of bilateral trade.

Table 1 presents evidence for the rest of the euro area. The values in the first column refer to averages over all euro area partner countries in the year 2006; the second column shows the respective values averaged over time since 2000. Note that in 1999, by definition, there was no misalignment. The table documents a considerable degree of divergence in bilateral unit labor costs across the euro area. It can also be seen that for most countries the recent misalignment is larger than the average value, pointing towards cumulative divergence processes. We conclude that there is a multiple and varied pattern of bilateral misalignment. Living with a common nominal anchor has proven less trouble-free ex post than was hoped for ex ante. In view of the above considerations, this strongly suggests a euro-induced effect of implicit currency misalignment on bilateral trade that should be taken into account when estimating the trade effect in a gravity context.

A remaining concern is whether the new currency arrangement indeed stands for a strong break with the monetary past of the respective countries. In particular, from a legal perspective, exchange rates where far from a free float under the European Monetary System (EMS) even before the currency union was formed. However, the bands within which national currencies were allowed to fluctuate still provided ample opportunity for exchange rate adjustments, in order to compensate for diverging

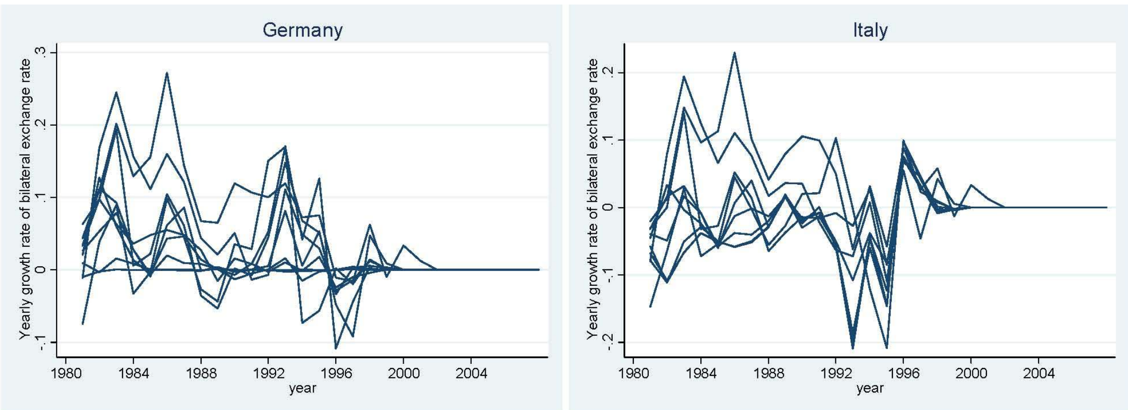
Table 1: **Currency misalignment by country**

Country (i)	2006	2000-2006
Germany	0.8490	0.9185
Austria	0.8989	0.9323
Finland	0.9610	0.9790
Belgium	0.9699	0.9798
France	1.0021	0.9970
Netherlands	1.0212	1.0397
Greece	1.0312	1.0208
Italy	1.0413	1.0108
Portugal	1.0752	1.0563
Spain	1.0877	1.0408
Ireland	1.1261	1.0545

Note: Averages across countries j.
Annual averages for 2000-2006.

nominal cost conditions. Thus, figure 2 shows that the bands were indeed used in non-trivial amounts for the various countries' macroeconomic mechanisms to absorb asymmetric shocks. The figure depicts yearly log-changes in bilateral exchange rates, again focusing on Germany and Italy as two obvious cases in point.[8]

Figure 2: **Pre-euro exchange rate movements for Germany and Italy**



[8]The European Monetary System (EMS)) has allowed nominal exchange rates to fluctuate within a band of 4.5% in the time from 1979 through 1993. Italy was an exception and was allowed to widen this band to 6%. Following a massive disruption in 1993, the band was further widened to 15%. Note also that not all countries in the sample were at all times members of the EMS. In particular, Austria joined in 1995, Finland in 1996 and Greece in 1998.

4 Currency Misalignment in the Gravity Model

4.1 "Gravity norm": The trade cost channel

We now turn to a theoretical gravity model in order to formalise our idea of disentangling the trade cost and the currency misalignment channels as two fundamentally different ways in which introducing the euro as a common currency within the EU may have affected trade volumes. Suppose we have the usual Dixit-Stiglitz-type underpinning of the gravity approach. Denoting the c.i.f.-price in country j for a variety arriving from country i by p_{ij}, the quantity of demand D_{ij} for this variety is

$$D_{ij} = A_j \left(p_{ij}\right)^{-\sigma}, \tag{1}$$

where $A_j := Y_j \left(P_j\right)^{\sigma-1}$ and $\sigma > 1$ denotes a uniform elasticity of substitution between different varieties of goods. In this expression, Y_j is equal to country j's GDP, and P_j is the exact price index (unit-expenditure function), depending on prices of all varieties shipped to market j.[9] Importantly, all variables on the right-hand side of (1) are in country j's currency.

To address the issue of *currency misalignment*, we now introduce nominal factor prices. Suppose that in each country there are K primary factors, and assume that all input use is in terms of the same bundle of primary inputs. We model this by means of a constant-returns-to-scale function $g(\mathbf{v})$, where $\mathbf{v}$ denotes a vector of factor inputs employed in order to generate the input bundle. More specifically, we assume that production of a variety requires a fixed amount f and a constant amount a of this bundle per unit of output. For ease of exposition, we assume technology to be uniform across all countries, although our results in now way hinge on this assumption. Unlike Helpman et al. (2008), we assume that all firms have the same productivity in terms of both marginal and fixed cost. Variable and fixed cost in any country i then depend on country i's factor prices $\mathbf{w}_i$. Writing $c(\mathbf{w})$ for the minimum unit-cost function dual to $g(\mathbf{v})$, the cost conditions in domestic currency are governed by

$$c_i = c\left(\mathbf{w}_i\right), \tag{2}$$

where $\mathbf{w}_i$ denotes a $K \times 1$ vector of *nominal* factor prices in country i. The c.i.f.-price

[9] In replacing expenditure levels through GDP, we assume total trade to be balanced.

of a typical variety exported from i to j is then equal to

$$p_{ij} = E_{ij} \frac{T_{ij} c(\mathbf{w}_i)\, a}{\rho}, \quad \text{with } \rho := (\sigma - 1)/\sigma \tag{3}$$

In this equation, we use E_{ij} to denote the nominal exchange rate, defined as the price of currency i expressed as in units of currency j. For simplicity, we scale units such that $a = 1$.

