ESSAYS ON CURRENCY UNIONS AND TRADE

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The countries constituting a currency union (a group of countries sharing a common currency) are thought to be more integrated among themselves than are other countries. The first chapter revisits this belief in the tradition of articles published by Andrew Rose. The first chapter demonstrates that only a subset of the currency unions examined by Rose are as integrated through trade as Rose proposed. The extent of integration is related first and foremost to the tariff rates prevailing within the union's member countries as well as the correlation of TFP shocks in the currency union. The seconde chapter demonstrates that trade in certain types of manufactured goods benefit from greater trade integration than do agricultural goods. The third chapter examines the ability for PPP to hold within currency unions. The chapter finds that PPP fails to hold for several countries within a currency union.

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PREFACE

Enumerating the people who deserve my thanks for bringing this dissertation into existence would surely lead to a document longer than the dissertation itself. First and foremost are my committee members. Steven Husted has been an unending source of patience, insight, and help. Inevitably, when a problem arose he would have the solution to it and my sole regret would be that I had not consulted him earlier. I also thank Dave DeJong, Marla Ripoll, and Shuichiro Nishioka for their efforts. Outside my committee, James Cassing has been a perpetual source of help and good cheer. Within the Economics Department, the Macroeconomics Seminar & Brown Bag as well as the Pittsburgh International Trade & Development Seminar have been fruitful venues for testing out ideas and receiving useful feedback.

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1.0 WOULD A CURRENCY UNION BY ANY OTHER NAME BE AS INTEGRATED?

1.1 INTRODUCTION

A series of papers authored or co-authored by Andrew Rose starting in the late 1990s conclude that countries sharing a single currency benefit significantly from this monetary arrangement. The benefits manifest themselves through large increases in trade within the currency union, ranging from 92% to 266%, results obtained by estimating gravity equations of bilateral trade (Glick and Rose (2002)). These results, termed the "Rose effect" in Baldwin (2006), have remained robust to multiple specifications, a rich set of control variables, and attempts to alter the estimation strategy, such as Barro and Tenreyro (2007). Rose himself acknowledges the surprising nature of the results: "In a world with derivative markets (at least for developed countries), it is hard to believe that lower transactions costs could lead trade to rise so much," (Rose and van Wincoop (2001)). The authors continue by saying:

> There are two ways to proceed. One can doubt the estimation results. Despite the extensive search of Rose (2000), there may still be some omitted factor that drives countries both to participate in currency unions and to trade more...
> Another tack is to take a harder look at the empirical model.

Of the two paths outlined above by Rose, subsequent studies (Persson (2001), Barro and Tenreyro (2007), Santos Silva and Tenreyro (2010)) have largely pursued the latter option, seeking to understand the implied, strong effects of currency union membership as a consequence of inappropriate estimation techniques that implemented the gravity equation empirically. These studies have led to improvements in the estimation of bilateral trade models. Santos Silva and Tenreyro (2006) critiques log-linearizations of the gravity equation which permit estimation through Ordinary Least Squares (OLS), the method typically used by Rose and his co-authors. Such a linearization can produce inconsistent estimates in the presence of heteroskedasticity. Santos Silva and Tenreyro (2006) advocates non-linear estimation using the Poisson Pseudo-Maximum Likelihood (PPML) estimator as a remedy for the inconsistency.

This paper shows that when properly estimated, using the PPML estimator, the currency union effect in a gravity equation implies no significantly higher integration for countries in a currency union than otherwise similar countries but lacking a common currency. However, a specification of the gravity equation that includes a vector of currency union dummies (one variable for each currency union considered: "heterogeneous integration") rather than a single dummy variable ("homogeneous integration": the practice in Rose (2000) and elsewhere), shows that certain currency unions (such as the ECCU in the Caribbean and the UEMOA in Africa) display levels of integration comparable to those found by Rose, while other currency unions do not (such as the Eurozone or countries using the US dollar).

Given that the universe of currency unions displays such heterogeneous levels of integration, I turn to the literature on currency union formation for characteristics of currency unions that could explain differences in the extent of integration. This paper contrasts the criteria on integration mentioned in the foundational, theoretical papers of this literature (namely Mundell (1961) and McKinnon (1963)) and the performance of these criteria in explaining trade flows with the gravity equation. In particular, business cycle or Total Factor Productivity (TFP) shocks and inflation are little related to the range of trade patterns in currency unions implied by results from a gravity equation with heterogeneous levels of integration across currency unions.

Tariffs, in contrast, are closely related to the heterogeneous trade-enhancing effects. More precisely, tariff rates and trade are *positively* correlated within a currency union. This finding arises from the unexpected fact that, on average, countries in currency unions tend to trade among themselves in goods subject to relatively high tariffs. Importers of high-tariffed goods tend to favor exporters from within the union so as to avoid the costs incurred when purchasing goods priced in a different currency, however small might be those transaction costs. A common currency creates a price wedge between firms within the currency union and firms outside the currency union. This wedge favors firms in a country inside the currency union when selling their goods to other countries inside the union. Though small, this advantage translates into a large effect on trade. Thus, the results of this paper echo those of Yi (2003) which describes circumstances under which small changes in tariffs can generate disproportionately large increases in trade.

Other work, such as Santos Silva and Tenreyro (2010), also emphasizes a return to considering the general economic characteristics of currency unions. However, Santos Silva and Tenreyro (2010) re-examines the literature on currency union operation and formation in order to broaden the criteria for a currency union's effectiveness beyond the criterion of greater intra-union trade. In contrast, this paper seeks answers to the long-puzzling result of an unexpectedly large increase in intra-union trade associated with a common currency by looking at the very characteristics Santos Silva and Tenreyro (2010) proposes as criteria.

The organization of the paper is as follows. Section 2 describes the methodology and data used in the paper as well as how results are reported. Section 3 presents results that replicate those in Glick and Rose (2002) and results that demonstrate the extent of heterogeneous integration across currency unions. Section 4 turns to the theoretical literature on currency unions for potentially omitted variables that may be closely related to currency union integration effects. Section 5 concludes.

1.2 DATA & METHDOLOGY

1.2.1 Methodology

The workhorse model for most empirical studies of currency unions is the gravity equation. As articulated in Anderson and van Wincoop (2003), the gravity equation for bilateral trade from country i to country j at time t, X_{ijt}, can be expressed as:

$$X_{ijt} = \frac{Y_{it}Y_{jt}}{Y_t^W}\left(\frac{b_{ijt}}{P_{it}P_{jt}}\right)^{1-\sigma} \tag{1.1}$$

Y_{it} denotes nominal income in i and Y_t^W denotes nominal world income. b_{ijt} denotes "the trade cost factor between i and j," or "bilateral resistances," (pp. 174-176). P_{it} denotes "the consumer price index of i" or "multilateral resistances," and reflects the price in i of goods purchased from j, inclusive of trade costs b_{ijt} (pp. 174-176). Estimating equation 1.1 first requires answering three questions: how to specify the conditional expectation for the regression, $E\left[X_{ijt}\left|Y_{it}, Y_{jt}, Y_t^W, b_{ijt}, P_{it}, P_{jt}\right.\right]$; how to account for (P_{it}, P_{jt}); and how to specify the b_{ijt}.

As mentioned earlier, several papers in the past decade have focused on the first question in order to explain trade flows generally and in order to understand the impact of a common currency on trade. Econometric testing of economic theory generally involves specifying the theoretical equation as a conditional expectation. This specification leads to an estimating equation comprised of a theoretical equation plus a regression error, v_{ijt}. The regression error is assumed to be uncorrelated with the regressors (here, $Y_{it}, Y_{jt}, Y_t^W, b_{ijt}, P_{it}, P_{jt}$). Traditional estimation of the gravity equation first transformed equation 1.1 into a linear equation by applying the logarithm function to both sides. The estimating equation became the log transformation of equation 1.1 plus a regression error, ϵ_{ijt}, assumed to be uncorrelated with the regressors (here, logarithmic transformations of output, multilateral resistances, and bilateral resistances).

Parameters estimated from a logarithmic-transformation of the gravity equation are traditionally interpreted as equivalent to what would be estimated from the multiplicative form of the gravity equation. Santos Silva and Tenreyro (2006) demonstrates that this assumption is generally false. This assumption would require either 1) the failure of Jensen's inequality or 2) a particular and unlikely relationship between the error terms of the multiplicative model and the log-transformed model. Heteroskedasticity in the multiplicative model exacerbates the problem.[1]

The second question concerns how to control for the (P_{it}, P_{jt}) or "multilateral resistance terms." Anderson and van Wincoop (2003) explains how to solve for the (P_{it}, P_{jt}) exactly as part of gravity theory. However, this process is computationally intensive. A common alternative (Glick and Rose (2002), Baltagi et al. (2003), Santos Silva and Tenreyro (2010),

[1]See Santos Silva and Tenreyro (2006) for more details.

Anderson and Yotov (2010)) is to use country fixed effects to control for the unobserved price indices. Baldwin (2006), however, notes that this approach lacks the ability to account for dynamic changes to the multilateral resistance terms. I rectify this problem by including country-year fixed effects.

The inclusion of country-year fixed effects has two advantages. One, it controls for changes to the multilateral resistances and related costs incurred by a country to engage in trade with the world. Two, it follows the suggestion of Baltagi et al. (2003) as a way to control for biases related to an unbalanced panel, which is the case here. A disadvantage of this approach is that the large number of country-year interactions requires tremendous computational resources in order to estimate the gravity equations for the full sample (1950-2008), especially with a non-linear method such as PPML. To compensate, I restrict, for a block of consecutive years, the coefficients of the country-year interactions for counrty i to be all equal. The value of the block is denoted by the variable `year_block_group`. For example, if `year_block_group` equals 5 and t ranges from 1980 to 1984, then the country-year coefficients are all equal for a given country i for years 1980-1984. I estimate the model for values of `year_block_group` equal to 15, 10, and 6 as a robustness check. The estimated coefficients on the b_{ijt} and Y_{it}, and change little. Table **??** presents the results.

