Less Perfect Unions: Average Treatment Effects of Currency Unions and the EMU on Trade Over Time

Joseph Kopecky

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www.josephkopecky.com
Updated:

Abstract

Estimating the currency union effect on trade has been a contentious topic, with a wide range of estimates on the true size of gains. One fundamental issue underlying many estimates is the lack of a accurate control group against which to compare outcomes, making it hard to understand the degree to which makes existing estimates even harder to interpret from the perspective of policy makers. Estimates of gains within the eurozone tend to be smaller, while the sovereign debt crisis in Europe caused many to question the long term viability of the union. It is crucial for the public debate over the costs and benefits of eurozone membership to bring more clarity to our understanding of the benefits from trade that such a union provides to its members. I propose a novel approach to this literature that applies inverse propensity score weighting as well as local projections to study both the traditional static estimates of trade as well as forecasts of the effect of currency unions on trade over time. I find that the static effect of currency unions on trade are in general still quite large for currency unions in general, but quite small for the emu. However, I find the puzzling result that the currency union effect on trade for the euro declined over the period from implementation until the recession in 2008. Since the expected effect should be fixed over time this suggests a deeper understanding of the simultaneous policy changes that take place over the period that may bias static effects upwards.

1 Introduction

The currency union effect on trade has been one of the most widely studied topics in international macroeconomics. Early estimates found implausibly large effects of the positive effects of currency union membership on bilateral trade, and sparked a cottage industry seeking to better understand these effects. This has proven to be a difficult question to answer, producing a wide range of estimates, wider still when the question is broadened include the effect of one specific group, the EMU. My approach seeks to improve these estimates by recognizing that studies of an *average treatment effect* of joining a monetary union have, in the past, often lacked clear control groups. I propose the use of a inverse propensity score weighted estimate of the currency union effect on trade, while also studying the dynamic effects that currency union entry may have over time. With the recent eurozone crisis bringing into sharp focus the economic and political costs that come from unifying under a central monetary authority, it is more important than ever to clarify the potential trade benefits that currency unions can deliver to member countries.

While the current literature provides a wide range of estimates, many of which are quite large, there is mounting evidence that the effect in the EMU has been smaller than previous unions. This difference in estimates gets at the heart of a deep problem with many attempts to understand the effects of macroeconomic policy. In trying to understand the treatment effect for a particular policy, it is often overlooked that the "treatment" countries have fundamentally different characteristics than those that act as "controls" in the pseudo experiment. This paper brings propensity score methods to the frontier of research on the currency union effect on trade in an attempt to correct for these differences. I show that these estimates are consistent with positive and significant estimates of the effect of currency union membership on trade that are in line with the lower end of estimates found in the current literature. Additionally I find relatively small and weakly significant effects for the eurozone effect on trade. I then estimate local projections for the dynamic effect of these memberships over time, finding the slightly puzzling result that these eurozone effects appear to have diminished over time.

The literature for positive and potentially quite large effects of currency unions on trade has its roots in Rose (2000). In Rose's original cross-sectional analysis he finds the somewhat shocking result that countries sharing a common currency enjoy three times higher trade than they would otherwise. In a follow up that exploits the time series evidence from panel data this effect was reduced to a much smaller, but still quite large doubling of bilateral trade (Glick and Rose, 2002). Common critiques of these results show that such effects are extremely sensitive to a wide range of idiosyncratic variables that make the currency union effect larger or smaller depending on the pair of countries observed (for example: Nitsch, 2002). Much of the variation studied in the pre-euro research comes from small, open economies who unilaterally adopt a large country's currency. While these estimates are perhaps more plausible within the context of such countries, it is unlikely that they offer much insight for the experience of the euro where a group of large economies multilaterally agree the share a currency. Despite these differences, I treat these well established estimates as a benchmark for study.

A common critique for empirical macroeconomic research is that it is difficult to approximate true randomized control design with data at aggregate levels. For one, there is often limited policy variation with which to conduct these studies, making applicability of their results out of sample limited. A second and more challenging problem stems from the endogeneity of policy making decisions, making it nearly impossible to interpret estimates of the effects of policy as causal. The attempt to emulate a randomized control trial, as a means of obtaining causal estimates, has been at the heart of the *credibility revolution* that has taken place in empirical microeconomics (Angrist and Pischke, 2010). Although policy treatment at the macro level is a far cry from such trials, approaching research through this lens makes more honest the strong assumptions that underly estimates, and makes problems of bias easier to attack. The primary problem that exists in nearly any policy at this level is the issue of selection into treatment. Economies with certain characteristics are much more likely to elect for *treatment* and as such bias results. Conveniently, there are readily available methods for treating such bias that have their roots in medical trials where there is concern for such selection issues. Propensity score matching relies on a first stage treatment equation that first attempts to predict the likelihood of receiving treatment and then weights estimates of treatment by this likelihood. There is precedent for the use of such methods in this context, Persson (2001) uses propensity score matching estimators to show that early estimates of the currency union effect appear to be plagued by these types of selection problems and that the effects appear to be overstated. Recently there has been greater advocacy for the use of these matching methods in other contexts to study macroeconomic policy for example: Angrist and Kuersteiner (2004), Angrist et al. (2013) and Jordà and Taylor (2013).

O'Rourke and Taylor (2013) study the eurozone in the context of an optimal currency area and find that it is lacking in the institutional architecture and integration required to enjoy the benefits that an optimal currency union, such as the United States can achieve. In the face of these costs it is increasingly important to understand what benefits, if any, members can expect from sharing a common currency now and in the future. Also the integration efforts that do go on simultaneously with currency unions make the causal effect of the joint currency even more difficult to understand. In my dynamic estimates I find that the initially positive effects of membership in the eurozone diminish steadily over time. This is a puzzling result on its face, but may suggest that other integration efforts, with shorter term benefits, may be behind some of the large estimates for union membership on trade.

My contribution is twofold. First, I investigate the extent that propensity score estimators affect both the currency union and eurozone effect on trade. I use a new estimator that will be more flexible than those used previously, including the small number of papers that have implemented matching estimators in this context. My static estimates of currency unions, and the euro effect, on trade add to those previous estimates. Second, I investigate the potential dynamic effect of currency unions over time using the policy propensity score estimator used in Jordà and Taylor (2013). With mounting evidence that the costs of the common currency in the form of lost of monetary independence are potentially quite high for many member states, it is more important than ever to understand the benefits that arise from membership, and whether those benefits will be enjoyed for the foreseeable future.

2 Data and methodology

I use *Direction of Trade* data from the IMF on bilateral trade. This data extends to 2015 but for the purposes of avoiding any ambiguity regarding the collapse of trade in the great recession I will focus most of my estimates on the pre-crisis period of 1960-2007.[1] I extend the Rose-Glick currency union data and merge this with exchange rate regime classification used in Shambaugh (2004).

In merging these datasets I lose a small amount of data, particularly for very small regions, some of whom are are involved in a currency union and are present in the Rose-Glick data. Although this loss is unappealing I will discuss that there does not appear to be a significant change in the parameter estimates when I replicate the results of Glick and Rose (2002). Further I still have a large sample with 271,104 observations with 154 countries (both developing and industrialized) with which to work. Additionally, as I will show the currency union effect in these countries may be substantially different that in the eurozone. While I find evidence that the effect of currency unions on trade in these small open economies is plausibly quite large, similar in size to estimates found in the literature. This paper should not be read as a critique of those estimates, but rather an attempt to better understand the context in which they are relevant.