Arguably, monetary stability over time requires that the purchasing power of a unit of money over the inputs required to generate a unit of aggregate output should remain constant. Alternatively, it may be defined as a constant level of the unit expenditure function. We define a stable nominal anchor as a constant level of $c(\mathbf{w})$.[10] By analogy, we define *bilateral purchasing power parity* (PPP) between countries i and j as a situation where both countries have the same nominal cost of generating the bundle $g(\mathbf{v})$, if expressed in the same currency unit. The PPP level of the nominal exchange rate, henceforth denoted by $\tilde{E}_{ij}$, is then implicitly defined through

$$c\left(\mathbf{w}_i \tilde{E}_{ij}\right) = c(\mathbf{w}_j) \quad \Longrightarrow \quad \tilde{E}_{ij} = \frac{c(\mathbf{w}_j)}{c(\mathbf{w}_i)} \tag{4}$$

The second equation uses linear homogeneity of the minimum unit-cost function. Notice that with C different currencies there are $C - 1$ independent exchange rates. If PPP holds between countries i and j, as well as between i and k, then it also holds for countries j and k.

In what follows, we use

$$m_{ij} := E_{ij} \Big/ \tilde{E}_{ij} \tag{5}$$

as the factor of *bilateral currency misalignment*. If $m_{ij} = 1$ throughout, then there is no currency misalignment, and $E_{ij} c(\mathbf{w}_i) = c(\mathbf{w}_j)$. Expressed in a single currency, say country 1's currency (e.g., US$), the minimum-unit-cost of the factor bundle $g(\mathbf{v})$ then is the same world-wide: $(E_{ij} E_{i1})\, c(\mathbf{w}_i) = c(\mathbf{w}_1)$ for all i and j.[11] All possible countries of origin for any country j's imports then have the same underlying cost conditions, governed by real forces like productivity.

[10] This captures the idea of a constant purchasing power of money over time, but it avoids dependence of the nominal anchor on the degree of variety offered in goods markets, which would arise when using the unit-expenditure function.

[11] Bilateral PPP implies that nominal cost in country i, expressed in j-currency is $E_{ij} c(w_i) = c(w_j)$. It also implies that the nominal cost in country j, expressed in country 1's currency is $E_{1j} c(w_j) = c(w_1)$. Taken together, this implies $E_{ij} E_{j1} c(w_i) = c(w_1)$ for all i and j.

Thus, for universal PPP, the gravity model of bilateral trade may be written and estimated without any role for nominal exchange rates, with all prices and trade values interpreted as being expressed in any one currency, say US$. Due to zero degree homogeneity of (1) in prices and incomes, the solution of the model is invariant to the currency in which incomes and prices are expressed, provided that PPP holds universally. For instance, in the model detailed in Kohler and Felbermayr (2009), introducing currencies and imposing bilateral PPP would then tie down $c(\mathbf{w}_i)$ for all i to $c(\mathbf{w}_1)$.

In what follows, we call this the *"gravity norm"*, and we use currency 1 as our "numéraire currency". Establishing a currency union affects "gravity norm trade flows" through the trade cost channel. Empirically, this is captured through a suitable specification of T_{ij}. In the sequel we shall indicate hypothetical "gravity norm values" through a tilde. The "gravity norm" demand function then emerges as

$$\tilde{D}_{ij} = \tilde{Y}_j \frac{\left[P_j\left(T_{1j}c(\mathbf{w}_1)/\,\rho \ldots T_{Cj}c(\mathbf{w}_1)/\,\rho\right)\right]^{\sigma-1}}{\left[T_{ij}c(\mathbf{w}_1)/\,\rho\right]^{\sigma}} \tag{6}$$

$$= \tilde{Y}_j \left[\frac{c(\mathbf{w}_1)}{\rho}\right]^{-1} \frac{\left[P_j\left(T_{1j}\ldots T_{Cj}\right)\right]^{\sigma-1}}{\left(T_{ij}\right)^{\sigma}}, \tag{7}$$

where $P_j(\cdot)$ denotes the familiar Dixit-Stiglitz-type price index over all varieties consumed in country j. It should be noted that $\tilde{Y}_j$ is notional "gravity norm GDP" of country j, expressed in currency 1. This will in general be different from actual GDP, also expressed in currency 1.

Anderson and Van Wincoop (2003) have shown that, with symmetric trade costs $T_{ij} = T_{ji}$, the usual equilibrium conditions of zero profits (free entry), as well as goods and factor market clearing, the following equations arise for the value of aggregate exports from country i to country j:[12]

$$\tilde{X}_{ij} = \frac{\tilde{Y}_i\tilde{Y}_j}{\tilde{Y}} \left(\frac{T_{ij}}{\tilde{\Pi}_i\tilde{\Pi}_j}\right)^{1-\sigma} \tag{8}$$

$$\text{with} \quad \left(\tilde{\Pi}_j\right)^{1-\sigma} = \sum\nolimits_{i=1}^{C} \tilde{s}_i \left(\tilde{\Pi}_i T_{ij}\right)^{1-\sigma} \quad \text{for} \quad i,j = 1,\cdots,C \tag{9}$$

where s_i is country i's share in world-GDP Y. Equations (8) and (9) represent the

[12] See Kohler and Felbermayr (2009) for a derivation of a similar equation that takes into account the so-called extensive country margin, whereby any given exporter does not necessarily serve all foreign markets.

full "gravity-norm-solution" of this model. Note that (9) represents a C-dimensional system of non-linear equations determining the so-called multilateral resistance terms $\tilde{\Pi}_j$ for all countries $j = 1, \cdots, C$ as functions of exogenous iceberg trade costs T_{ij}. Symmetry of trade costs implies that a country's multilateral trade resistance is the same on its export and its import side.