The third question concerns bilateral resistances. Bilateral resistances represent trade costs between a pair of countries. Trade costs are rarely observable directly. Many studies proxy for these costs with variables describing the geography of the pair (such as distance and contiguity); the political relations between the pair (were the countries part of a colonial empire); and the economic relations between the pair (have the countries signed a trade agreement; do the countries share a common currency). I describe the rich set of controls for this paper in an appendix. The key element of bilateral resistances for this paper is whether or not a pair of countries shares a common currency. Previous papers on the trade effects of a common currency have controlled for a common currency with a single dummy variable (such as Rose (2000), Rose and van Wincoop (2001), Glick and Rose (2002)). Denote this variable as CU_{ijt}. If countries i and j share a common currency at time t, then $CU_{ijt} = 1$, else 0. This specification implies that currency union membership would have an equal effect, all else held equal, for trade between France and Germany as well as for trade between Sénégal and Togo. I denote this specification as "homogeneous integration." The estimated value of the currency union coefficient is interpreted as a measure of integration among countries; an equal effect on trade within all different currency unions implies an equal level of integration with all different currency unions.

Although this paper includes estimation results for homogeneous integration, the possibility for "heterogeneous integration" seems more likely. As the set of currency unions commonly studied ranges from formal, treaty-based unions (such as the Eurozone) to *ad hoc* arrangements (such as dollarized countries), it seems unlikely that the influence of a single currency would be similar across unions. Even the set of treaty-based unions displays a large degree of heterogeneity. The Eurozone consists of some of the world's richest while the East Caribbean Currency Union (ECCU) and the *Communauté financière africaine* (CFA) zone consist of former European colonies. The CFA zone, consisting almost exclusively of former French colonies (Equatorial Guinea, a former Spanish colony, is an exception) in two different regions (the UEMOA and CEMAC, each with a separate central bank), "survived decolonization due in part to France's efforts to maintain [it]," efforts that have included French intervention to maintain a fixed exchange rate between the CFA Franc and the French Franc (now the Euro) (Parmentier and Tenconi (1996), Masson and Pattillo (2005)). In contrast, the United Kingdom made few such efforts in setting up the East Caribbean Central Authority, later the East Caribbean Central Bank (ECCB), to administer the ECCU in the mid-1960s (Van Beek (2000)). Furthermore, the policies of these central banks differ substantially. Reserves must exceed at least 20% of liabilities in the two central banks that comprise the CFA zone, while reserves must exceed at least 60% of liabilities of the ECCB (Masson and Pattillo (2005) and Van Beek (2000)). Each region within the CFA zone has a separate currency, the West African CFA franc for the UEMOA and the Central African CFA franc for the CEMAC. Although these currencies trade at a 1:1 ratio, neither currency is legal tender in the other zone. Further, Gulde and Tsangarides (2008) argue that the UEMOA and CEMAC are two distinct currency unions and display different levels of integration. Although this paper does not attempt to show mechanically how differences in monetary policies across currency unions impact trade, this paper permits different unions to have different intra-union trade-enhancing effects. Consequently, this paper includes a vector of dummy variables for currency union membership, each variable corresponding to a distinct currency union (including treating the UEMOA and CEMAC separately). The dummy variables are defined similarly to CU_{ijt}. For instance, $ECCU_{ijt} = 1$ if i and j both belong to the ECCU in time t, else 0. F-tests routinely reject the equality of all estimated currency union coefficients, demonstrating that the effect of a common currency on trade and, hence, the extent of integration differ tremendously across currency unions.

I now specify precisely the estimating equations used in this paper. Let T denote the number of years. Let C denote the number of countries. I estimate a regression of the following form for the OLS log-linear estimation on a pooled sample:

$$\begin{aligned} \ln X_{ijt} &= \alpha_1 \ln\left(Y_{it} \times \ln Y_{jt}\right) + \alpha_2 \ln Y_t^W + \sum_{r=1}^{T}\sum_{u=1}^{C} \gamma_{ru} d_{ru} + \sum_{s=1}^{T}\sum_{v=1}^{C} \gamma_{sv} d_{sv} \\ &\quad + \alpha_{CU} CU_{ijt} + \beta \cdot b_{ijt} + \epsilon_{ijt} \end{aligned} \tag{1.2}$$

where CU_{ijt} is the scalar (homogenous integration) or vector (heterogeneous integration) of currency union membership.

The imposition of a single coefficient for $\ln Y_i$ and for $\ln Y_j$ is a consequence of the use of "bilateral trade" for X_{ijt} as opposed to exports. I will explain this distinction in section 1.2.2. Y_t^W is world GDP and b_{ijt} is a vector of variables to proxy for the bilateral trading costs. The summation terms are the time-varying dummy variables that proxy for the multilateral resistance. d_{ru} is a dummy variable equal to 1 if $u = i$ and if $t = r$, else 0. A similar definition applies to d_{sv}. These variables control for the (P_{it}, P_{jt}) or multilateral resistance terms. I estimate a regression of the following form for the PPML estimation on a pooled sample:

$$\begin{aligned} X_{ijt} &= \exp\Bigg(\alpha_1 \ln\left(Y_{it} \times \ln Y_{jt}\right) + \alpha_2 \ln Y_t^W + \sum_{r=1}^{T}\sum_{u=1}^{C} \gamma_{ru} d_{ru} + \sum_{s=1}^{T}\sum_{v=1}^{C} \gamma_{sv} d_{sv} \\ &\quad + \alpha_{CU} CU_{ijt} + \beta \cdot b_{ijt}\Bigg) + \upsilon_{ijt} \end{aligned} \tag{1.3}$$

I now discuss other aspects of the estimation. The PPML estimates in this paper come from a pooled cross-sections of country pairs over time. Wooldridge (2002) discusses the assumptions by which pooled PPML produces consistent estimates and appropriate standard errors. Wooldridge notes that it is not necessary to assume that the true conditional distribution of the data be Poisson in order to ensure consistency. The first necessary assumption is that $E\left[v_{lt} \mid x'_{lt}\right] = 0$ for all t where l indexes country-pairs, t indexes years, x'_{lt} is the vector of independent variables, and v_{it} is the error term. This assumption is a generalization to each time period, t, of the standard, minimal assumption required to obtain consistent estimates for M-estimation in a cross-section regression. The second assumption is the use of "fixed-T, large-N asymptotics," in the words of Wooldridge (2002). Such asymptotics ensure that any dynamic behavior in the regressors or error terms bias neither the coefficient nor standard error estimates (when standard errors are calculated from a robust, "sandwich"-form of a variance-covariance matrix). The time period, T, covered by the regressions ranges from 23 to 50 years. The size of the cross sections is the number of country pairs and ranges from around 2000 to nearly 30000. These assumptions, along with the use of a robust, sandwich-form variance-covariance matrix that clusters standard errors on country pairs, ensure that the estimates from the PPML procedure in this paper are consistent and that the standard errors are correct and "fully robust to the presence of serial correlation in the score and arbitrary conditional variances," (p. 670).[2]

1.2.2 Data

Although the Glick and Rose (2002) dataset is publicly available at Andrew Rose's website (whose ease of access I gratefully acknowledge), I construct a dataset from the sources he cites, so as to extend the analysis beyond 1997, the last year in the data for Glick and Rose (2002). I follow Glick and Rose (2002) in the construction of "bilateral trade" (as opposed to exports) for the traditional OLS and PPML regressions. Bilateral trade in Glick and Rose (2002) is defined as the average over all possible values of recorded exports and imports between any two countries i and j. That is to say, "bilateral trade" is the average over all of the following, subject to availability: exports f.o.b. from i to j; exports f.o.b. from j to i; imports c.i.f. from i to j; imports c.i.f. from j to i. Combining export data with the import data, which is generally more complete, owing to its importance in assessing customs

[2] See chapter 19 of Wooldridge (2002) for more details.

duties, allows for the inclusion of more country pairs than would be possible using export data alone.

The use of bilateral trade in this manner has implications for other variables. As there is no meaningful distinction between exporter and importer in the definition of "bilateral trade" used in the OLS and PPML methods, I do not distinguish between exporter's GDP or importer's GDP. Consequently, for any pair of countries (i, j) in the traditional OLS and PPML regressions, I restrict the coefficients for $\ln Y_i$ and $\ln Y_j$ to be equal.

The 210 entities in my dataset referred to as "countries," for the sake of simplicity, include not only sovereign nations but also regions such as Guam, Hong Kong, and the West Bank and Gaza. Bilateral trade data comes from the IMF's *Direction of Trade Statistics* for 1948-2008. The value of GDP comes from the World Bank's *World Development Indicators* for post-1960 values and the Penn World Tables Mark 6.2 for pre-1960 values.

The control variables that compose the b_{ijt} include the currency union relationships, distance, other economic and geographic features, and colonial heritage. I use the CEPII database for Great Circle distances, augmented with information obtained from the CIA Factbook and from `http:\\www.timeanddate.com`.[3] As the CEPII data political relationships is time-invariant and as my period of interest spans the European decolonization of Africa and Southeast Asia, I use the independence dates provided by the Factbook in order to construct time-varying measures of political relationships. Information on regional trade agreements comes from the WTO's RTA database, augmented with information provided by the various secretariats of the RTAs on changes in RTA membership. Currency union membership comes from Glick and Rose (2002), augmented by IMF staff reports and other publications. The term currency union in this literature refers not only to formal unions such as the EMU or CFA but also to countries that fix their own currency to or use the currency of another country, such as the use of the US Dollar in El Salvador and Liberia. A list of currency union members and a full list of definitions of the other proxy variables for bilateral resistance can be found at the end of the paper. I refer to the Eurozone as countries in the EMU and those that have adopted the euro unilaterally (such as Macedonia).