In Table 1, I show a few summary statistics, presented for all countries and then for both currency union members and non-members. I do this to emphasize for a few key gravity equation variables that there are substantial differences characteristics between these two groups. The difference in log trade, as should be expected from prior literature, is quite large. Currency union pairs are also substantially closer together and economically smaller both in terms of GDP and GDP per capita. I will show in Section 3.3 that a two step

[1] In appendix A I rerun many of the traditional estimates using the full sample and find the effects are, predictably, a bit smaller, but not greatly different from those reported

propensity score estimator yields substantial differences in the currency union effect on trade. The reason that this will be the case is that such an estimator will attempt to re-weight the control group of non-currency union countries such that it better matches the treatment group of countries in a currency union. In essence, to find the effect that would be estimated if these groups had similar summary statistics.

Table 1: Summary Statistics

All Countries					
Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
Log average nominal $ bilateral trade	1.133	3.466	-27.967	12.506	516361
log_distance	8.157	0.819	3.684	9.422	516361
Log of Product of Real GDPs	49.135	2.735	37.057	60.376	426959
Log of Product of Real GDPs per capita	17.324	1.825	11.061	23.441	426953
Currency Unions					
Log average nominal $ bilateral trade	2.554	3.634	-9.372	11.65	7402
log_distance	6.925	0.955	3.783	9.35	7402
Log of Product of Real GDPs	46.98	4.089	37.61	57.063	6128
Log of Product of Real GDPs per capita	16.415	2.854	11.447	22.827	6128
Non Currency Unions					
Log average nominal $ bilateral trade	1.112	3.459	-27.967	12.506	508959
log_distance	8.175	0.803	3.684	9.422	508959
Log of Product of Real GDPs	49.167	2.697	37.057	60.376	420831
Log of Product of Real GDPs per capita	17.337	1.802	11.061	23.441	420825

3 The Currency Union Effect on Trade: Static Results

3.1 Replicating Previous Estimates

I begin by running a series of standard gravity equations on my dataset. Though I use slightly different data for trade and a smaller set of controls I have specified the regressions in Table 2 table extensions of the kind of estimates found in Glick and Rose (2002) and Klein and Shambaugh (2006). The specification that I use utilizes the within country-pair variation over time by including pair and year fixed effects. In the appendix I provide similar estimates specifying a number of different variations on my baseline model. The estimating equation is:

$$\begin{aligned}\ln X_{ij,t} &= \beta_0 + \beta_1 CU_{ij,t} + \beta_2 \ln Y_{i,t} \times Y_{j,t} + \beta_3 \ln y_{i,t} \times y_{j,t} \\ &+ \beta_4 P^d_{ij,t} + \beta_5 P^I_{ij,t} + \alpha_{ij} + \rho_t + \epsilon_{ij,t}\end{aligned} \tag{1}$$

Where $CU_{ij,t}$ is an indicator equal to one when country-pair ij share a common currency in period t and $X_{ij,t}$ is the log of bilateral trade between countries i and j. I control also for contemporaneous GDP ($Y_{i,t}$), GDP per capita ($y_{i,t}$), direct ($P^d_{ij,t}$) and indirect ($P^I_{ij,t}$) pegs between country ij in time period t. This estimation is in most ways fairly standard in the gravity equation literature although controlling for various fixed exchange rates is most similar to Klein and Shambaugh (2006) in form.

I find a model that includes direct and indirect pegs an appealing framework as such policies are a similar and are likely similarly motivated for countries who join a currency union for the purpose of increasing trade. This is important to my framework on two dimensions. First investigating weaker exchange rate regimes gives a natural alternative for countries who wish to enjoy similar trade benefits of a currency union. Second in the specification of the policy function for currency union treatment lagged peg variables are a reasonably important variable, particularly for developing countries for whom the choice to be in a currency union may be just an incremental movement from previous peg regimes.

In Table 3, I show the results from the regressions, for which I estimate equation one over three sub-samples of my data. The first column shows my estimation over the time period of the Rose-Glick paper, I find estimates for the currency union of 0.687 which is reassuringly close to their corresponding estimate of 0.65. Adding fixed exchange rates appears to have little effect on the size or significance of the currency union effect in this context. I find estimates over the post-Bretton Woods period of the Klein and Shambaugh (2006) setup of 0.406 somewhat larger than their corresponding estimate of 0.194, but relatively close given that they have included a number of additional exchange rate volatility controls. This is within the plausible range of estimates found in their study. The most interesting result is that the effect disappears when I extend this sample to 2007, where I find a positive but only weakly significant estimate of the coefficient on currency unions. The estimation of 0.1 is fairly close to a number of papers in the literature that attempt to estimate the effect of the EMU.

Shifting the time horizon and drastically changing the results suggests a fundamental difference between the currency union effect of the mid twentieth century and those observed at the end with the formation of the EMU. The majority of countries in currency union arrangements in the early part of the sample are small open economies and those at the end are large, developed European economies. It is likely, as has been suggested that the effect is not the same across groups. If the effect on trade of policies involving currency unions and fixed exchange rates differ across different kinds of countries then we would expect to see this estimate vary widely based on the composition of treated observations in the sample.

3.2 Heterogeneous Currency Union Effects on Trade

A potential issue with homogeneous currency union estimators is that we should not expect the effect on trade to be the same between large industrialized countries and small developing economies. As such an estimate that averages the currency union effect across these groups has little meaning and certainly does not help to inform policy decisions. One potential way to solve this problem is addressed in Klein and Shambaugh (2006) by estimating the currency union and exchange rate regime effect on trade across pairs of countries in bins based on whether the pair contains two industrialized countries, two developing, or a mix of both. They find that the effect of all pegs and currency unions on trade in industrial-industrial country pairs is negative but insignificant. For industrial-developing

Table 2: Currency Union Effect on Trade: Traditional Estimates

	(1) 1960-1998	(2) 1960-1998	(3) 1973-1998	(4) 1973-2008
	(1)	(2)	(3)	(4)
VARIABLES	ltrade	ltrade	ltrade	ltrade
currency union	0.688***	0.728***	0.485**	
	(0.129)	(0.137)	(0.204)	
cu non emu				0.413**
				(0.164)
emu				0.224***
				(0.0514)
direct_peg		0.0682	0.197**	0.165**
		(0.0665)	(0.0875)	(0.0772)
indirect_peg		-0.0542**	0.00525	-0.00884
		(0.0219)	(0.0304)	(0.0254)
lgdp	0.406***	0.394***	0.502***	0.686***
	(0.0465)	(0.0519)	(0.0618)	(0.0509)
lgdppc	0.657***	0.659***	0.533***	0.400***
	(0.0469)	(0.0520)	(0.0607)	(0.0501)
regional	0.514***	0.394***	0.239***	0.266***
	(0.0451)	(0.0490)	(0.0522)	(0.0324)
Constant	-28.98***	-28.47***	-32.16***	-38.97***
	(1.568)	(1.775)	(2.149)	(1.770)
Observations	249,822	207,864	167,322	258,826
R^2	0.863	0.866	0.878	0.869

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

and developing only pairs it is positive. There are only a handful of currency union observations for industrialized pairs in the pre-euro sample where the effect is positive and strong. The Table 3 re-runs the baseline estimations for these groups, finding indeed that there is a large amount of heterogeneity in the estimates for currency unions as well as all kinds of exchange rate regimes.