4.2 Asymmetric shock and implicit misalignment

Deviations from the "gravity norm" may arise due to asymmetric shocks, or different shock absorption mechanisms across countries. Consider, for instance, endowment shocks subject to a downward rigidity of some nominal wage rate. Faced with such rigidities, countries often follow a strategy of permitting differential increases of nominal wages and prices, so as to achieve real wage flexibility and, thus, to avoid unemployment. It is easy to see that this may give rise to misalignment. The $K-1$ equilibrium *relative* factor prices are determined through the following system of $K-1$ equilibrium conditions:

$$\frac{c_k(\mathbf{w}_i)}{c_1(\mathbf{w}_i)} = \frac{v_{ik}}{v_{i1}} \qquad \text{for } k = 2 \ldots K \tag{10}$$

This simply states that, for all possible factor pairs, the cost-minimising input ratios in production of aggregate output are in line with the corresponding relative endowments.[13] Suppose that the *common nominal anchor* requires $c(\mathbf{w}) = 1$, and assume that at time 0 we have $c\left(\mathbf{w}_j^0\right) = c\left(\mathbf{w}_i^0\right) = 1$, with $\mathbf{w}_i^0$ and $\mathbf{w}_j^0$ expressed in common currency, and satisfying equilibrium conditions (10). Moreover, suppose that countries i and j are hit by asymmetric endowment shocks $\mathbf{v}_i^1 - \mathbf{v}_i^0 \neq \mathbf{v}_j^1 - \mathbf{v}_j^0$, and assume that country j can absorb this through full employment factor prices $\mathbf{w}_j^1$ that satisfy $c\left(\mathbf{w}_j^1\right) = 1$. A case of misalignment may then arise, if for country i a change in factor prices that satisfies both, (10) and $c\left(\mathbf{w}_i^1\right) = 1$, is inconsistent with its downward rigidity of nominal wages. Specifically, in order to avoid unemployment, country i may allow for nominal factor price changes that still satisfy (10), but are in line with the given nominal wage rigidity through a deviation from the nominal anchor $c\left(\mathbf{w}_i^1\right) > 1$. This implies that $\tilde{E}_{ij} < 1$. With E_{ij} tied down to 1 by the common currency, the outcome then is an "implicit overvaluation" of country i's currency.

[13]Remember that $c(\cdot)$ is the unit cost-function dual to $g(\mathbf{v})$, which defines the input bundle used in production, both for variable and for fixed inputs.

4.3 Currency unions: The misalignment channel

To highlight deviations from the "gravity norm" caused by currency misalignments $m_{ij} \neq 1$, we first rewrite the underlying demand equation (1) expressing all right-hand side variables in currency 1, using actual exchange rates E_{ij} instead of PPP rates. Due to the usual homogeneity property, this does not affect demand D_{ij}. We have

$$D_{ij} = Y_j E_{j1} \frac{\left[P_j \left(E_{j1} E_{1j}\ T_{1j} c(\mathbf{w}_1)/\,\rho \ldots E_{j1} E_{Cj}\ T_{Cj} c(\mathbf{w}_C)/\,\rho\right)\right]^{\sigma-1}}{\left[E_{j1} E_{ij}\ T_{ij} c(\mathbf{w}_i)/\,\rho\right]^{\sigma}}, \tag{11}$$

where Y_j is actual GDP expressed in country j's currency. Observing that $E_{j1} \equiv m_{j1}\tilde{E}_{j1}$, as well as $E_{ij} \equiv m_{ij}\tilde{E}_{ij}$ and $\tilde{E}_{ij} c(\mathbf{w}_i) \equiv c(\mathbf{w}_j)$, we arrive at

$$D_{ij} = Y_j \tilde{E}_{j1} \left[\frac{c(\mathbf{w}_1)}{\rho}\right]^{-1} \frac{\left[P_j \left(m_{1j} T_{1j} \ldots m_{Cj} T_{Cj}\right)\right]^{\sigma-1}}{\left(m_{ij} T_{ij}\right)^{\sigma}} \tag{12}$$

In this equation, we have replaced $E_{j1}/m_{j1} \equiv \tilde{E}_{j1}$.

Equation (12) may now be rewritten so that it expresses actual country j demand for a typical variety originating from country j as composed of two parts: the notional "gravity norm" demand $\tilde{D}_{ij}$, and a currency misalignment term. More specifically, we have

$$D_{ij} = y_j \frac{\left[M_j \left(m_{1j} T_{1j} \ldots m_{Cj} T_{Cj}\right)\right]^{\sigma-1}}{\left(m_{ij}\right)^{-\sigma}} \cdot \tilde{D}_{ij}, \tag{13}$$

where $y_j := Y_j/\tilde{y}_j$ is the ratio of actual to "gravity norm GDP", and

$$M_j \left(m_{1j} T_{1j} \ldots m_{Cj} T_{Cj}\right) := \frac{P_j \left(m_{1j} T_{1j} \ldots m_{Cj} T_{Cj}\right)}{P_j \left(T_{1j} \ldots T_{Cj}\right)} \tag{14}$$

may be interpreted as a trade-cost-weighted index of country j's bilateral currency misalignments.[14]

Equations (12) and (13) are quite revealing. As argued above, the standard formulation of the gravity model which abstracts from currencies and nominal exchange rates altogether can be interpreted as holding when currencies are at well-defined PPP-values. Allowing for currency misalignments leads to a very intuitive reformulation of the model in terms of deviations from this "gravity norm". Misalignment-ridden demand is related to "gravity norm" demand in a relatively straightforward way, where misalignment terms appear in complete analogy to iceberg-type trade

[14] "Gravity norm GDP" expressed in currency 1 is equal to $\tilde{Y}_j \equiv \tilde{y}_j \tilde{E}_{j1}$, where $\tilde{y}_j$ is expressed in country j's own currency.

costs. In addition to the direct price-effects of misalignment, there is the ratio of actual GDP Y_j to the "gravity norm" level of GDP $\tilde{y}_j$, both expressed in country j's currency. Note that this ratio y_j involves two dimensions in that currency misalignment has implications not just for prices, but also for production volumes and the number of the varieties produced through the usual equilibrium conditions of zero profits, as well as commodity and factor market clearing. Hence, y_j measures more than a mere valuation effect from non-PPP values of country j's bilateral exchange rates.

It is important to recognise that $\left[M_j\left(m_{1j}T_{1j}\ldots m_{Cj}T_{Cj}\right)\right]^{\sigma-1} / \left(m_{ij}\right)^{-\sigma}$ is no multilateral resistance term. Equations (12) and (13) are alternative representations of the underlying demand function, not a general equilibrium solution of the gravity model with potential currency misalignment. Imposing the familiar zero-profit and market clearing conditions leads to a formulation of the gravity model analogous to equations (8) and(9). Since our empirical approach does not rely on a direct estimation of this model with observations on m_{ij}, we abstain from an explicit derivation. However, there is one point that deserves attention. As emphasised above, the standard solution due to Anderson & Van Wincoop (2003) assumes symmetry in trade costs, i.e., $T_{ij} = T_{ji}$. This type of symmetry seems ruled out for a solution based on (12), where the focus is on a currency-misalignment-induced deviation from a PPP "gravity norm". Trade resistance from currency misalignment is necessarily asymmetric, since $m_{ij} = 1/m_{ji}$.