[3]The CEPII database has been since replaced with a dataset constructed by Keith Head, Thierry Mayer and John Ries.

1.2.3 Marginal effects, coefficients, and relative effects

The paper uses linear and non-linear regressions of trade to understand the marginal effect of currency union membership as a determinant of the level of trade. In a linear model, a coefficient of a variable is the marginal effect of that variable. A coefficient is *not* a marginal effect in a non-linear model, as the marginal change in the outcome variable depends not only on the change in the regressor in question but also on the values of the other variables. Ratios of coefficients, however, are ratios of marginal effects in linear and in non-linear models.

The body of this paper reports ratios of coefficients instead of the coefficients themselves in order to permit meaningful comparisons of the marginal effect of variables across estimation techniques. Specifically, for any regressor, x, the paper reports:

$$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$$

where $\hat{\beta}_x$ denotes the coefficient estimated for regressor x and $\hat{\beta}_{\ln distance}$ denotes the estimated coefficient for the log of distance. There are two reasons for using distance as a benchmark against which to evaluate the effect of other variables. First, distance is a classic regressor in gravity equations and is often seen as good proxy for transportation costs. Second, $\hat{\beta}_{\ln distance}$ is negative and significant in all regressions. P-values and superscript symbols accompanying the relative effect for variable x are based on Wald tests of the null hypothesis that the ratio equals 0.[4] Tables of relative effects are reported at the end of the paper.

1.3 RESULTS

1.3.1 Baseline homogenous integration

The OLS estimates on a longer panel of data yield results comparable to those found in Glick and Rose (2002). The relative effect of currency union membership is 1.17 in Glick and Rose (2002) while it is 0.8 in this paper (see table 1.1). Other variables have largely similar relative effects in both papers (for instance, contiguity and commmon language). Contrasting

[4] $**$ denotes 99% significance; $*$ denotes 95% significance; † denotes 90% significance.

the OLS results in this paper with the PPML results, the PPML approach suggests that a common currency does *not* have a significant effect on bilateral trade. Unexpectedly, the estimated coefficient for currency union membership is actually negative, though the coefficient is insignificant and the relative effect is small.[5]

Some variables have comparable relative effects on trade regardless of the estimation technique used. Such variables include *postcol*, *colonizer_variant*, and *commlang_off*. Other variables differ in relative effects on trade across estimation techniques. The PPML approach gives much more weight to the GDP of countries i and j, 0.974, than do any of the other approaches. World GDP is negative and significant for the PPML but not for the OLS. Gravity theory implies a negative result, as trade from i to j is proportionate to $\frac{Y^i Y^j}{Y^W}$ where Y^W denotes world GDP. Both contiguity and a regional trade agreement have relatively large effects in the PPML equation, but relatively smaller effects in the OLS. The relative effect of a regional trade agreement is smaller than is the relative effect of a common currency for OLS but not for PPML approach.

1.3.2 Baseline heterogeneous integration

Do the results from the PPML approach in table 1.1 mean that currency unions trade less among each other and are less integrated than Rose previously claimed? Consider the possibility that integration (measured by intra-union trade) differs across the set of currency unions. Results from this specification are reported in table 2.3. The ECCU, UEMOA, the Danish krone zone, and India-Bhutan unions are large, positive, and significant. Australia and Singapore-Brunei have smaller, though still positive and significant, relative effects. The estimated common currency effects for these currency unions are generally larger in magnitude than are the effects for any other of the regressors, reinforcing the general message in Rose's work. Surprisingly, the PPML estimate for the Euro is insignificant, but the relative effect is in line with previous findings (see Flam and Nordstrom (2006) and Micco et al. (2003)). The CEMAC, the other CFA zone, has almost no effect. Previous studies have suggested that the UEMOA is more integrated than is the CEMAC (see Gulde and

[5] Though not reported here, the results are comparable for the PPML if I truncate the sample at 1997, the last year included in Glick and Rose (2002).

Tsangarides (2008)). Dollarized countries demonstrate little integration through the use of the US dollar. This result may be unsurprising as dollarization is often associated with historical or political links with the US or as a credible hedge against inflation. This results is also consistent with previous investigations of dollarization and trade (see Klein (2005)).

1.4 CURRENCY UNION CHARACTERISTICS AND TRADE

A natural question to ask after seeing the wide range of heterogeneous trade enhancement among currency unions in table 2.3 is "what explains why one currency union has strong trade-enhancing effects while another currency union does not?" The answer to this question is not obvious. The explanations for the estimated effects of a currency union on trade do not arise from country-specific characteristics but from interactions among multiple countries in a non-additive fashion. Recall that the regression includes time-varying country indicators to control the multilateral resistance terms. Consequently, these indicators absorb any country-specific characteristics of trade, leaving the currency union indicators to control exclusively for features of currency union behavior related to trade.

The currency union variables belong to the specification for bilateral resistance. As this specification consists of reduced-form proxies for trade costs, the estimated coefficients of the bilateral resistances lack direct economic interpretation. The existing literature on the gravity equation offers little guidance on the question of assigning such an economic interpretation to the estimated coefficients of the bilateral resistances. Thus, I turn to the theoretical literature on currency unions for insight into interpreting the estimated bilateral resistance coefficients. Recall that bilateral resistances pertain to trade costs between a particular pair of countries. Therefore, interpreting the estimates of the currency union effects requires identifying variables pertaining to interactions between a pair of countries in the context of currency union operations.

To see if a particular economic variable, within a currency union, has influence on trade so as to explain the estimated currency union effects in table 2.3, I re-estimate the gravity equation with that variable. Denoting the variable as Z, the estimating equation enhanced with variable Z becomes:

$$\begin{aligned} X_{ijt} &= \exp\Big(\alpha_1 \ln\left(Y_{it} \times \ln Y_{jt}\right) + \alpha_2 \ln Y_t^W + \alpha_3 Z_{ijt} \\ &\quad + \sum_{r=1}^{T}\sum_{u=1}^{C} \gamma_{ru} d_{ru} + \sum_{s=1}^{T}\sum_{v=1}^{C} \gamma_{sv} d_{sv} + \beta \cdot b_{ijt}\Big) + \upsilon_{ijt} \end{aligned} \tag{1.4}$$

where k indexes currency unions. The three variables represented by Z in this section are Total Factor Productivity (TFP), inflation, and tariffs.

1.4.1 TFP

Mundell (1961) emphasizes that an optimal currency area is one where all regions within the area suffer similar business cycle shocks at similar times. Hence, if a group of countries constitutes an optimal currency area, they should regularly pass through the same phases of the business cycle at roughly the same time. Consequently, the cross-sectional variance of shocks to the business cycle (and, hence, economic growth) across countries would be low, on average. Therefore, the currency union effect may merely represent fluctuations in productivity across the currency union.

To test whether the trade-enhancing effects of the currency unions are consequences of the synchronization of business cycles, I compute TFP and included it in the gravity equation. I follow Caselli (2005) and use data from the Penn World Table Mark 6.2 in order to construct TFP. Interestingly, the correlation between the currency union effects estimated in table 2.3 and the cross-sectional standard deviation of TFP within the currency union, averaged over time, is -0.62. This result supports the view in Mundell (1961). The negative correlation means that low average variance in TFP implies a high benefit from a single currency. Mundell also characterizes an optimal currency area by factor mobility within the area and immobility between the area and outside areas. Trade, embodying a country's factors or serving as factors themselves (for example, trade in intermediate goods) proxies for factor mobility. Therefore, it is not surprising to find a negative correlation between trade within a currency area and the variance of productivity shocks across the currency area.

To test whether the trade-enhancing effects of the currency unions are consequences of the synchronization of business cycles, I include TFP in the gravity equation. I introduce TFP into the estimating equation in the following way, using the notation from equation 1.4: $Z_{ijt} = \ln(TFP_{it} \times TFP_{jt})$. Results are in table 1.3. TFP has a significant effect on trade. However, the effects for currency unions change little, except for two unions: India-Bhutan and the Eurozone. Interestingly, the relative effect of the Eurozone is larger and significant than is it in the baseline model without TFP. That is to say, only when controlling for business cycles does the Eurozone display a strong level of integration. This result contrasts with the spirit of Mundell, that integration goes hand-in-hand with convergence across economies of business cycle movements. TFP alone appears to have little ability to explain the intra-union trade effects of a common currency for other currency unions.

1.4.2 Inflation

McKinnon (1963) proposes an alternative way to understand the motivation behind the formation of a currency union and the consequences of the formation. McKinnon considers the problem of a small, open economy where tradeable goods represent a large share of consumption and where the economy seeks to establish a store of value for its currency. McKinnon states that "one of the aims of monetary policy is to set up a stable kind of money whose value in terms of a representative bundle of economic goods remains more stable than any physical good," (McKinnon (1963), p. 721). In such circumstances, McKinnon argues that "pegging a currency of a small area to maintain its value in terms of a representative bundle of imports from a large outside area is virtually the same thing as pegging it to the outside currency," (p. 722). If the "large outside area" is "a number of small areas which trade extensively with each other," then the above-mentioned pegging strategy is equivalent to having "each currency pegged to the others," (p. 722). In the context of currency unions, a single member of a currency union represents the small, open economy and the set of other countries in the union represents the "large outside area." McKinnon also notes that "if we move across the spectrum from closed to open economics, flexible exchange rates become both less effective as a control device for external balance and more damaging to internal price-level stability," (p. 719). Hence, the effects in table 2.3 may reflect the intersection of an economy's openness and its effectiveness at maintaining price stability.

To test the possibility that the effects from table 2.3 represent the intersection of an economy's openness and its effectiveness at maintaining price stability, I re-estimate equation 1.4 replacing the log of TFP with the log of inflation. I report only the results using a CPI, though results from the GDP deflator are similar.[6] Let $Z_{ijt} = \ln\left(CPI_{it} \times CPI_{jt}\right)$. Table 1.4 shows the results from a model with the log of inflation for each country pair. The results change little for the currency union coefficients from those in table 2.3. The relative effect for the CEMAC is no longer significant. Thus, inflation seems little-related to the means by which intra-currency union trade is increased.