Table 3: Full sample estimation by level of development

	Ind_Ind	Ind_Dev	Dev_Dev
VARIABLES	log_trade	log_trade	log_trade
currency_union	0.275***	0.342***	0.734***
	(0.0316)	(0.0754)	(0.0862)
direct_peg	0.183***	0.379***	-0.499
	(0.0428)	(0.0433)	(0.358)
indirect_peg	0.0831***	0.257***	0.0891***
	(0.0201)	(0.0199)	(0.0215)
lrgdp	-1.013***	0.476***	0.481***
	(0.0829)	(0.0350)	(0.0442)
lrgdp_pc	1.892***	0.337***	0.146***
	(0.0857)	(0.0329)	(0.0404)
Constant	32.38***	-15.95***	-14.25***
	(2.692)	(1.168)	(1.468)
Observations	12,541	103,690	116,629
R^2	0.954	0.862	0.760

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The positive and significant sign for within industrial pairs on direct pegs is driven entirely by the 1960-1972 period of this sample and becomes strongly negative when I restrict to the post-Bretton Woods period, although the effect on currency union is robust to such changes in sample. For industrial-developing pairs I find positive estimates that are at least somewhat significant for currency unions and strongly so for exchange pegs. These numbers are all more of less consistent with those found in Klein and Shambaugh (2006) although I have many more currency union observations to work with in my estimation of industrial pairs.

That there are differences across development type is not particularly surprising. Most authors in this literature have been clear that estimates found based on small developing economies cannot necessarily be applied to the European experience or for any industrialized country for that matter. In addition many studies of the currency union effect on trade within the European monetary union have found small effects. Micco et al. (2003) for example, studies the early effects of the EMU and finds estimates ranging roughly between 0.05 and 0.2. In their post-emu analysis, Glick and Rose (2015) find a wide range of estimates for the euro effect on trade, settling on a parameter estimate that is significantly more modest than those found in Table 2 and for the currency union effect on industrialized pairs in Table 3. The results in Table 3 serve to underline the point that we should not expect all country pairs to have a homogenous currency union, or indeed fixed exchange rate effect on trade.

Chen and Novy (2017) suggest another, more rigorous methodology for dealing with heterogeneity in the currency union effect. They show that the currency union effect varies across the size of bilateral import shares. In order to overcome the simultaneity bias that would result from interacting their currency union variable with the outcome variable they propose a two step estimator that first predicts log import shares using importer-year and exporter year fixed effects as well as time invariant pair controls. They find that as a pair's predicted bilateral trade increases, so too does the estimated currency union effect fall. I extend the estimates from Table 2 to account for this heterogeneous effect on trade by first specifying the following equation:

$$\ln X_{ij,t} = \alpha_{i,t} + \alpha_{j,t} + \gamma Z_{ij} + \epsilon_{ij,t} \tag{2}$$

Where $\alpha_{i,t}$ and $\alpha_{j,t}$ are importer-year and exporter-year fixed effects and X_{ij} are a series of controls used commonly in gravity equation estimations including: log distance between the pair, common language, shared common colonizer, landlocked status, island status, and regional trade agreements. After this generate predicted bilateral trade shares between each pair as $\ln \widehat{X_{ij}}$, which is then interacted with currency union and emu status in the gravity equation:

$$\begin{aligned} \ln X_{ij,t} = \beta_0 + \beta_1 CU_{ij,t} + \beta_2 CU_{ij,t} \times \ln \widehat{X_{ij}} + \beta_3 \ln Y_{i,t} \times Y_{j,t} + \beta_4 \ln y_{i,t} \times y_{j,t} \\ + \beta_5 P^d_{ij,t} + \beta_6 P^I_{ij,t} + \alpha_{ij} + \rho_t + \epsilon_{ij,t} \end{aligned} \tag{3}$$

In Table 4, I implement as similar methodology to that used in Chen and Novy (2017) to the estimates I replicated from the prior literature in Table 2. For comparability to those estimates instead of bilateral import shares (their outcome variable) I use the same average of bilateral trade flows that are used in Table 2. While the static results I find in the following section do not allow for heterogeneity in the currency union effect (with the exception of between EMU and non-EMU pairs), I acknowledge that their result underlines the same fundamental problem that they emphasize.

3.3 Propensity Score Estimators in Trade

The propensity score estimators specify a first stage estimate of treatment to match controls based on observable characteristics. The fundamental assumption that underscores these estimators is the correct specification of the policy function, which in principle should include any controls that improve fit. This seems desirable as a number of potential difficulties arise in the causal identification of the currency union effect in standard gravity equations. Numerous studies find that omitted variables such as colonial history, political linkages, and other historical relationships are likely to be important this estimation. Persson (2001) uses pooled international trade data from Rose (2000) and estimates the average treatment effect on treated observations (ATT) using two separate methods *nearest neighbor* and *stratification* of propensity score matching. Bringing propensity matching estimators

Table 4: Heterogeneous Effect on Bilateral Trade Shares

	(1) 1960-1998	(2) 1960-1998	(3) 1973-1998	(4) 1973-2008
custrict	0.831***	0.896***	0.555***	
	(0.179)	(0.178)	(0.208)	
cu_ltradehat	-0.0490	-0.0773**	-0.0687**	
	(0.0340)	(0.0337)	(0.0282)	
cuwoemu				0.489***
				(0.179)
cuwoemu_ltradehat				-0.0736**
				(0.0366)
emu				-0.0124
				(0.175)
emu_ltradehat				0.0300
				(0.0218)
direct_peg		0.0861	0.220**	0.184**
		(0.0661)	(0.0876)	(0.0776)
indirect_peg		-0.0551**	0.00376	-0.00999
		(0.0220)	(0.0304)	(0.0254)
lgdp	0.408***	0.397***	0.503***	0.688***
	(0.0465)	(0.0519)	(0.0618)	(0.0509)
lgdppc	0.654***	0.655***	0.531***	0.398***
	(0.0470)	(0.0520)	(0.0607)	(0.0501)
regional	0.515***	0.396***	0.242***	0.269***
	(0.0450)	(0.0489)	(0.0522)	(0.0324)
Constant	-29.03***	-28.55***	-32.19***	-39.01***
	(1.569)	(1.775)	(2.150)	(1.770)
Observations	249,822	207,864	167,322	258,826
R^2	0.863	0.866	0.878	0.869

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

to study the effect of the euro on trade, Chintrakarn (2008) finds that countries within the EMU trade 9% to 14% percent more than other country-pairs.