Our approach, however, does not involve estimation of a currency misalignment representation of the gravity model, based on observations of m_{ij}, as defined in (5). Instead, we propose to augment the empirical specification of real trade costs by an index representation of *nominal cost divergence* between countries i and j, defined as

$$\bar{m}_{ij} := 1 \Big/ \tilde{E}_{ij} = c(\mathbf{w}_i)/\, c(\mathbf{w}_j). \tag{15}$$

By index representation, we mean values of $\bar{m}_{ijt}$ relative to a benchmark value $\bar{m}_{ij0}$. Ideally, time 0 would be a period where E_{ij} was in line with PPP as defined above. Then, if the change in relative nominal unit-cost $c(\mathbf{w}_j)/\, c(\mathbf{w}_i)$ that has occurred from time 0 to t is offset by a PPP-movement in nominal exchange rates, such changes should not be revealed to influence trade flows X_{ijt}. Inclusion of the usual trade cost determinants should fully explain variation in trade flows which are in line with the "gravity norm". If two countries i and j have different currencies with a "reasonably flexible" nominal exchange rate, such an offsetting movement is likely to take place.[15] By way of contrast, if they share a common currency, this implies $E_{ij} = 1$, regardless of $\bar{m}_{ijt}$. Hence, any change in $\bar{m}_{ijt}$ by definition constitutes a currency misalignment, and should exert a statistically significant influence on bilateral trade flows X_{ijt}, capturing their deviation from the "gravity norm" $\tilde{X}_{ijt}$.

In the subsequent empirical estimation, we follow common practice in controlling for multilateral trade resistance through country×time fixed effects. Importantly, however, our model strongly suggests that multilateral trade resistance is asymmetric for imports and exports. After all, one country's implicit overvaluation is the other country's undervaluation. Hence, in our estimation we depart from symmetry by separately including importer×time and exporter×time fixed effects.

5 Econometric implementation

We now proceed towards an econometric model, based on the above gravity model, that allows us to estimate the consequences of "implicit currency misalignment" for levels of bilateral trade in the euro area. The principal purpose is to empirically disentangle this channel from the conventional trade cost channel, in order to obtain a more informative picture of the trade effect of the euro. Our approach enables us to take a country-specific view on this issue. Our results will reveal substantial cross-country heterogeneity which has gone unnoticed in the literature up to this point. We first discuss the general properties of our econometric model and then turn to empirical estimation.

5.1 An econometric model

The question at the heart of this section is the following: Does bilateral divergence in relative wage and cost competitiveness levels exert an effect on trade among the euro area countries that does not exist for countries outside a fixed exchange rate arrangement? Put differently, is euro area trade affected by the fact that euro member countries cannot adjust their internal exchange rates in order to compensate for shock absorptions that are inconsistent with a common nominal anchor? Answering this question naturally involves testing of whether the effect of the cost-divergence-term $\bar{m}_{ijt}$ on bilateral exports is different for within euro area trade flows, compared

[15] Nominal exchange rates need not be perfectly flexible. Offsetting movements in the above sense are possible, indeed likely also for "managed" exchange rates.

to trade between non-members. For the latter it should not matter much, since their exchange rates can adjust. This is the key hypothesis that we want to test.

We propose to do so using the following log-linear econometric model:[16]

$$
\begin{aligned}
\ln(X_{ijt}) = \alpha_0 &+ \beta_1 \ln(Y_{ijt}) + \beta_2 \mathrm{EUboth}_{ijt} + \beta_3 \mathrm{EA2}_{ijt} \\
&+ \beta_4 \ln(\bar{m}_{ijt}) + \beta_5 [\mathrm{EA2}_{ijt} \times \ln(\bar{m}_{ijt})] \\
&+ \xi_{it} + \mu_{jt} + \gamma_{ij} + \epsilon_{ijt}
\end{aligned} \tag{16}
$$

As suggested by our gravity model developed above, this equation relates the bilateral log-exports from country i to country j at time t to the product of the two countries' contemporaneous GDPs, joint membership in the EU15 (EUboth) and in the euro area (EA2), as well as the cost-divergence-term $\bar{m}_{ijt}$, both in isolation and interaction with euro area membership. In addition, the model allows for exporter×time and importer×time fixed effects ξ_{it} and μ_{jt}, respectively, controlling for the asymmetric multilateral resistance terms that we have emphasised in section 4 above. Symmetric fixed effects γ_{ij} capture all time-invariant trade impediments that are specific to country pairs, such as borders and distance. Common macroeconomic trends determining the overall level of world trade are nested within ξ_{it} and μ_{jt}. Finally, ϵ_{ijt} denotes an error term.

The key to answering the question stated above lies in the second line of equation (16), with the cost-divergence-term $\ln(\bar{m}_{ijt})$ and the interaction term between euro area membership and cost-divergence. This specification asks whether – and by how much – the effect of diverging nominal cost conditions $\bar{m}_{ijt}$ on bilateral exports is different if i and j are both euro area countries from cases where the two countries have different currencies with flexible exchange rates. Looking at the conventional effect of euro membership on bilateral exports, we now realise that this effect also depends on the cost divergence $\bar{m}_{ijt}$. In a nutshell, the coefficients of the above equation allow us to answer two distinct euro-related questions about the determinants

[16] Our data set does not involve any zero or missing trade flows and the countries are generally considered to be large economies. We therefore feel confident using a log-linear approach and refrain from estimation of alternative versions along the lines of Silva and Tenreyro (2006). In a more recent paper, Silva and Tenreyro (2010) estimate the euro effect on trade using PPML techniques. They do not account for implicit currency misalignment, but in terms of the other coefficients their results are similar to the ones we retrieve later in this section using linear methods.

of bilateral exports:

$$\text{effect of nominal cost divergence} \;:\; \beta_4 + \beta_5 \times EA2_{ijt} \tag{17a}$$

$$\text{effect of the euro} \;:\; \beta_3 + \beta_5 \times \ln(\bar{m}_{ijt}) \tag{17b}$$

The euro effect is thus estimated conditional on the level of $\bar{m}_{ijt}$. For instance, the effect at the initial levels of $\bar{m}_{ijt} = 1$ is equal to β_3. This can also be interpreted as the average effect of introducing the euro across all member countries, comparable to the effects estimated in most of the literature. The *maintained hypothesis* is that, while β_4 may well be zero, β_5 should be statistically different from zero and take on a negative value.