1.4.3 Tariffs

The consideration of tariffs as a means to understand a currency union's behavior may seem, at first glance, an odd choice. As members of the best-known currency union, the Eurozone, also belong to a common market with no internal tariffs, the idea that member countries of other currency unions would be close enough to share a common currency but not close enough to abolish internal tariffs seems surprising. Such taxes, however, exist. As an example of how the Eurzone differs from other currency unions, the common tariff from 1966-1974 on intra-union trade among most members of the UEMOA was 50 percent (Masson and Pattillo (2005)). More generally, as a currency union is a group of countries all of whom have pairwise fixed exchange rates, tariffs remain the unique policy by which a government might influence trade directly. Corden (1997) discusses tariffs as second-best policy to correct a current account imbalance under fixed exchange rates.

To explore this avenue, I use tariff data from the UNCTAD TRAINS database. These data are available only from 1988 forward for countries using the Harmonized Commodity Description and Coding System (or Harmonized System, "HS"). The database reports

[6]Note that the gravity equation inherently includes a representation of openness as envisioned by McKinnon (imports over consumption). First, note that homothetic preferences assumed by Anderson and van Wincoop (2003) imply that consumption is proportional to income. Next, exports from i to j are the imports to j from i. As $x_{ij} = \frac{Y_i Y_j}{Y^W}\left(\frac{b_{ij}}{P_i P_j}\right)^{1-\sigma}$ implies $\frac{x_{ij}}{Y_j} = \frac{Y_i}{Y^W}\left(\frac{b_{ij}}{P_i P_j}\right)^{1-\sigma}$, the gravity model accounts already for openness.

product-level tariff data as well as the average tariff rate on all goods imposed by country j on country i's exports in year t.[7] To incorporate the tariff data into the gravity equation, I modify the tariff data in a way similar to the construction of the bilateral trade data between i and j. For country pair (i, j) in year t, I average the tariff rate imposed by i on j in t with the rate imposed by j on i in t. Continuing the notation introduced in equation 1.4, Z_{ijt} is the log of this average.

Examining just the data on tariffs for countries in currency unions reveals some surprises. Figures 2.4 - 2.9 at the end of the paper show the simple, average tariffs imposed by countries in a currency union on fellow members of a currency union (the blue line) and on countries outside a currency union (red line). Countries in a currency union tend to import from their fellow currency union members goods upon which the importing country imposes a higher tariff. Even unions with little intra-union trade, such as the CEMAC and dollarized-zone, display this pattern.

Table 1.5 shows the results from the gravity equation enhanced with the level of tariffs. Tariffs have little effect on changing the estimation results. However, the inclusion of the tariff level alone does not capture the entire response of trade to tariffs, particularly in a context where exchange rate regimes differ across country pairs. Eichengreen and Irwin (2010) analyze the effect of increasing tariffs across most of the developed world in the late 1920s and early 1930s. Eichengreen and Irwin (2010) demonstrate that the response of trade to tariffs differs with the exchange rate regime prevailing in the importing country (gold standard, Sterling bloc, gold bloc, exchange controls). Recognizing that the effect of tariffs on trade differs across types of exchange rate regimes, I re-estimate the gravity equation with the level of tariffs as well as interactions between currency union membership and tariff levels in order to capture the fact that different currency union arrangements will lead to different trade responses to tariffs. The specification is described in equation 1.5:

[7] As a robustness check, I have estimated the gravity equation on data starting at 1988 but without tariffs. Results, though not reported here, are little changed from the results estimated on the full sample.

$$X_{ijt} = \exp\left(\alpha_1 \ln\left(Y_{it} \times \ln Y_{jt}\right) + \alpha_2 \ln Y_t^W + \alpha_3 Z_{ijt} + \sum_{k\in\{CU\}} \alpha_k \left(Z_{ijt} \times k_{ijt}\right)\right. \tag{1.5}$$
$$\left. + \sum_{r=1}^{T}\sum_{u=1}^{C} \gamma_{ru} d_{ru} + \sum_{s=1}^{T}\sum_{v=1}^{C} \gamma_{sv} d_{sv} + \alpha_{CU} CU_{ijt} + \beta \cdot b_{ijt}\right) + \upsilon_{ijt}$$

The inclusion of the currency union indicator variable, the tariff level, and the tariff-currency union interaction alters the interpretation of the effect of a common currency on trade. Previous studies of currency unions relied on a single, currency union-specific control variable. These studies ascribed to the estimated coefficient the effect of a common currency to reduce *all* trade costs and, consequently, to increase trade. However, previous studies of currency unions also interpreted the estimated effects on trade of a common currency with regard to the reduction of a *particular* trade cost: the cost to exchange currencies and hedge against exchange rate uncertainty.

The specification in equation 1.5 splits the effect of a common currency on trade into 2 components. The currency union-tariff interaction captures the effect of a common currency on trade through a country's tariffs. The currency union indicator variable captures all other effects, chief among which is the significance for trade of eliminating exchange rate transaction costs.

The resulting relative effects from estimating equation 1.5, shown in table 1.7, demonstrate a strong change from the baseline model's relative effects reported in table 2.3. Only one large union, the UEMOA, retains a positive currency union effect. Only two other unions (India-Bhutan and Singapore-Brunei) have positive and significant effects. All other unions have insignificant or *negative* and significant relative effects.

Unsurprisingly, the coefficient on the log of tariffs is negative and significant. Surprisingly, the estimated coefficient for the interaction of currency union membership and the log of average tariff rates is negative for only two of the currency unions examined (UEMOA and India-Bhutan). The interaction is *positive* and significant for three large unions (ECCU, CEMAC, dollarized countries) and positive and insignificant for Singapore-Brunei.

The literal (and counterintuitive) implication of the positive coefficient mentioned-above is that tariffs predict *higher* trade within a currency union. A more reasonable conclusion is that trade within a currency union tends to consist of goods on which the currency union members have imposed relatively high tariffs. In contrast, trade between a country in a currency union and a country outside that union tends to involve goods on which the currency union member imposes lower tariffs (recall figures 2.4 - 2.9). What leads to this pattern is not obvious. The intersection between the composition of trade (high-tariffed versus low-tariffed goods) involves decisions made by 2 parties (governments and firms) each of whom has different objectives. Consequently, the traditional interpretation of the currency union coefficients from the baseline model in table 2.3 as measures of currency union integration differs depending on whether either party's objective dominates.

Given a particular pattern of trade among currency union countries, the governments of those countries may tariff certain goods more severely than other goods, in order to extract rents if the demands are sufficiently inelastic. Viewed this way, the currency union effects reported in table 2.3 represent the extent to which countries within a union continue to trade among themselves *despite* trade costs (as the effects in table 2.3 come from the baseline model, a model that does not condition fully on the trade costs). This interpretation seems improbable as agents would not likely maintain for decades the elevated trading relations, indicated by the baseline results in table 2.3.

It seems reasonable, instead, to suppose that given a tariff scheme imposed by a government, traders in a country seek to reduce transaction costs wherever possible. Importing high-tariffed goods mostly from a country within the currency union, avoiding the cost associated with foreign exchange, may be such a method. Exporters inside currency union countries benefit at the margin over exporters outside currency union countries when the exporters sell into the currency union.

Given the above scenario, the currency union effects reported in table 2.3 represent the extent to which agents within a currency union country reduce total transaction costs by purchasing goods from inside the union rather than from outside. A common currency does not lower transaction costs *per se*, as the coefficients on the non-interacted currency union dummies in table 1.7 are largely insignificant or negative and significant. Rather, the common currency becomes an avenue pursued by importers to avoid further trade costs in the presence of high tariffs. The higher the tariffs, the more importers pursue this avenue to lower other trade costs, indicated by the positive coefficient on the currency-union tariff interaction. Though long-standing beliefs held that a common currency should reduce trade costs, the extent of this reduction was rarely thought sufficient to explain the large trade increases found in Rose's work (see Anderson and van Wincoop (2004)). The results in this paper confirm that a common currency does little to lower trade costs directly. Including tariffs in the gravity equation reconciles the belief that actual trade cost reductions engendered by a common currency should be small with the empirical finding that a common currency enhances trade significantly (the "Rose effect"). This reconciliation occurs because, in the presence of other trade costs, namely tariffs, a common currency creates a wedge in the overall price between importing from a firm within the currency union and importing from a firm outside the currency union. The higher are tariffs within a currency union country, the larger is a trader's incentive to use this wedge, evidenced by the positive interaction terms on tariffs and common currency in table 1.7. This finding echoes Yi (2003) where, under vertical specialization (a good is assembled gradually in multiple countries and is, consequently, exported and re-exported multiple times), modest differences in tariff rates can produce large increases in trade.

The positive, significant tariff-currency union interactions are unlikely to be a result of endogeneity. Endogeneity would be a concern only if factors determining the composition of trade also determine the value of trade. Tariffs are frequently higher on goods in industries with strong political influence (such as agriculture and basic textiles), industries whose products are generally cheaper than non-textile manufactured goods. This pattern holds both for industrialized and developing countries (see Cline et al. (2004)). Consequently, there is no positive correlation between the value of trade and tariff rates. However, manufactured goods other than textiles but similar in price to textiles or agriculture are unlikely to have the same intensity of tariff protection as do textiles or agricultural products. Consequently, there is little to no negative correlation between the value of trade and tariff rates. Thus, endogeneity has little potential to explain the results found here.