While a replication of the Persson (2001) methodology on my data yields similar estimates, these simple propensity score rely on ad hoc matching of observations and it is not clear how to allocate groups into bins. Further the estimation of average treatment effects arising from these estimates depends entirely on the proper specification of the first stage treatment equation. It is possible to improve these estimates by implementing an inverse propensity score weighing with regression adjustment (IPWRA). A desirable feature of this approach is that it is *doubly robust* and will yield consistent estimates of treatment as long as either model is correctly specified. These estimators are well explained in Jordà and Taylor (2013) who state the IPWRA estimator as:

$$ATE_{IPWRA} = \frac{1}{n_1} \sum_t \left[\frac{CU_t \left(m_1 \left(X_t, \hat{\beta}_1 \right) \right)}{\hat{p}_t} \right] - \frac{1}{n_0} \sum_t \left[\frac{(1 - CU_t) \left(m_0 \left(X_t, \hat{\beta}_0 \right) \right)}{1 - \hat{p}_t} \right] \quad (4)$$

Where CU_t is a dummy representing whether or not a pair has begun a currency union in time t, $\hat{p}_t$ is the predicted probability of treatment from the first stage estimation, and $m_{0,1}$ is an estimate of the mean of the outcome conditional on control/treatment. My first stage specification to predict these probabilities of treatment with a logit model that uses the standard gravity estimators of that are used in equation one as well as other variables that can be used to predict treatment. The treatment equation is:

$$\begin{aligned} CU_{ij,t} = \gamma_0 + \gamma_1 \ln Y_{i,t} \times Y_{j,t} + \gamma_2 \ln y_{i,t} \times y_{j,t} + \gamma_3 \ln Dist_{ij,t} \\ + \gamma_6 P^d_{t-1} + \gamma_7 P^I_{t-1} + \gamma Z_{ij} \end{aligned} \quad (5)$$

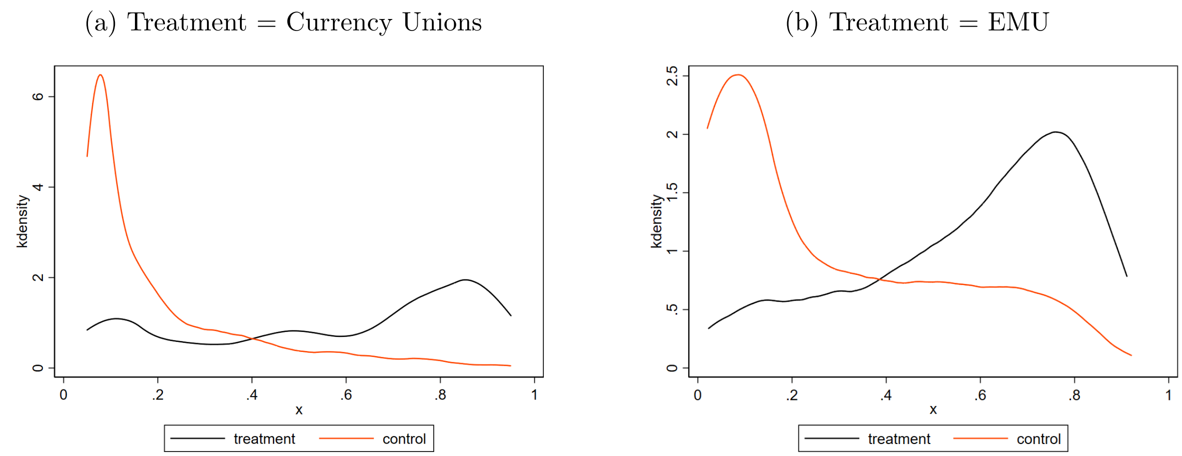
Where I have included the standard gravity variables, log-product of GDP, log distance and log per-capita GDP. I also lagged terms for direct and indirect exchange rate relationships which do not include currency unions. Finally I include a number of variables in Z_{ij} that are commonly used in these equations such as past colonial relationship, common language, participation in regional trade agreements, and shared borders.

I restrict analysis to the common support of treatment and controls. In practice this means dropping a reasonably large amount of observations that are either below the lowest predicted probability for treatment, or above the highest probability for controls. In my baseline results I will only consider data that is along this common support, as is clear in the Table 5 results, this has a particularly large affect on the number of observations in the estimation of the EMU affect on trade. This is because a large portion of the non-emu data have extremely small estimated probabilities, as one might expect. It is not uncommon to lose a great deal of data with matching estimators and while truncation of probabilities within bands is a common solution to this, it was not sufficient to keep this mass of low probability observations from biasing the estimated effect significantly downward.

In Figure 1, I show that after controlling for being on a common support of the probability distribution, my first stage yields sufficient overlap across groups to continue the analysis. The two density plots are separated for the two separate analysis both for all currency unions and for the effect on the EMU alone. Having sufficient overlap between the treatment and control is crucial in order to have sufficient comparability with which to estimate differences between the two groups. Other matching estimators either match along this distribution for nearest neighbors, or broad probability bins and assess the treatment effects within those specific groups. My IPWRA methodology does not require doing so and allows me to take advantage of all of the variation across this common support.

Given these first stage estimates, I find the IPWRA estimate for the effect of currency unions on trade. My estimate of the mean conditional on treatment ($m_{1/0}$) is simply the conditional mean from equation 1 that was used in the above specifications which uses standard gravity estimates, other non-currency union peg relationships, a time trend and country-pair fixed effects. I estimate this effect both for all currency unions and for the euro

Figure 1: Probability of Treatment: Overlap



alone. The first two columns show the OLS results for each of these two outcome variables. The first of these directly corresponds to column 3 of my OLS results in Table 2 while the second is the same estimation with membership in the European monetary union replacing currency union as the coefficient of interest. Columns 3 and 4 give my estimation of the IPWRA estimator of these effects.

Table 5: IPWRA estimates of currency unions and the euro on trade

	OLS: CU	OLS: EU	IPWRA: CU	IPWRA: EU
Currency union	0.485**	0.224***	0.661***	0.063***
	(0.204)	(0.051)	(0.025)	(0.009)
Observations	258,826	258,826	234,550	7,197

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Interestingly the effect of the matching estimator is to increase the effects for currency unions in general, while decreasing them for the EMU. The increase for currency unions in general is from about a 50% increase from trade in the OLS fixed effects regression to a predicted increase of just over 90%. For the EMU, the effect of utilizing the matching estimator is a reduction of the effect of being in a monetary union on trade from an increase of about 25% down to only a 6% increase in trade. In both cases the estimates are significant and while the currency union estimate is squarely within those in the prior literature, the EMU estimate is very near the lower bound of existing estimates for the effect of eurozone membership. The effect for all currency unions is well below that found in Glick and Rose (2002), but on a similar magnitude, suggesting that in general currency union membership leads to about a 50% increase in bilateral trade. However the euro effect is now quite small, yielding only slightly more than a 6% increase. This is on the lower bound, but well within the findings of the literature on the effect of the emu. Indeed in their recent post-emu update Glick and Rose (2015) find mixed positive and negative results, in the end suggesting that the most plausible effect is a moderate positive effect, which is confirmed here.

These estimates still rely on the static specification of gravity. That is, treatment is defined simply by whether a country is currency in a currency union or not and the effect is unable to change over time. These estimates still do not allow for entering/exiting a currency union to have differential and cumulative effects on future values of trade. This is extremely important because not only because past evidence tells us that currency unions rarely break, but also because current euro crisis shows that it is politically very difficult to leave a monetary union once joined.

4 Dynamic policy propensity score estimates

4.1 Dynamic gravity equations

In this section I explore the possibilities of dynamic effects of currency unions on trade. The first distinction that I make here is that while I still estimate the probability of treatment in the same way, I now consider treatment in my estimator to be a dummy equal to one if the country-pair began a currency union in the recent period. I choose to ignore currency union breaks at present as I do not expect the effect to be symmetric and wish to focus on more recent years in order to study the effect of the EMU. As such there are too few currency union breaks to make any estimate particularly meaningful. In my sample from 1972-2007 I observe 161 currency union pair starts.