Before proceeding with estimation, we want to address the question of what happens if the model is estimated omitting the variables $\ln(\bar{m}_{ijt})$ and $[\text{EA2}_{ijt} \times \ln(\bar{m}_{ijt})]$, as in the literature up to now. Perhaps surprisingly, we can come up with a precise answer. We need only observe the particular relationships between various covariates in equation (16). First of all, notice that $\ln(Y_{ijt}) = \ln(Y_{jit})$ is perfectly symmetric across importers and exporters, while $\ln(\bar{m}_{ijt})$ is "perfectly asymmetric", meaning $\ln(\bar{m}_{ijt}) = -\ln(\bar{m}_{jit})$. Hence, these two covariates are perfectly orthogonal by construction. The same holds true, not just for $\ln(Y_{ijt})$, but also for all other perfectly symmetric terms, such as EUboth_{ijt} and EA2_{ijt}. Note that what we have is complete orthogonality even in small sample data, which implies, but is more than, statistical independence. Hence, inclusion of the cost-divergence term $\ln(\bar{m}_{ijt})$ as such will literally leave the coefficient estimates relating to GDP, EU15 membership and euro membership, i.e., β_1, β_2 and β_3, unaffected.

This seems like a reassuring result. Statistical independence implies that omitting the cost-divergence-term in the estimation of (16) as such does not give rise to biased estimates of the *average* euro effect across countries. Moreover the estimate obtained for the trade cost channel effect, $\hat{\beta}_3$ is exactly equal to the estimated *marginal* effect of EA2 obtained upon inclusion of the misalignment channel, if evaluated at the sample mean: $\hat{\beta}_3 + \hat{\beta}_5 \times \text{mean}[\ln(\bar{m}_{jit})]$. The reason is that, with a balanced panel, we have $\text{mean}[\ln(\bar{m}_{jit})] = 0$. By definition, the average country has no misalignment. This is an important result, as it indicates that the estimates obtained so far in the literature do have a precise meaning against the backdrop of our extended model. At the same time, however, the result clearly indicates an important limitation. We know from section 3 that the typical euro area country deviates substantially from the sample mean. Cost divergence and, thus, implicit currency misalignment abounds. An informative picture of trade effects from euro area membership is obtained only if the above model is estimated in full, including the cost-discrepancy terms $\ln(\bar{m}_{ijt})$ and $[\text{EA2}_{ijt} \times \ln(\bar{m}_{ijt})]$. This is true all the more as we have shown in Section 2 that trade volume effects that arise from deviations from the "gravity norm" have different welfare implications, compared to trade effects that shift the "gravity norm" level of trade.

5.2 Estimation results

Estimation of models like (16) needs to control for unobserved country-pair-effects that may be correlated with the covariates of the equation. There are at least two approaches that one may pursue towards this end. The first is the so-called fixed effects (FE) estimator (or "within estimator"), the second is the first difference (FD) estimator. Both approaches eliminate all time-invariant, unobserved pair-specific heterogeneity. For $T = 2$, both estimators are identical, but for $T > 2$ the relative efficiency of the estimators depends on whether or not the error terms in (16) are serially correlated. If they are, then the FD estimator is more efficient than the FE estimator, as emphasised by Baier and Bergstrand (2007). A further advantage of the FD estimator is that it is not compromised by trade and GDP data that follow near-unit-root processes. This is because, in order to wipe out time-invariant unobserved heterogeneity, the FD estimator relies on differencing with respect to the previous period, while the FE estimator achieves the same goal by subtracting sample means. Weighing all strengths and weaknesses, our preferred estimation employs FD. However, for the sake of comparison with earlier studies and with an eye on robustness, we report FE-estimates in the appendix.

It is important to be clear about the definition of the interaction term in the FD estimation. More specifically, using Δ to denote the first difference operator, the FD estimation equation is

$$\begin{aligned}\Delta \ln(X_{ijt}) = {} & \beta_1 \Delta \ln(Y_{ijt}) + \beta_2 \Delta \text{EUboth}_{ijt} + \beta_3 \Delta \text{EA2}_{ijt} \\ & + \beta_4 \Delta \ln(\bar{m}_{ijt}) + \tilde{\beta}_5 [\text{EA2}_{ijt} \times \Delta \ln(\bar{m}_{ijt})] \\ & + \tilde{\xi}_{it} + \tilde{\mu}_{jt} + \tilde{\epsilon}_{ijt}, \end{aligned} \tag{18}$$

where a tilde denotes suitably transformed fixed effects. Notice that the interaction term in this equation is no straightforward first difference of the interaction term in (16), hence the coefficient $\tilde{\beta}_5$ which is related to, but not identical to β_5 in (16). More specifically, for the FD version of the econometric model, our maintained hypothesis implies that *changes* in the cost discrepancy term $\ln(\bar{m}_{ijt})$ lead to different *changes* in bilateral exports for euro member countries, compared to countries with independent currencies.[17]

For both approaches, FE and FD estimation, we proceed in "three × three steps", featuring three alternative restrictions regarding fixed effects and three different specifications regarding included or excluded covariates, respectively. To facilitate a quick and easy interpretation, tables 2 (in the text) and A.2 (in the appendix) organise our presentations around these steps of estimation. The first set of results allows for country pair and year fixed effects, but collapses the exporter×time and importer×time fixed effects to a simple year fixed effect: $\xi_{it} = \mu_{jt} = \delta_t$ (and accordingly for the FD version). These results, presented mainly for reasons of comparison, are found in columns A through C of tables 2 and A.2, respectively. It is important to bear in mind, however, that these estimates are likely to be biased, since they omit the multilateral resistance terms that we have emphasised in Section 4 above. Therefore, we present a second set of results where we control for multilateral trade resistance, but assuming symmetry as in Anderson and Van Wincoop (2003), meaning $\xi_{it} = \mu_{jt}$. In other words, these results – found in columns D through F of tables 2 and A.2 – include country×time fixed effects that do not make a distinction between a country's role as an importer and exporter, respectively. However, this is exactly what our extended gravity model of Section 4 strongly suggests we should do. Hence, a final set of results allows for the most general set of fixed effects, i.e., $\xi_{it} \neq \mu_{jt}$, and accordingly for the FD version (18). In these results, we thus have separate importer- and exporter×time fixed effects.