1.5 CONCLUSION

The extent of trade integration within currency unions has received great attention in the past decade. Although a modern estimation technique implies that, under homogeneous integration, a common currency has little effect on trade, the same technique reveals heterogeneity in integration across currency unions where small unions in Africa and the Caribbean display large trade-enhancing effects, but the Eurozone has a small effect. This paper turns to the theoretical literature on currency union for guidance and finds that TFP and inflation have little explanatory power regarding the diversity of currency union effects on trade. Rather, the currency union effects display unexpected positive correlation with tariff rates on the goods traded within the union. This paper demonstrates that for a country i, within a currency union, the common currency provides a wedge between the prices faced by i's importers from exporters outside the union and from exporters inside the union. The higher the tariff rates in i, the greater incentive on the part of i's firms to minimize costs, such as avoiding the costs to purchase foreign currency, however small these costs may be. As a consequence, intra-union trade is larger than trade within a group of otherwise similar countries, as found by Andrew Rose. Unlike Rose and others, this paper establishes that the common currency itself does not lower trade costs directly. The common currency becomes the means by which importers mitigate trade costs in the presence of high tariffs. Thus, this paper validates Rose's conclusion (greater integration among currency unions) and describes the environment (high tariffs) in which a seemingly small reduction in trade costs (the use of a common currency) indirectly leads to a large increase in trade and, hence, integration.

The results in this paper demonstrate that understanding the extent of intra-union trade requires a close consideration of tariff policy. However, it remains unclear whether the extent of intra-union trade is mainly a consequence of fiscal decisions (tariff policy in response to firm behavior) or of firm-level decisions (firm behavior in response to tariff policy). Furthermore, as tariff rates are gradually falling world-wide, including in currency union countries, the effects on the overall economies of the currency unions are far from obvious. Addressing these questions may require new tools. DSGE models of optimal monetary and fiscal policies within a currency union, such as those by Galí and Monacelli (2008) and by Ferrero (2009) provide a framework to describe the environment in which trade integration differs across different types of goods within a single currency union. These models would be useful for at least two questions. One, the models could quantify the importance of the two above-mentioned motives in explaining the observed pattern of trade. Two, the models could evaluate the welfare effects of reducing tariffs in a union whose exporters benefit from selling into other, high-tariffing countries within the union. Future research will use these tools and better explain the determinants of international trade, generally, as well as the intersection of exchange rate regimes, trade composition, and tariffs in international trade.

1.6 CURRENCY UNIONS AND THEIR COMPOSITION

1.6.1 East Caribbean Currency Union (ECCU)

Antigua and Barbuda Barbados (1965-1972) Dominica St. Kitts and Nevis St. Lucia St. Vincent and the Grenadines

1.6.2 West African Economic and Monetary Union (UEMOA)

Benin Burkina Faso Côte d'Ivoire Guinea-Bissau (1997-) Mali Mauritania (1960-1973) Niger Senegal Togo

1.6.3 Communauté Économique et Monétaire de l'Afrique Centrale (CEMAC)

Cameroon Central African Republic Chad Congo, Rep. Equatorial Guinea (1985-) Gabon Madagascar (1960-1972)

1.6.4 European Monetary Union (EMU) / Euroized

Austria (1999-) Belgium (1999-) Cyprus (2004-) Estonia (2004-) France (1999-) Finland (1999-) Germany (1999-) Greece (2001-) Ireland (1999-) Italy (1999-) Latvia (2005-) Luxembourg (1999-) Macedonia (2002-) Malta (2005-) Netherlands (1999-) Portugal (1999-) Slovak Republic (2006-) Slovenia (2007-) Spain (1999-)

1.6.5 Dollarized countries

American Samoa The Bahamas (after 1973) Bermuda Ecuador (after 2000) El Salvador (after 2001) Guam Liberia Marshall Islands Federated States of Micronesia Northern Mariana Islands Palau Panama Puerto Rico Virgin Islands (U.S.)

1.6.6 India

Bhutan India

1.6.7 Denmark

Denmark Færoe Islands Greenland

1.6.8 Australia

Australia Kiribati Tonga (until 1990)

1.7 CONTROL VARIABLES AND DEFINITIONS

- CU_{ijt} is 1 if countries i and j belong to the same currency union in time t.
- $ECCU_{ijt}$ is 1 if countries i and j belong to the East Caribbean Currency Union in time t.
- $UEMOA_{ijt}$ is 1 if countries i and j belong to the *Union Economique et Monétaire Ouest Africaine* (West African Economic and Monetary Union) in time t.
- $CEMAC_{ijt}$ is 1 if countries i and j belong to the *Communauté Economique et Monétaire de l'Afrique Centrale* (Central African Economic and Monetary Coummnity) in time t.
- $AUSTRALIA_{ijt}$ is 1 if countries i and j both use the Australian dollar at time t.
- EMU_{ijt} is 1 if countries i and j both use the Euro at time t.
- $BHUTAN_{ijt}$ is 1 if i = India and j = Bhutan (or vice versa) at time t.
- $BRUNEI_{ijt}$ is 1 if if i = Singapore and j = Brunei (or vice versa) at time t.
- ln_dist_{ijt} is the log of Great Circle distance between countries i and j.
- $contig_{ijt}$ is 1 if countries i and j share a border.
- $comlang\_off_{ijt}$ is 1 if countries i and j share a common or official language.
- rta_{ijt} if 1 if countries i and j adhere to a trade agreement in time t.
- $colonizer\_variant_{ijt}$ is 1 if i maintains or has maintained some level of sovereignty over j up to time t, 0 otherwise. Sovereignty could be of an administrative nature, such as the US relationship with Guam, or complete sovereignty, such as France's control over Algeria before 1962.
- $comcol_{ijt}$ is 1 if countries i and j are both under the same, third-country colonizer in time t.
- $postcol_{ijt}$ is 1 if countries i and j were both under the same, third-country colonizer before time t but are now independent.
- $transcol_{ijt}$ is 1 if countries i and j were both under the same, third-country colonizer before time t but only 1 country has left the colonial relationship.

1.8 TABLES

Table 1.1: Estimation results : Baseline model, homogeneous common currency effects, 1950-2008
Dependent variable is the log of exports (OLS) or level of exports (PPML).

Variable	**OLS**		**PPML**	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
Pair belongs to the same currency union	0.799**	(0.000)	-0.287	(0.396)
$\ln(Y_{it} \times Y_{jt})$	0.258**	(0.000)	0.974**	(0.000)
$\ln Y_t^W$	0.318**	(0.000)	-0.147†	(0.075)
Pair belongs to a Regional Trade Accord	0.287**	(0.000)	0.543**	(0.000)
Countries are contiguous	0.315**	(0.000)	0.801**	(0.001)
Colonizer-colonized relationship	1.064**	(0.000)	0.753**	(0.001)
Countries are colonies of same country	0.868**	(0.000)	-1.56*	(0.041)
Country pair transitioning from colonialism	0.415**	(0.000)	-0.637†	(0.073)
Countries were colonies of same country	0.492**	(0.000)	0.345*	(0.033)
Shared common or official language	0.268**	(0.000)	0.366*	(0.01)
Number of observations	346254		346254	
R^2	0.76			
Number of pairs	14912		14912	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 1.2: Estimation results : Baseline model, heterogeneous common currency effects, 1950-2008
Dependent variable is the level of exports.

Variable	PPML	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
East Caribbean Currency Union	3.945**	(0.000)
West African Economic and Monetary Union	3.285**	(0.000)
Central African Economic and Monetary Union	0.069	(0.911)
Australia zone	1.655**	(0.001)
Dollarized zone	-0.509	(0.183)
Euro zone	0.095	(0.454)
Danish zone	8.013**	(0.000)
India-Bhutan	4.214**	(0.000)
Singapore-Brunei	1.35*	(0.014)
$\ln(Y_{it} \times Y_{jt})$	0.892**	(0.000)
$\ln Y_t^W$	0.068	(0.411)
Pair belongs to a Regional Trade Accord	0.545**	(0.000)
Countries are contiguous	0.793**	(0.001)
Colonizer-colonized relationship	0.763**	(0.001)
Countries are colonies of same country	-1.511*	(0.047)
Country pair transitioning from colonialism	-0.612†	(0.081)
Countries were colonies of same country	0.332*	(0.041)
Shared common or official language	0.364*	(0.011)
Number of observations	346254	
Number of pairs	14912	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 1.3: Estimation results : Interaction of currency unions and TFP, 1960-2008, Relative effects

Variable	PPML	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
East Caribbean Currency Union	4.232**	(0.000)
West African Economic & Monetary Union	3.385**	(0.000)
Central African Economic & Monetary Union	-0.972	(0.21)
Australia zone	1.406*	(0.027)
Dollarized zone	-0.789†	(0.071)
Eurozone	0.73*	(0.04)
India-Bhutan	2.116	(0.115)
Singapore-Brunei	1.578*	(0.01)
Eurozone $\times \ln(TFP_{it} \times TFP_{jt})$	-1.412	(0.329)
East Caribbean Currency Union $\times \ln(TFP_{it} \times TFP_{jt})$	2.404†	(0.087)
West African Economic & Monetary Union $\times \ln(TFP_{it} \times TFP_{jt})$	-2.192	(0.144)
Central African Economic & Monetary Union $\times \ln(TFP_{it} \times TFP_{jt})$	-2.974†	(0.07)
Australia zone $\times \ln(TFP_{it} \times TFP_{jt})$	0.941	(0.278)
Dollarized zone $\times \ln(TFP_{it} \times TFP_{jt})$	-0.874	(0.816)
India-Bhutan $\times \ln(TFP_{it} \times TFP_{jt})$	6.071*	(0.048)
Singapore-Brunei $\times \ln(TFP_{it} \times TFP_{jt})$	0.1	(0.867)
$\ln(TFP_{it} \times TFP_{jt})$	1.645**	(0.000)
$\ln(Y_{it} \times Y_{jt})$	1.117**	(0.000)
$\ln Y_t^W$	-1.334	(0.264)
Pair belongs to a regional trade agreement	0.501**	(0.000)
Countries are contiguous	1.236**	(0.000)
Colonizer-colonized relationship	0.476	(0.106)
Country pair transitioning from colonialism	-0.581	(0.148)
Countries were colonies of same country	0.42*	(0.021)
Pair share a common language	0.152	(0.238)
Number of observations	223924	
Number of pairs	12428	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 1.4: Estimation results : Interaction of currency unions and inflation, 1960-2008, Relative effects