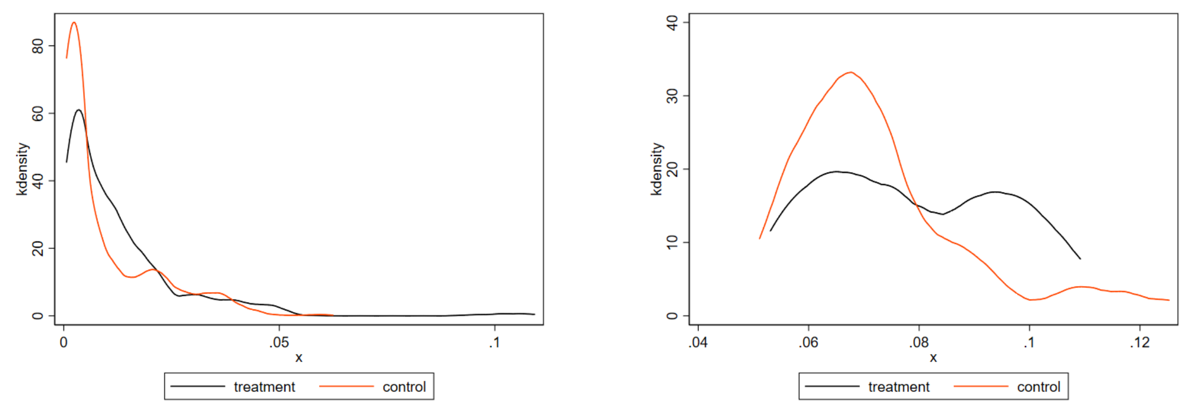
The static models used previously do not allow for dynamic evolution of the trade relationship over time and as such do not allow for the treatment effect of currency unions to be studied over time. The growing importance of fixed costs in the trade literature also supports the idea that such dynamics may be important. In a recent paper that studies the effect of entry into the EMU on trade, Bergin and Lin (2012) find strong evidence that trade adjusts dynamically over a number of years and that adjustment occurs in European countries even before the establishment of the currency union. Campbell (2013) finds that the Rose-Glick coefficient is largely driven by geopolitical events such as colonization, the effects of which decay over time. While the bias is corrected in such a static setup if omitted variables can be accounted for, allowing for the trade relationship to evolve dynamically also can alleviate such concerns. The sensitivity of trade estimates to idiosyncratic oddities of a country-pair's history makes matching estimators especially appealing as it allows me to assign comparison of treatment and control in a way that at least attempts to account for these difficulties.

To estimate the IPWRA estimator for this setup I again follow Jordà and Taylor (2013) who specify the average treatment effect of a policy choice in time t on the outcome in time t+h. This is the same estimate as used previously except now I estimate the *h-step ahead* change in log trade that results from entry into a currency union in the current period. This means simply altering the conditional mean in equation 2 to this response over changing time horizons as well as changing the definition of treatment to mean whether a pair has entered into a currency union in the current time period. This also means reestimating the treatment first stage equation to one which considers a country as being treated if they joined a monetary union in the current period.

Unlike my static gravity estimators, in which the "treatment" effect was that state of being in, or out, of a currency union (or the emu), here the treatment is whether a country opts into a currency union agreement in period t. As a result the first stage estimation makes for less precise estimates of the probability of joining into such an agreement as there are significantly fewer observations where a country in the current year has joined into a monetary union. To improve the accuracy in this case, I reestimate Equation 5 with CU_{ij}^{join} and $EMU_{ij,t}^{join}$ as the outcome including lagged variables for both direct and indirect pegs, as well as for the size of the pair's GDP. While this helps specify a model that has predictive power for the EMU it proves more difficult for currency unions in general. Figure 2 shows the overlap for both cases where there is only small difference in the case of the effect for all currency unions.

Figure 2: Probability of Treatment: Overlap

(a) Treatment = Joining Currency Union (b) Treatment = Joining EMU



How exactly to go about estimating dynamic effects for the average treatment effect of a currency regime choice in time t on the outcome in time t+h is not immediately clear. The seemingly obvious choice would be to estimate the gravity equation with lagged trade as is suggested in Bun and Klaassen (2002), using lagged dependent vairables as instruments estimated in a GMM framework of Arellano and Bond (1991) and Blundell and Bond (1998). However while this estimate is consistent, and deals with the potential biases of estimating dynamic panels with large N and small T found by Nickell (1981), such estimates have been shown to be particularly prone to over-fitting and as a result are quite sensitive to specification.(see Bowsher (2002)). I find in some preliminary regressions using this specification that indeed the estimates seem to be highly sensitive to choices both of controls and number of lags to include.

In the face of such uncertainty I opt to specify a simple local projection method of Jordà (2005) in order to estimate the h-step ahead impulse response of bilateral trade to a country-pair joining a currency union. I consider specifying this regression both in log changes and in levels of the standard gravity estimates and find little difference between the results. I therefore choose to estimate the prediction of the conditional mean h steps ahead in levels of standard gravity variables as:

$$ln(X_{ij,t+h}) - ln(X_{ij,t}) = \beta_0 + \beta_1 CU_{ij,t} + \beta_2 ln(Y_{i,t} * Y_{j,t}) + \beta_3 ln(y_{i,t} * y_{j,t}) + \beta_4 ln(distance_{ij}) \quad (6)$$

Table 6 shows the average treatment effect for each year after the start of a currency union. This is the estimate of equation 2 using the first stage estimation of treatment for currency unions given in equation 3 where instead of currency union membership I replace the dependent variable with entering a currency union. I calculate these estimates for up to 7 years after entry into a union, stopping at that point so that none of the observations contain estimates from after the trade collapse caused by the financial crisis of 2008-2009.

Table 6: Dynamic impact of eurozone entry on trade

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
EMU Entry	0.076*	0.095*	0.083*	0.079*	0.094*	0.055	-0.017
	(0.004)	(0.072)	(0.049)	(0.059)	(0.062)	(0.068)	(0.071)
Observations	15,277	15,277	15,277	15,277	15,277	15,277	15,277