Within each set of assumptions regarding the structure of fixed effects, we first report estimates that ignore all nominal cost divergence terms in columns A, D and G. Obviously, this is mainly for comparison with existing literature. In line with the

[17]Applying plain first differencing to $[\text{EA2}_{ijt} \times \ln(\bar{m}_{ijt})]$ would imply that we attach meaning to the *levels* of $c(\mathbf{w}_i)$ and $c(\mathbf{w}_j)$ behind our observations of $\ln(\bar{m}_{ijt})$. We must be careful to avoid this. The reason is that in the OECD data source that we use, the underlying data on $c(\mathbf{w}_i)$ and $c(\mathbf{w}_j)$ are defined as *indices* with base period 2005. Scaling each of the unit-labor cost index to 100 for 2005 negates a meaningful international comparison for any one year. We therefore restrict our analysis to using changes across time. In doing so, we scale our measure such that $\bar{m}_{ij,1999} = 1$. Thus, we must avoid ever using information on the absolute *levels* of $c(\mathbf{w}_i)$ and $c(\mathbf{w}_j)$ in our data transformations. It can be shown that first-differencing the interaction term in (16) would imply that we do so. The above definition of the interaction term in (18) guarantees that we do not. It is, thus, consistent with this data limitation. For FE estimation, by complete analogy we first apply the "within transformation" to $\ln(\bar{m}_{ijt})$, and then interact this with EA2_{ijt}. Again, our hypothesis is that β_4 should not be different from zero, while $\tilde{\beta}_5$ is statistically significant and negative.

goal of our paper, we then include the divergence terms $\ln(\bar{m}_{ijt})$ or $\Delta\ln(\bar{m}_{ijt})$, respectively, to see whether or not nominal cost divergence as such makes a difference. Notice, however, that this specification does *not* yet address our prime concern. Our key hypothesis comes into play only when comparing coefficient estimates obtained upon inclusion of $\ln(\bar{m}_{ijt})$ or $\Delta\ln(\bar{m}_{ijt})$ alone with those obtained upon including interaction terms EA2$\times\ln(\bar{m}_{ijt})$ or EA2$\times\Delta\ln(\bar{m}_{ijt})$, respectively. Loosely speaking, the hypothesis implies that most of the significance of the cost divergence term gets shifted into the interaction term, if included in the specification.

Our estimation relies on a panel of 20 OECD countries for the years from 1993 through 2006 - a common setup in the euro effect literature.[18] Table 2 presents results obtained using the FD estimator, while the FE estimates are presented in the appendix table A.2. In either case, the orthogonality results that we have derived in the previous subsection nicely come through: Coefficient estimates for log-GDPs, as well as the EU15- and euro-area variables, do not change if we include the cost-divergence variable $\ln(\bar{m}_{ijt})$. Also, the results are generally in line with the early literature on the trade effect of the euro, as in Micco et al. (2003). The coefficient for the product of GDPs is rather low, but this is a frequent finding for recent OECD-country data and fixed effects specifications; see Baldwin et al. (2008). The *in*significant coefficient for EU membership may appear surprising at first sight. But considering that within the range of our sample only three countries have joined (Austria, Finland and Sweden), it becomes obvious that there is little time-series variation left in the data for a fixed-effects-estimation. The insignificant coefficient estimates are thus hardly surprising.[19]

The trade cost effect from fixed effects estimation presented in columns A through C of table A.2 are broadly in line with the earlier consensus estimates of the literature: The euro is revealed to increase the level of bilateral trade by about 9 percent.[20] But a positive trade cost channel effect is not upheld in the FD estimation of table 2 where coefficients are all insignificant, which corroborates the consensus in more recent contributions to the literature.

[18]The countries included are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom, and United States. The time span was chosen with data quality considerations in mind. In particular, Baldwin (2006) discusses weaknesses of pre-1993 trade data for European countries. Trade data are taken from the IMF DoTS and are retrieved via Datastream. The unit labor cost indices, used for construction of the cost-divergence-terms, are provided by the OECD.

[19]Estimating the effect of EU membership on trade in a setting without fixed effects and over a longer time period usually yields coefficients around 20% (Baldwin (2006)).

[20]This is calculated in the familiar way as $[\exp(\hat{\beta}_3) - 1] \times 100$.

Table 2: **Estimation results – First Difference (FD) Estimator**

	time effects			country $\times$ time effects			importer/exporter $\times$ time effects	
	A	B	C	D	E	F	G	H
log-product GDPs	0.489***	0.489***	0.489***	0.749***	0.749***	0.749***	0.407***	0.407***
	(10.03)	(9.98)	(10.03)	(6.17)	(6.16)	(6.16)	(4.07)	(4.07)
both in EU15	-0.001	-0.001	-0.001	-0.043	-0.043	-0.043	-0.043	-0.043
	(-0.06)	(-0.06)	(-0.06)	(-1.26)	(-1.27)	(-1.26)	(-1.21)	(-1.21)
both in EA	0.011	0.011	0.011	-0.015	-0.015	-0.015	-0.015	-0.015
	(0.49)	(0.49)	(0.49)	(-0.39)	(-0.39)	(-0.39)	(-0.40)	(-0.40)
$\Delta \ln(\bar{m}_{ijt})$		-0.098	-0.055		-0.098	-0.055		0
		(-0.99)	(-0.52)		(-1.10)	(-0.58)		(.)
EA2$\times\Delta \ln(\bar{m}_{ijt})$			-0.485***			-0.485**		-0.714**
			(-3.06)			(-2.37)		(-2.07)
Observations	4940	4940	4940	4940	4940	4940	4940	4940
R^2	0.185	0.186	0.186	0.271	0.271	0.272	0.373	0.373

Notes: Dependent variable: ln exports. Period covered: 1993-2006. Sample includes potentially 20x19 country pairs. Estimation method: first differences. All regressions include a constant (not shown). Robust t-statistics are shown in parentheses. $***$ and $**$ indicate significance at 1% and 5%, respectively.

While the FE estimation in table A.2 reveals a significantly negative effect for the level of $\ln(\bar{m}_{ijt})$, the same is not true for the FD results in table 2. However, as emphasised above, our key hypothesis requires that we compare estimates for the coefficient on this variable when appearing alone in the regression equation with estimates obtained upon inclusion of the interaction term with euro-area membership. The value of $\hat{\beta}_4$, indicating the negative influence of nominal cost divergence on bilateral exports per se, becomes much smaller if we control for euro area currency misalignment, in line with our theoretical considerations of Sections 2 and 4 above. At the same time, the coefficients β_5 and $\tilde{\beta}_5$, respectively, come out with statistically significant negative estimates in either specification, except for the final column of Table A.2. Thus, our hypothesis receives impressive empirical support. To summarise, the FD estimation suggests that a significant currency misalignment problem from nominal cost divergence occurs *only* for euro-area divergence, and it does so with clear statistical significance, as witnessed by the t-statistics for the estimates of $\tilde{\beta}_5$. The results displayed in column (H) in table 2 suggest that a 10% increase in the misalignment index, on average, leads to a 7% decrease in bilateral exports and vice versa. Given that the estimation in this case does not allow us to include both $ln(\bar{m}_{ijt})$ and the interaction term at the same time, the above value gives us the total effect of misalignment for euro area trade flows. This is irrespective of whether misalignment matters for other trade flows or not.