Variable	PPML	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
East Caribbean Currency Union	3.67**	(0.000)
West African Economic & Monetary Union	3.076**	(0.000)
Central African Economic & Monetary Union	-0.573	(0.322)
Australia	0.815	(0.38)
Dollar zone	-0.422	(0.313)
Eurozone	-0.271	(0.105)
India-Bhutan	5.787**	(0.000)
Singapore-Brunei	1.408**	(0.001)
ECCU $\times \ln \text{Inflation}_{ijt}$	-0.005	(0.959)
UEMOA $\times \ln \text{Inflation}_{ijt}$	-0.032	(0.522)
CEMAC $\times \ln \text{Inflation}_{ijt}$	0.081	(0.321)
Dollar zone $\times \ln \text{Inflation}_{ijt}$	0.161†	(0.088)
Eurozone $\times \ln \text{Inflation}_{ijt}$	0.185**	(0.002)
India-Bhutan $\times \ln \text{Inflation}_{ijt}$	-0.456	(0.152)
Singapore-Brunei $\times \ln \text{Inflation}_{ijt}$	-0.02	(0.862)
$\ln \text{Inflation}_{ijt}$ (CPI)	0.012*	(0.036)
$\ln (Y_{it} \times Y_{jt})$	0.765**	(0.000)
$\ln Y_t^W$	0.208†	(0.058)
Pair belongs to a Regional Trade Accord	0.597**	(0.000)
Colonizer-colonized relationship	0.82**	(0.000)
Countries are colonies of same country	-2.887**	(0.005)
Country pair transitioning from colonialism	-0.563	(0.145)
Countries were colonies of same country	0.444**	(0.003)
Countries are contiguous	0.788**	(0.000)
Shared common or official language	0.317*	(0.021)
Number of observations	217523	
Number of pairs	12325	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 1.5: Estimation results : Tariffs and TFP, Relative heterogeneous effects, 1988-2008.
Dependent variable is the level of exports.

Variable	**PPML**	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
East Caribbean Currency Union	3.524	(0.000)**
West African Economic & Monetary Union	3.564	(0.000)**
Central African Economic & Monetary Union	-0.931	(0.161)
Australia Zone	2.052	(0.000)**
Dollar zone	-0.411	(0.379)
India-Bhutan	4.598	(0.000)**
Singapore-Brunei	1.251	(0.027)*
$\ln(Y_{it} \times Y_{jt})$	0.817	(0.000)**
$\ln Y_t^W$	0.215	(0.137)
Pair belongs to a Regional Trade Accord	0.381	(0.000)**
Colonizer-colonized relationship	0.412	(0.248)
Country pair transitioning from colonialism	-0.498	(0.255)
Countries were colonies of same country	0.387	(0.025)*
Countries are contiguous	1.349	(0.000)**
Shared common or official language	0.282	(0.045)*
$\ln \text{tariffs}_{ijt}$	0.097	(0.286)
$\ln \sigma_{tariffs}$	0.105	(0.033)*
Number of observations	69609	
Number of pairs	9876	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 1.6: Estimation results : Tariffs (interacted) and TFP, Relative heterogeneous effects, 1988-2008.
Dependent variable is the level of exports.

Variable	**PPML**	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
East Caribbean Currency Union	-2.798	(0.48)
West African Economic & Monetary Union	8.385**	(0.000)
Central African Economic & Monetary Union	-8.936**	(0.000)
Dollar zone	-2.211**	(0.000)
India-Bhutan	7.453**	(0.000)
Singapore-Brunei	1.418*	(0.01)
ECCU $\times \ln \text{tariffs}_{ijt}$	2.377*	(0.04)
UEMOA $\times \ln \text{tariffs}_{ijt}$	-1.726†	(0.05)
CEMAC $\times \ln \text{tariffs}_{ijt}$	2.765*	(0.01)
Dollar zone $\times \ln \text{tariffs}_{ijt}$	0.994**	(0.000)
India-Bhutan $\times \ln \text{tariffs}_{ijt}$	-0.69**	(0.000)
Singapore-Brunei $\times \ln \text{tariffs}_{ijt}$	0.079	(0.62)
$\ln \text{tariffs}_{ijt}$	-0.099*	(0.01)
$\ln \sigma_{tariffs}$	0.201**	(0.000)
$\ln (Y_{it} \times Y_{jt})$	0.669**	(0.000)
$\ln Y_t^W$	0.447*	(0.01)
Pair belongs to a Regional Trade Accord	0.355**	(0.000)
$\ln (TFP_{it} \times TFP_{jt})$	1.312**	(0.000)
Countries are contiguous	1.634**	(0.000)
Colonizer-colonized relationship	0.253	(0.52)
Country pair transitioning from colonialism	-0.483	(0.33)
Countries were colonies of same country	0.405*	(0.04)
Shared common or official language	0.26	(0.11)
Number of observations	69609	
Number of pairs	9876	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 1.7: Compare changes in year block group (PPML): 1950-2008

Variable (1)	(2)	(3)	(4)
CU_{ijt}	-0.18	-0.194	-0.199
	(0.222)	(0.224)	(0.222)
$\ln(Y_{it} \times Y_{jt})$	0.678**	0.63**	0.487**
	(0.025)	(0.023)	(0.021)
$\ln Y_t^W$	-0.189**	-0.096†	0.278**
	(0.058)	(0.053)	(0.062)
Pair belongs to a Regional Trade Accord	0.346**	0.352**	0.363**
	(0.055)	(0.056)	(0.061)
Log of distance	-0.643**	-0.642**	-0.64**
	(0.034)	(0.034)	(0.034)
Countries are contiguous	0.515**	0.514**	0.511**
	(0.118)	(0.118)	(0.118)
Colonizer-colonized relationship	0.496**	0.501**	0.504**
	(0.16)	(0.159)	(0.158)
Countries are colonies of same country	-1.039*	-1.013*	-1.008*
	(0.486)	(0.494)	(0.496)
Country pair transitioning from colonialism	-0.397†	-0.405†	-0.428†
	(0.227)	(0.222)	(0.224)
Countries were colonies of same country	0.222*	0.226*	0.23*
	(0.101)	(0.102)	(0.102)
Shared common or official language	0.253**	0.25**	0.25**
	(0.088)	(0.089)	(0.089)
Number of observations	346254	346254	346254
Number of pairs	14912	14912	14912
Value of `year_block_group`	15	10	6