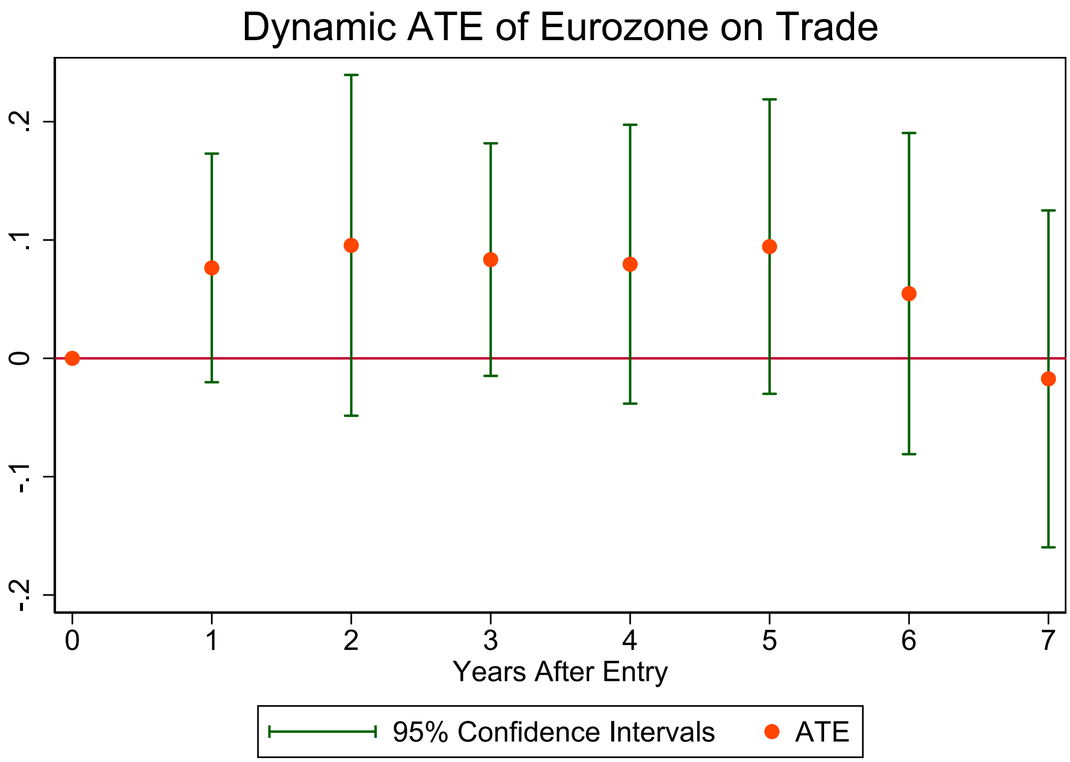
Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Not too surprisingly these estimates look a bit on average like the those that I found for the euro in the static case, with the mean of these effects fairly close to the overall effect found in Table 6. These effects are insignificant after year six and almost exactly zero by seven. In robustness estimates beyond that horizon (excluding countries that joined later and are in recession at year 8) I find no significant effect at any levels, suggesting that this is not an anomaly, but that the emu effect has puzzlingly weakened over this time. These suggest that, for euro countries, currency union membership gave increasing benefits in early years that then become indistinguishable from zero. I chose when defining the original euro members to begin the union in 1999 when the currency was born virtually. One could argue this is more of a hard peg before the actual introduction of physical currency in 2002 and it has been shown, both in my Table 2 as well as in Klein and Shambaugh (2006), that pegs appear to have weaker trade effects than currency unions. This may be why there is a slight strengthening in early horizons.

In Figure 3, I plot these estimates along with two standard error bands. Some previous studies of the EMU have speculated that the long run effects of the common currency may be quite large and persistent, making the somewhat modest short term increases more palatable. I do not find compelling evidence that this is the case, although perhaps a more comprehensive structural model of trade dynamics is needed to study this relationship precisely.

Figure 3: Dynamic Effect of Eurozone Entry on Trade



The results of declining trade in the years following are hard to explain. If entering a currency union gives euro members easier trade through lowered transaction costs and no exchange rate risk, then such an effect should persist as long as the union does. One possible explanation is the much of the currency union effect being picked up for the EMU countries here is due to unobserved endogenous effects of other policies that are simultaneously taking place. Eurozone integration involved a number of sweeping policy changes outside of the single currency, it is possible that one or more of these has a significant, but transitory effect on trade that is being picked up by my euro membership variable. Interestingly work by De Sousa (2012) which studies long run trends in currency unions finds that in general the effect has been in decline, speculating that financial globalization may be decreasing the benefits of currency union membership. If trade frictions are falling for all countries, then perhaps many of the benefits of being in a common currency are declining as well. Since most of the EMU countries joined at a similar time it's plausible that some kind of unobserved trend that interacts with the time trend (controlled for in fixed effects) could be at play here.It is hard to believe that such forces are operating on such a short timeline, especially among financially developed and integrated countries, but the effect is small enough that it is a reasonable candidate explanation.

It is important to note that this decline happens before the *trade collapse* of 2008, as I restrict my sample to those years. Unfortunately, it is because of this trade collapse and the following recession and euro crisis that even with some new data now available, it would be difficult to read much into a window that extends much further than the one used here and thus I restrict the analysis. For other currency unions, no such restriction is necessary and I estimate effects on a slightly larger ten year window. I show the effect of currency union membership on trade for all currency unions in Table 7 and Figure 7. Estimates, as with the EMU are found using the two step estimator, first on the probability of joining a currency union in a given year, and then a local projection of the 'h-step' ahead estimate of joining. As mentioned, it was difficult to specify a first stage equation for currency unions in general with little variation in treatment and control propensity score weights. As a result the two step estimation has little affect on these local projections.

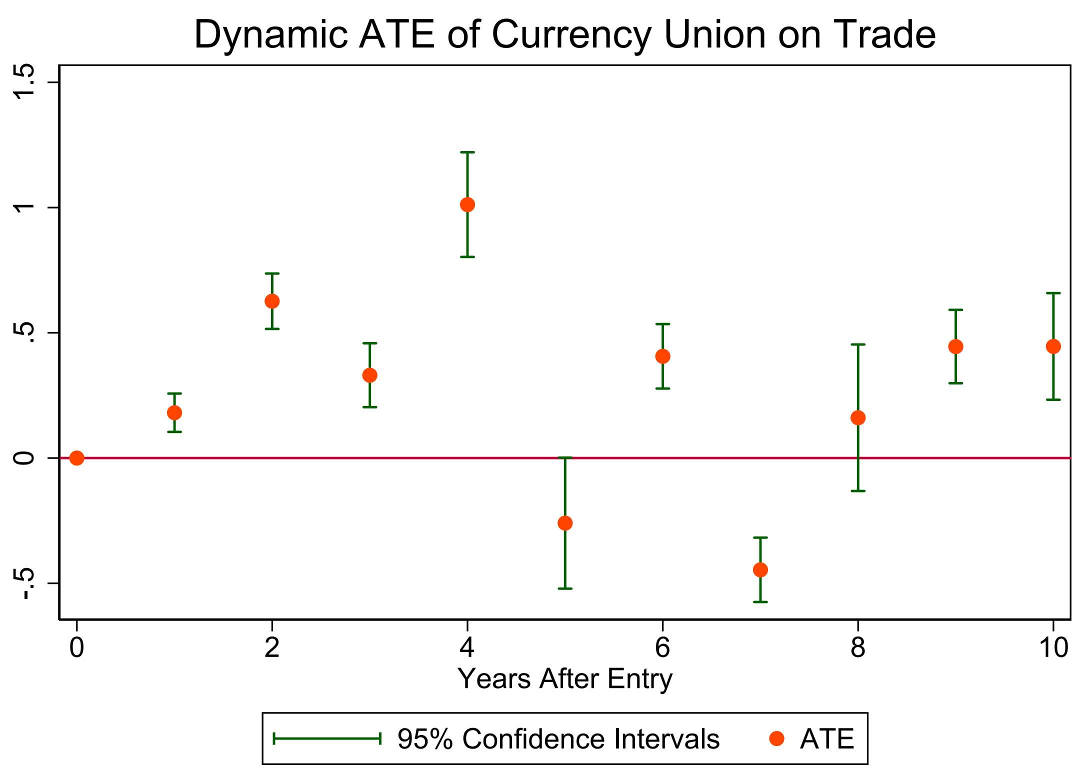
Table 7: Dynamic impact of currency union entry on trade

	Year 1	Year 2	Year 3	Year 4	Year 5
CU Entry	0.181***	0.626***	0.331***	1.01***	-0.260
	(0.038)	(0.055)	(0.0638)	(0.1045)	(0.131)
Observations	19,350	19,350	19,350	19,350	19,350

	Year 6	Year 7	Year 8	Year 9	Year 10
CU Entry	0.406***	-0.446	0.161	0.445***	0.445***
	(0.0644)	(0.0643)	(0.146)	(0.073)	(0.106)
Observations	19,350	19,350	19,350	19,350	19,350

The biggest takeaway from the dynamic estimation of currency union entry on trade is that there is a large amount of variation at different horizons. Using a sort of Olympic scoring of dropping the high and low outliers one could come to the conclusion that in general the effect appears to be somewhat persistent and consistently in the 0.4-0.6 range. It seems likely that the strong outliers are being driven by certain cases as there are, as mentioned far fewer 'treatment' observations to work with when limiting the outcome variable to the year of entry into a union, and as such no specification of the model yields a neat trend. I take this as weak evidence that for currency unions in general the effect is relatively persistent over time.