In a similar vein, the FE estimation clearly indicates that it is *primarily* the use of the common currency that makes cost-divergence an implicit currency misalignment, causing a deviation of trade flows from the "gravity norm" level.

These results hold important implications for the policy discussion, since trade creation through currency misalignment is fundamentally different from trade effects through the conventional trade cost channel, as we have emphasised in Section 2 above. While euro-induced trade cost reductions may be expected to exert a largely symmetric influence on trade across countries and for imports as well as exports, the misalignment channel is of an asymmetric nature, affecting exports and imports for each country differently, and with substantial asymmetry across euro-member countries. Also, while trade-cost-induced trade creation is clearly welfare increasing, the same does not hold true for a misalignment-induced boost in exports. Trade cost reductions are readily identified as sources of additional gains from trade, accruing to all countries on the same footing. In contrast, euro-induced trade effects from "implicit currency misalignment" are akin to terms of trade effects. Somewhat paradoxically, the welfare effects associated with such trade effects are negative for countries where the euro boosts exports, and vice versa for countries where the euro predominantly boosts imports.[21]

Our results thus strongly suggest that we look at euro-induced trade effects in a disaggregate manner across member countries. Table 3 depicts the euro effect for each country, as calculated from our coefficient estimates and each country's average level of misalignment towards other member states since the start of the euro. Given the insignificant coefficient estimates for the conventional trade cost channel of the euro effect, we treat this channel as non-existent. Yet, we stress that the misalignment effect, and therefore the induced heterogeneity of the overall effect, does not depend on the level of the trade cost channel effect. We would always see some countries gaining more than others, but on a different level.[22] The implied heterogeneity is considerable. Germany and Austria stick out as the only countries with a sizable trade effect of above 5%. For Belgium, Finland and France the overall effect is still positive, yet close to zero. The Netherlands join the countries of Southern Europe and Ireland with negative effects on their bilateral euro area exports. Thus, the true impact of entering the currency union creates trade gains for some,

Table 3: **Country specific euro effects**

Country	overall euro effect on exports in %
Germany	6.26
Austria	5.14
Finland	1.53
Belgium	1.46
France	0.21
mean	0.00
Italy	-0.76
Greece	-1.46
Netherlands	-2.74
Spain	-2.81
Ireland	-3.72
Portugal	-3.84

but not for all countries. For others, the opposite holds true.

[21] This statement ignores the welfare effects from intertemporal trade. Of course, a trade surplus generates additional net foreign assets which represent future consumption possibilities which should not be ignored when considering the welfare implications of euro-induced trade scenarios.

[22] The values are calculated based on results from column (H) in table 2 with the help of equation (17b) and the values from table 1.

Besides assessing different specifications of our estimation equation, we have put our estimates to further robustness checks.[23] First, we shorten the sample length, starting in 1995 and dropping the EU15 indicator variable. This does not change the results in any noteworthy way.

Second, we split the sample into pre-euro years and the years following the euro's introduction. This allows us to test whether the misalignment effect was already present before 1999 for the euro countries. Reassuringly, we find no misalignment effect for the future euro members before the launch of the common currency. We take this as evidence that the EMS provided enough flexibility for nominal exchange rates to adjust in a way maintaining purchasing power parity. For the years in which the euro is a reality we find the misalignment effect to be negative and significant for the euro members, confirming our above results. Table 4 summarises this robustness check. In the appendix, we list all results in detail.[24]

Table 4: **Effect of misalignment before and after the euro's introduction**

	1993 - 1998			1999 - 2006		
	A	B	C	A'	B'	C'
EA2$\times\Delta\ln(\bar{m}_{ijt})$	0.031	0.031	0.060	-0.676***	-0.676***	-0.759**
	(0.14)	(0.17)	(0.30)	(-2.72)	(-2.79)	(-2.16)

Notes: First-difference estimation;
A: time effects only, B: country×time effects, C: importer/exporter×time effects.
Robust t-statistics are shown in parentheses. For the 1993-1999 subsample EA2 identifies pairs among future euro member countries.

6 Summary and Concluding Comments

Joining a currency union involves a cost in that it implies the loss of an independent monetary policy. In the case of the euro, it also implies enforced stress on fiscal discipline and rules of conduct. Having lost monetary autonomy, some countries find it difficult to absorb macroeconomic shocks in ways that are consistent with the common nominal anchor set by the common monetary policy. Facing these costs,

[23] Detailed results from those robustness checks are shown in the appendix.

[24] We have also taken notice of alternative data sources for our unit labour cost measure, notably the indicator available from Eurostat. However, this data source provides information for EU countries only. Furthermore, data on Greece are missing and the time period available is shorter. In summary, there is not enough variation in this rudimentary sample to estimate the effect of misalignment in a way comparable to our above approach.

countries that have joined the euro area had high hopes for a boost in intra euro area trade that might compensate for the hardships.

In this paper, we argue that the cost and benefits of currency unions cannot be compared independently of each other. Loss of monetary autonomy implies that divergence in nominal cost competitiveness cannot be absorbed through nominal exchange rate movements, which in turn triggers sizable trade effects. Countries with deteriorating labor cost competitiveness face a decrease in exports. The overall trade effect then emerges as the combination of a savings in trade cost, and a shock stemming from what we call "implicit currency misalignment". This introduces substantial heterogeneity into the cross-country distribution of gains from the euro. In the end, the cost of a currency union apply to all members, but the benefits are unequally distributed, in some cases possibly not even enough to compensate for the costs.

We apply an extended gravity equation, in order to estimate this effect directly, and separately from the conventional trade cost channel. First, we augment a traditional gravity model to incorporate nominal exchange rates, which serves as a guidance for modeling implicit currency misalignment when analysing the effects of monetary unions. Secondly, we include a nominal cost divergence term in the regression setup. Of crucial importance, we interact it with the dummy indicating euro membership, in order to test the key hypothesis that such divergence has different implications for trade between euro-area member countries, compared to countries that enjoy independent currencies and, thus, the option of nominal exchange rate adjustment.