Figure 1.1: Cemac average simple tariff rate

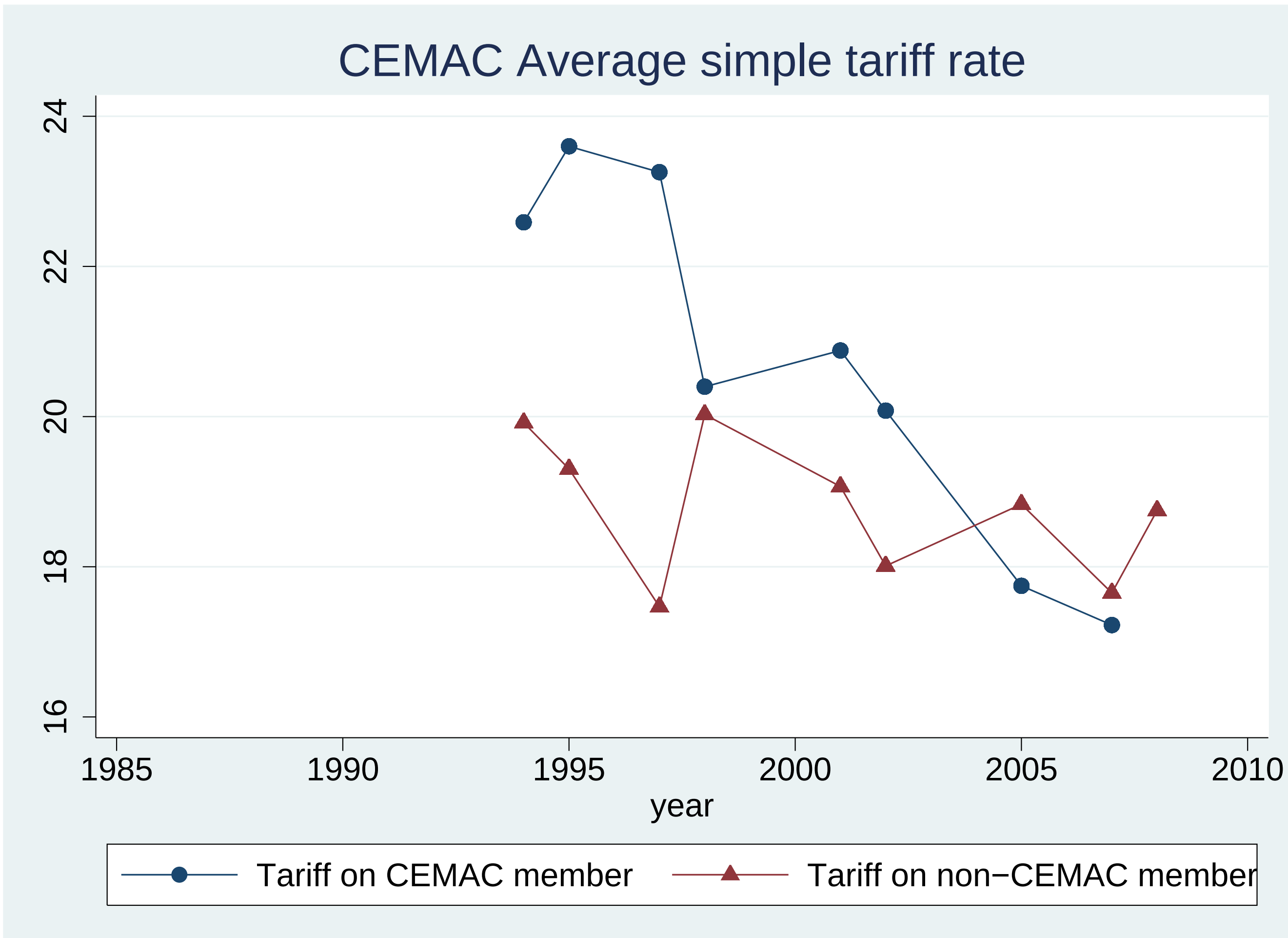


Figure 1.2: Eccu average simple tariff rate

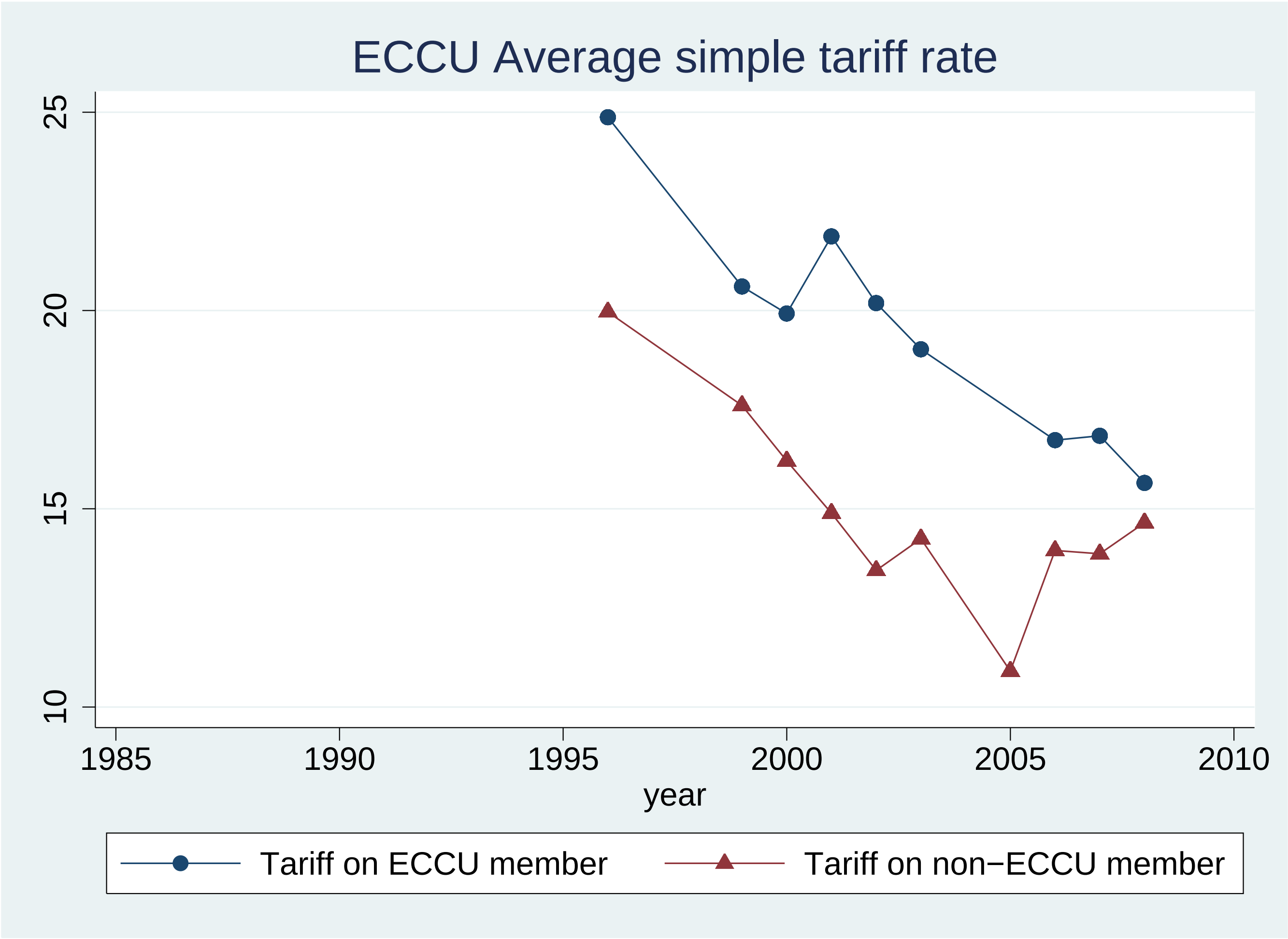


Figure 1.3: Dollar zone average simple tariff rate

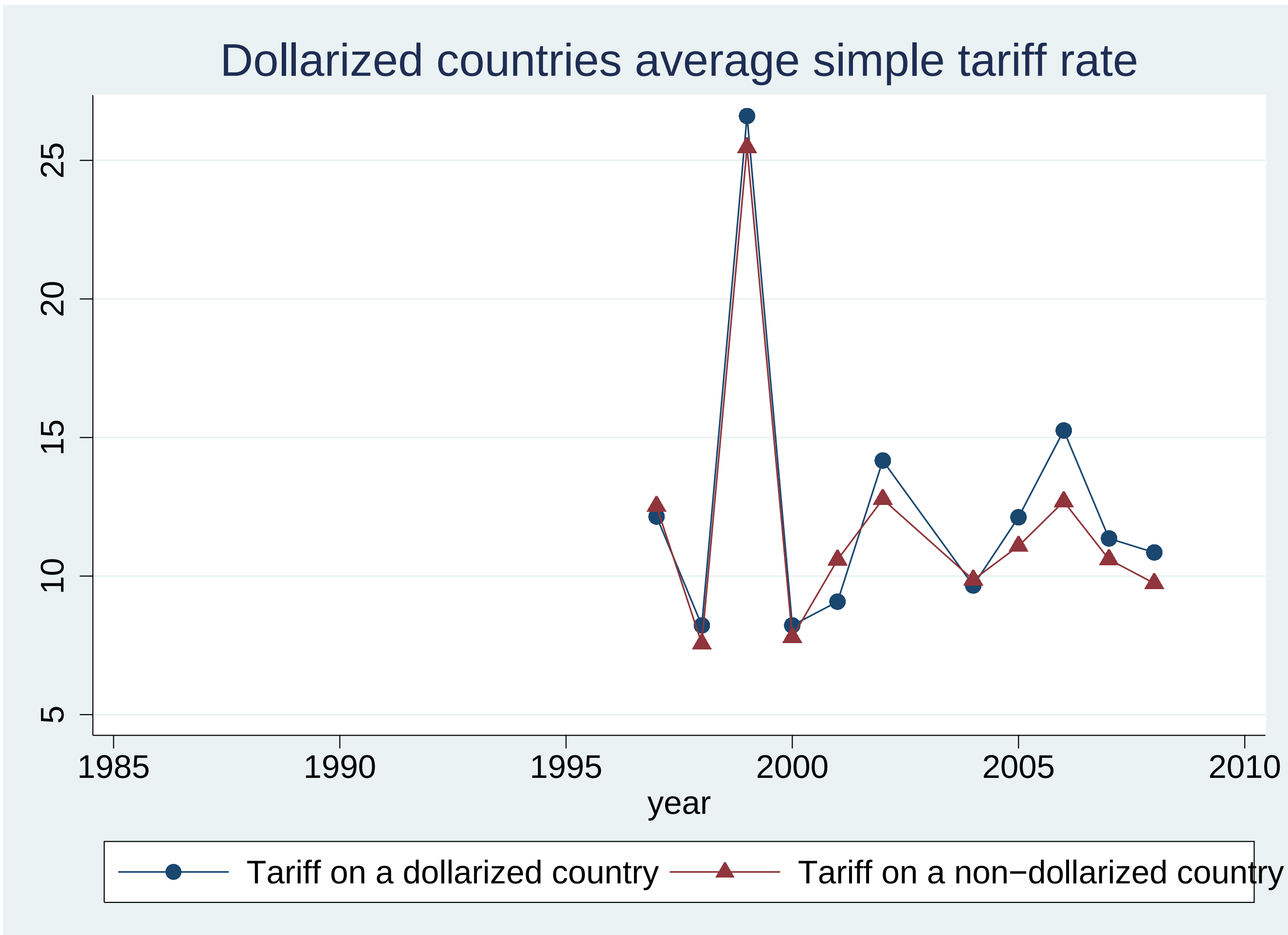
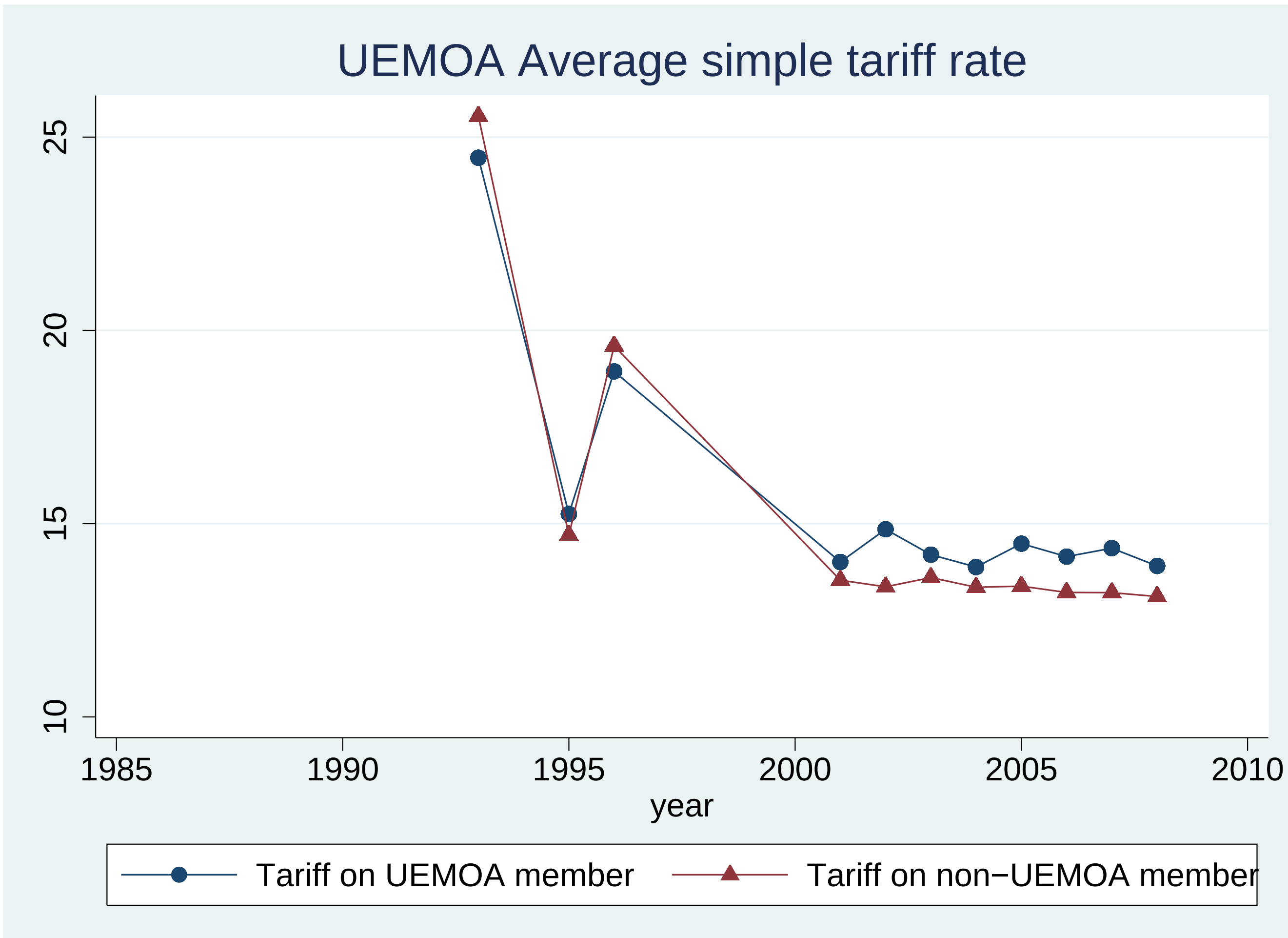