Figure 4: Dynamic ATE of Currency Union Entry on Trade



On the subject of dynamic effects of currency unions, a crucial policy question is the effect of currency union breakups. During recent eurozone crisis there was heated debate on the potential costs of leaving the monetary union. Though no countries chose to do so it is worth studying the effect that past cases of union breakups have had on bilateral trade, if only for context. Before doing so, it is worth noting that eurozone economies are already highly integrated in many other ways such that I expect the negative effects of such a breakup will dissipate rather quickly relative to any estimates drawn from developing countries. Indeed it is perhaps the high degree of economic integration that is to blame for such a models emu effect on trade in the first place, member countries having already captured many of the gains that might be enjoyed by means of such an arrangement.

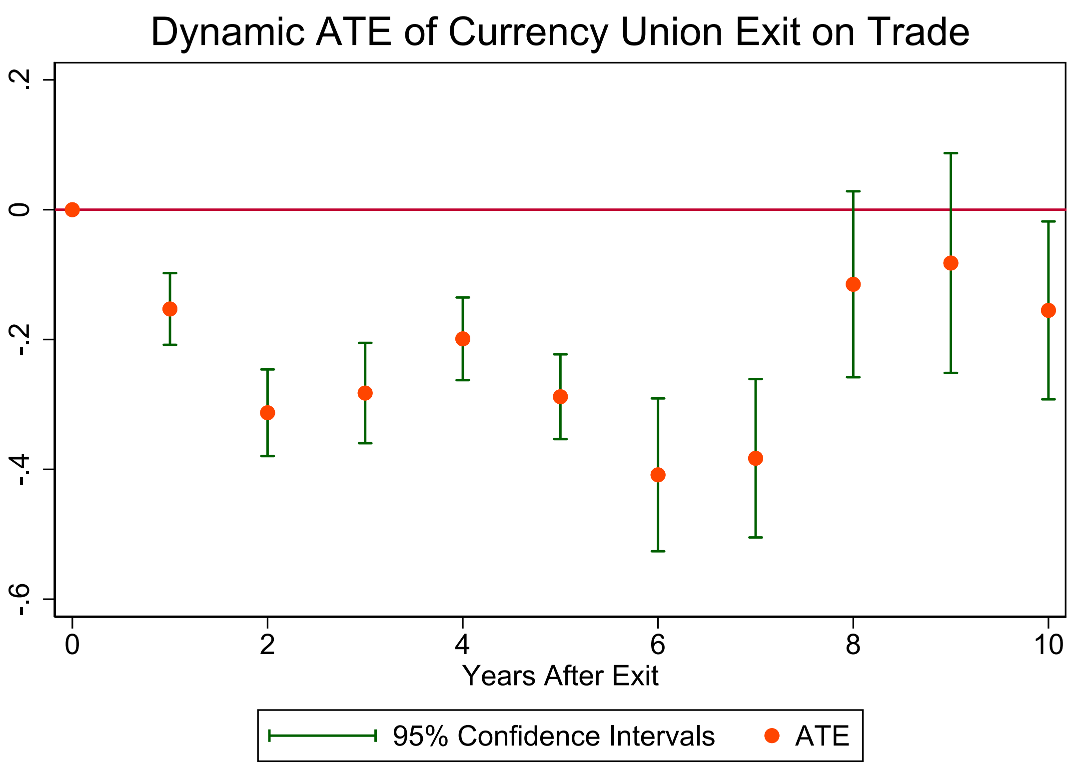
Table 8 shows the ten year estimates of the effect of exiting a currency union on bilateral trade. There are 139 break-ups in my sample, and many of these are former colonies leaving the currency of their past colonizer. While that makes this information impossible to apply to the case of developed countries, my use of a two step estimator, for the first time, takes seriously the control group used so that these estimates can more reasonably reflect the average effect for the types of countries we have observed going through such a chance. It takes eight years for the negative affect of leaving such a union to decline and it is not clear if it erodes completely. I find declines in bilateral trade falling from about 20% to a peak of about a 50% in year six.

Table 8: Dynamic impact of currency union exit on trade

	Year 1	Year 2	Year 3	Year 4	Year 5
CU Exit	-0.153***	-0.313***	-0.282***	-0.199***	-0.288***
	(0.028)	(0.033)	(0.039)	(0.0318)	(0.0326)
Observations	109,832	109,832	109,832	109,832	109,832

	Year 6	Year 7	Year 8	Year 9	Year 10
CU Exit	-0.408***	-0.383***	-0.115*	-0.082	-0.155**
	(0.059)	(.061)	(.072)	(.085)	(0.069)
Observations	109,832	109,832	109,832	109,832	109,832

Figure 5: Dynamic ATE of Currency Union Exit on Trade



5 Conclusions

I show that propensity score weights can have a substantial impact on estimates of the currency union effect on trade. While the affect that this methodology has is in general to lower the estimated relationship between membership and bilateral trade, the difference between my IPWRA estimates and those recovered from traditional methods is substantial when applied to the case of the EMU. I argue that this is due to the fact that the majority of countries make for a poor control group to the well integrated economies that make up the eurozone. While my methodology does not allow for heterogeneous effects, as in Chen and Novy (2017), my contribution similarly seeks to understand the problem with estimating a currency union effect on trade without accounting for characteristic differences among economies in currency unions and those that are not. My estimates also fail to account for a number of possible factors, perhaps most importantly the diversion of trade from previous sources to those within the EMU. This could potentially bias my estimate upward as is evident in Micco et al. (2003) who when accounting for such diverted trade finds EMU estimates in the range of 8 to 16 percent, lower than traditional estimates, but higher than the 6% that I find, such diversion may bring my estimates downward as well.

The choice to join a currency union has historically been a highly persistent one, especially relative to the more flexible alternative of a fixed exchange regime. Indeed it is already clear that it will be politically difficult for European countries to abandon the monetary union despite some members having potentially large incentives to do so. Therefore the dynamic effect of shared currency on trade over time is important as it is a decision countries likely will have to live with for extended periods. I find that any gains in trade euro countries enjoy die out after the seventh year of adoption of a common currency, while the pain of exit for non-euro countries take a similar time to die out.

Another consideration that studies of currency unions, this one included, fail to recognize is the potential that not all unions are entered with the same level of bilateral support. While countries in the eurozone, and a number of other unions, enter into a common currency multilaterally, many currency unions in the sample represent unilateral decisions by a small developing country to adopt the currency of a large industrialized economy. While the former likely represents a need to smooth transaction costs, which though potentially quite important are unlikely to have the kind of impact that early estimates of currency unions suggested with increases in bilateral trade of over 50%. However the unilateral adoption by a small developing nation may adopt a stable currency for a much larger number of reasons, perhaps to aid in the promotion of export driven growth. In such cases the currency union effect may be hard to separate other policies. While my methodology advances the estimates of currency unions to better account for the differences between countries that enter monetary unions, and those that do not, I believe that a more careful historical analysis of the policies of countries that choose to enter these arrangements would be greatly beneficial to our understanding of how monetary unions affect trade. As for countries in the eurozone, certainly trade promotion is not the only potential benefit of a monetary union. While I do not find particularly large effects, this does not necessarily mean that the monetary union can, or should, be easily abandoned. I provide merely weak evidence that the gains from trade being enjoyed by the average European country are not particularly large and are potentially declining over time.