Our results confirm the aforementioned worries. Implicit misalignment is found to exert a significant influence on bilateral exports for euro-area countries. In particular, we find an increase in the misalignment index (representing implicit overvaluation of the currency) by 10% to reduce exports by 7% on average. Furthermore, we do not find a positive trade cost effect of the euro. Combining these numbers with the average levels of bilateral misalignments since the start of the currency union, a disaggregate view reveals substantial country heterogeneity. For most of the euro area members the trade effects came about asymmetrically from euro-induced currency misalignment, boosting exports beyond the "gravity norm" for some countries, while boosting imports beyond this norm (and reducing exports below) for others. Indeed, our results indicate that in the ten year history of the euro, these misalignment effects have dwarfed the conventional effects running through the trade cost channel.

We conclude with three words of caution. First, given the empirical significance of the currency misalignment channel, countries considering to join the euro should not expect a sizable and balanced increase in their exports and imports to and from other euro members. In one way or the other, they are likely to be affected also by "implicit currency misalignment" that derives from asymmetric shocks, or from asymmetric mechanisms of nominal shock absorption, in the face of a common nominal anchor. If a certain country expects to remain in line with the nominal anchor which is set by the union monetary authorities, it will still be affected by other countries' inability, or unwillingness, to do the same. Secondly, a low effect of the euro on quantities traded does not mean that there are no cost-savings from introducing the euro. The larger part of cost savings operates, not through additional trade, but through less costly transactions in existing trade volumes, i.e., through first order "rectangular" welfare effects. Finally, and perhaps most importantly, countries should avoid falling victim to mercantilistic thought when contemplating entry into the euro area. From a static welfare perspective, asymmetric misalignment effects that boost exports are akin to adverse terms of trade effects.

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A Additional tables

In this Appendix we present the results from various robustness checks. We first present some basic summary statistics. Subsequently, we show the results from a fixed effects estimator. Note that we first perform the within-transformation, and then compute the interaction term. We do so to avoid dependence of the interaction term on the *levels* of unit labor costs. We then present the results from various FD-regressions, where we (i) consider a shorter panel, (ii) use a different definition of unit labor costs, and (iii) split the sample in a pre-Euro and a post-Euro period.

Table A.1: **Summary Statistics**

Variable	Observations	Mean
$\Delta ln(X_{ijt})$	4940	.0791825
$\Delta ln(\bar{m}_{ijt})$	4940	6.36e-10
$\Delta EA2$	4940	.0222672
$\Delta EU15$	4940	.0145749
$\Delta ln(Y_{ijt})$	4940	.1145259
$EA2 \times \Delta ln(\bar{m}_{ijt})$	4940	2.00e-10

Table A.2: **Estimation Results – Fixed Effects (FE) Estimator**

	time effects			country × time effects			importer/exporter × time effects		
	A	B	C	D	E	F	G	H	I
log-product GDPs	0.471***	0.471***	0.471***	0.596***	0.596***	0.596***	0.614***	0.500***	0.614***
	(10.82)	(10.75)	(10.82)	(11.04)	(11.01)	(11.09)	(9.94)	(9.72)	(9.94)
both in EU15	0.014	0.014	0.014	-0.034	-0.034	-0.034	-0.034	-0.034	-0.034
	(0.48)	(0.50)	(0.50)	(-0.57)	(-0.57)	(-0.57)	(-0.66)	(-0.66)	(-0.66)
both in EA	0.082***	0.082***	0.082***	-0.010	-0.010	-0.010	-0.010	-0.010	-0.010
	(3.10)	(3.18)	(3.25)	(-0.22)	(-0.22)	(-0.22)	(-0.26)	(-0.26)	(-0.26)
$\ln(\bar{m}_{ijt})$		-0.206**	-0.146*		-0.206***	-0.146**		-0.727***	
		(-2.45)	(-1.70)		(-2.94)	(-2.07)		(-6.04)	
EA2$\times\ln(\bar{m}_{ijt})$			-0.562***			-0.562***			-0.148
			(-3.64)			(-4.58)			(-0.81)
Observations	5320	5320	5320	5320	5320	5320	5320	5320	5320
R^2	0.678	0.681	0.682	0.732	0.735	0.736	0.799	0.799	0.799

Notes: Dependent variable: ln exports. Period covered: 1993-2006. Sample includes potentially 20x19 country pairs. Estimation method: within fixed effects. All regressions include a constant (not shown). Robust t-statistics are shown in parentheses. $***$, $**$ and $*$ indicate significance at 1%, 5% and 10%, respectively.

Table A.3: **Estimation Results – First Difference (FD) Estimator, 1995-2006**

	time effects			country × time effects			importer/exporter × time effects	
	A	B	C	D	E	F	G	H
log-product GDPs	0.480***	0.480***	0.480***	0.749***	0.749***	0.749***	0.407***	0.407***
	(9.15)	(9.08)	(9.12)	(6.17)	(6.16)	(6.17)	(4.07)	(4.07)
both in EA	0.0105	0.0105	0.0105	-0.0147	-0.0147	-0.0147	-0.0147	-0.0147
	(0.48)	(0.48)	(0.48)	(-0.39)	(-0.39)	(-0.39)	(-0.40)	(-0.40)
$\Delta \ln(\bar{m}_{ijt})$		-0.0989	-0.0360		-0.0989	-0.0360		0
		(-0.83)	(-0.27)		(-0.87)	(-0.28)		.
EA2×$\Delta \ln(\bar{m}_{ijt})$			-0.504**			-0.504**		-0.714**
			(-2.32)			(-2.34)		(-2.07)
Observations	4180	4180	4180	4180	4180	4180	4180	4180
R^2	0.151	0.152	0.152	0.236	0.236	0.237	0.341	0.341

Notes: Dependent variable: ln exports. Period covered: 1995-2006. Sample includes potentially 20x19 country pairs. Estimation method: first differences. All regressions include a constant (not shown). Robust t-statistics are shown in parentheses. $***$, $**$ and $*$ indicate significance at 1%, 5% and 10%, respectively.

Table A.4: **Estimation Results: Split Sample**

	1993 - 1998	1999 - 2006
log-product GDPs	0.601***	0.198**
	(6.12)	(2.51)
both in EA		-0.101
		(-1.08)
EA2$\times\Delta\ln(\bar{m}_{ijt})$	0.0596	-0.759**
	(0.30)	(-2.16)
Observations	1900	2660
R^2	0.430	0.337

Notes: First-difference estimation with importer/exporter×time effects.
Robust t-statistics are shown in parentheses.
For the 1993-1999 subsample EA2 identifies trade
among future euro member countries.