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A Currency Union Effects on Trade: Full Sample and Changing Fixed Effects

In Table 2.2 I replicate some prior estimates from the literature on homogeneous currency union effects on trade. In particular I follow some of the conventions in Klein and Shambaugh (2006) to restrict the sample studied, extending their post-Bretton Woods period to the financial crisis in 2008. In the following tables I run the specifications from that table extending the sample to the post crisis to more recent data (up to 2014), while also running for a number of different fixed effects. In Table 9 I run this for all currency unions using pair and year fixed effects, extending the framework to account for non-EMU and EMU pairs in Table 10. There is not a drastic different when these extra years are included relative to Table 2.2 in terms of currency union and EMU effects, although the sample period can have a substantial impact on the effect of other fixed exchange regimes. In particular finding them to be much more significant in the post-Bretton Woods period.

In Tables 11 and 12 I repeat this with Importer-year and Exporter-year fixed effects and pairid fixed effects. While this shrinks the effects considerably they are still quite large and significant, for the most part, maintaining the relative size different between non-EMU and EMU countries. Under these fixed effects there aren't any substantial differences between non-currency union exchange rate regimes across specifications.

Table 9: All Currency Unions

VARIABLES	(1) All Years	(2) All Years	(3) 1972 to Present
Currency Union	0.649***	0.684***	0.312***
	(0.0663)	(0.0744)	(0.0679)
direct_peg		0.0649	0.149**
		(0.0616)	(0.0656)
indirect_peg		-0.0774***	-0.0486**
		(0.0198)	(0.0235)
lgdp	0.697***	0.674***	0.795***
	(0.0352)	(0.0402)	(0.0462)
lgdppc	0.413***	0.442***	0.330***
	(0.0359)	(0.0408)	(0.0461)
regional trade agreement	0.334***	0.280***	0.221***
	(0.0263)	(0.0280)	(0.0270)
Pairid FE	X	X	X
Year FE	X	X	X
Observations	426,508	340,970	300,415
R^2	0.855	0.858	0.866

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 10: Currency Union and EMU Effect

VARIABLES	(1) All Years	(2) All Years	(3) 1972-Present
CU non-EMU	0.774***	0.842***	0.420***
	(0.0972)	(0.107)	(0.159)
EMU	0.415***	0.372***	0.245***
	(0.0542)	(0.0539)	(0.0443)
direct_peg		0.0706	0.146**
		(0.0616)	(0.0662)
indirect_peg		-0.0735***	-0.0482**
		(0.0198)	(0.0235)
lgdp	0.691***	0.668***	0.793***
	(0.0354)	(0.0404)	(0.0463)
lgdppc	0.418***	0.447***	0.332***
	(0.0360)	(0.0409)	(0.0461)
regional	0.342***	0.290***	0.223***
	(0.0263)	(0.0281)	(0.0270)
Pairid FE	X	X	X
Year FE	X	X	X
Observations	426,508	340,970	300,415
R^2	0.855	0.858	0.866

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 11: All Currency Unions

VARIABLES	(1) All Years	(2) All Years	(3) 1972-Present
Currency Union	0.326***	0.300***	0.209***
	(0.0671)	(0.0761)	(0.0776)
direct_peg		0.179***	0.126**
		(0.0528)	(0.0612)
indirect_peg		-0.00972	-0.00524
		(0.0239)	(0.0258)
lgdp	-1,984	-851.2	-23.08
	(1,829)	(2,022)	(2,187)
lgdppc	-763.9	-525.8	1,876
	(3,819)	(4,198)	(4,522)
regional	0.288***	0.272***	0.214***
	(0.0299)	(0.0320)	(0.0317)
Exporter-Year FE	X	X	X
Importer-Year FE	X	X	X
Pairid FE	X	X	X
Observations	426,171	340,709	300,262
R^2	0.879	0.882	0.886

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 12: Currency Unions and EMU

VARIABLES	(1) All Years	(2) All Years	(3) 1972-Present
CU non EMU	0.362***	0.342***	0.200
	(0.0921)	(0.105)	(0.150)
EMU	0.239***	0.201***	0.217***
	(0.0638)	(0.0662)	(0.0616)
direct_peg		0.180***	0.126**
		(0.0527)	(0.0617)
indirect_peg		-0.00896	-0.00525
		(0.0239)	(0.0258)
lgdp	-1,987	-861.2	-22.66
	(1,829)	(2,022)	(2,187)
lgdppc	-790.3	-549.5	1,878
	(3,819)	(4,198)	(4,522)
regional	0.289***	0.273***	0.214***
	(0.0299)	(0.0320)	(0.0317)
Exporter-Year FE	X	X	X
Importer-Year FE	X	X	X
Pairid FE	X	X	X
Observations	426,171	340,709	300,262
R^2	0.879	0.882	0.886

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

B Dynamic Effect of Currency Union (non EMU)

My data already struggles with the dynamic affect of joining a currency union given difficulty in the first stage estimation. For that reason I left the estimation of the effect excluding the EMU for this appendix. I use the same first stage estimating equation which is that of Equation 5 with one period lags on both types of fixed exchange regime as well as the log products of GDP And GDP per capita. I show both the overlap of probabilities among non emu currency union joins and the common support of the control group as well as the predicted effect of currency unions on trade ten years ahead of entering into the currency union. These estimates look somewhat like fuzzier versions of the one presented in Figure 4 of the paper, but with a few more puzzlingly negative periods bot hat the very beginning and end the sample. Since many of the currency unions in

Figure 6: Overlap Treatment of Non-EMU Currency Unions

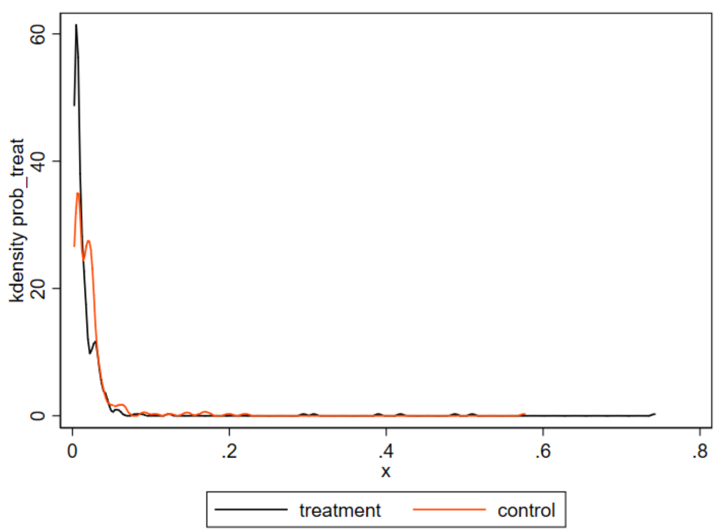

Figure 7: Dynamic ATE of Currency Unions On Trade