Figure 1.4: Waemu average simple tariff rate



2.0 A SECTORAL ANALYSIS OF CURRENCY UNIONS

2.1 INTRODUCTION

The effect of a common currency on trade has received significant attention in the past decade. Starting with the work of Andrew Rose (Frankel and Rose (1998), Rose (2000), Rose and van Wincoop (2001), Glick and Rose (2002)), researchers have generally found large effects of a common currency on trade for currency unions. However, the first chapter in this dissertation demonstrates that only a few of the currency unions previously studied (such as the East Caribbean Currency Union and the West African Economic and Monetary Union) demonstrate as high of a level of integration by trade as found in the above-mentioned studies. The first chapter also shows that the extent of integration is closely related to tariff levels. In particular, the higher the level of tariffs prevailing across the currency union, the greater is the intra-union trade. When controlling for tariffs, the results indicate that a common currency appears to have little direct impact on the costs to trade. Consequently, a common currency has little direct impact on the volume of trade. However, in the presence of high tariffs, an importer is more likely to favor an exporter located in a country that uses the same currency as does the importer, in order to reduce additional trade costs, the implication of the afore-mentioned results. Consequently, trade and tariffs are *positively* correlated within a currency union. Therefore, a common currency's largest effect on trade is an indirect effect, through tariffs. The positive correlation accounts for the large effects of a common currency on trade found in previous studies.

Though the first chapter demonstrates that currency unions are different, left unanswered is the question of *why* currency unions should differ along the particular dimensions of trade enhancement via tariffs. Why should tariffs appear to expand integration for some unions but not for others? This chapter proposes the analysis of disaggregated trade as the first step to answering this question. Recall that a common currency's relevance as a control variable for studying bilateral trade owes itself to the ability to forego transaction costs for purchasing foreign exchange (see Rose (2000), Rose and van Wincoop (2001), and Anderson and van Wincoop (2004)). Anderson and Yotov (2010) note that trade costs generally differ depending on the nature or characteristics of the goods being traded.

Tariffs are unarguably a key trade cost and differ across commodity types. As a stylized fact, tariffs on agricultural goods and low-skilled-intensive manufacturing goods tend to be higher than are tariffs on other manufactured products, which in turn are higher than are tariffs on resources such as minerals or petroleum. This pattern holds for both developed and developing countries (see Cline et al. (2004)). If the common currency has a differential impact on trade by commodity type and if the tariff variable is the sole variable able to distinguish the composition of a trade flow (owing to the afore-mentioned stylized fact), it is unsurprising that the tariff-currency union interactions would absorb the existence of a differential effect by commodity type. Thus, the very significance of tariffs within currency unions demonstrated in chapter 1 suggests that the ability of a common currency to enhance intra-union trade by reducing trade costs will differ across unions as the composition of trade differs across unions.

This chapter investigates sectoral differences in trade patterns across currency unions. This chapter combines two strands of literature. The first strand is a long-standing literature examining the effect on trade of hedging exchange rate volatility by focusing on currency unions (in addition to the works of Rose, see Persson (2001), Micco et al. (2003), Klein (2005), Barro and Tenreyro (2007), Santos Silva and Tenreyro (2010)). The second strand of literature is the examination of trade determinants for disaggregated trade (Anderson and Yotov (2010), Cissokho et al. (2013)). This literature emphasizes that trade costs, controlling for which is a crucial step in any empirical analysis of trade, differ across product types. The gravity equation or gravity-like equations have proven to be a useful framework for analyzing aggregate trade flows and for estimating the magnitudes of different variables on total trade costs (Eaton and Kortum (2002), Evenett and Keller (2002), Santos Silva and Tenreyro (2006), Head et al. (2010)). Therefore, a framework that can bring the key elements of the gravity equation (national output by product type, iceberg trade costs or "bilateral resistances," and traded good price indices or "multilateral resistances") to an individual sector can bridge the two literatures to bring the well-established success of using the gravity framework to a reliable and informative analysis of disaggregate trade flows. To this end, Anderson and Yotov (2010) develop a gravity model for an individual class of goods, similar to the structure developed in Anderson and van Wincoop (2003). Though Anderson and Yotov (2010) develop sector-specific gravity equation of bilateral trade to examine the incidence of trade barriers on exporters and importers, this chapter is the first known use of sector-specific gravity to analyze currency unions.

Most empirical work concerning currency unions has examined aggregate trade. However, the early literature on currency unions suggests that the composition of production (and, by extension, trade) plays a key role in analyzing the motivation for and consequences of sharing a common currency. Mundell (1961) argues for defining a common currency over a region of economic activity where all sub-regions pass through the same phases of the business cycle at the same time. In particular, the shocks to the business cycle that Mundell emphasizes are sector-specific shocks. Hence, Mundell creates a strong association between an optimal currency area and a particular industry. McKinnon (1963) states that a country's decision to fix its exchange rates with trading partners or to maintain an independent currency will depend on the composition of tradable and non-tradable goods within its economy. The composition of tradable and non-tradable goods likely differs across regions of the world. As a currency union generally consists of countries within the same geographic region, an understanding of how tradable goods and non-tradable goods differ across the set of currency unions becomes an important consideration when analyzing a currency union and its performance.

Despite the strong theoretical motivation for considering the composition of production and currency unions, empirical work analyzing the intersection of currency union membership and heterogeneity in trade composition is limited. Rose and Engel (2002) finds weak evidence that currency unions display greater specialization in production and, hence exports. Gulde and Tsangarides (2008) compares and contrasts the performance of the two zones within the *Communauté financière africaine*, the Cemac and the Waemu, given the importance of petroleum extraction in the Cemac. The contribution of this chapter is to explore and compare systematically the extent of integration across currency unions and sector of trade.

This chapter uses sector-specific gravity equations of bilateral trade to show that different currency unions have different degrees of trade across different sectors. Several unions (the Eccu, Waemu, Cemac, Rand zone, Australia zone, Danish zone, and India-Bhutan) display a high level of integration through trade in manufacturing. The Eurozone and Dollarized zone, by contrast, demonstrate little integration through trade in manufacturing but exhibit a modest level of integration through trade in agriculture. Considering the trade in manufactured goods more closely, this chapter shows that currency unions demonstrate differing levels of integration through trade within more narrowly-defined manufacturing sectors. In particular, trade is highest for the Eccu, Cemac, Waemu, Australia zone, and Danish zone for goods classified with 2-digit ISIC Revision 3 codes ranging from 20 to 37. India and Bhutan as well as Dollaried countries exhibit a slightly higher degree trade integration for industrial activity classified with 2-digit ISIC codes ranging from 15 to 19. The Eccu, Cemac, Waemu, Australia zone, Danish zone, and Dollarized zones also exhibit increased trade, though of a smaller magnitude, for industries with codes 15 through 19.

The organization of the chapter is as follows. Section 2.2 presents the sectoral gravity equation and discusses the estimation procedure and the sources of data. Section 2.3 presents results from one level of disaggregating aggregate trade into agricultural trade and manufactured goods trade.[1] Section 2.4 presents results from a further disaggregation of manufactured goods trade.

2.2 SECTORIAL GRAVITY EQUATION AND DATA

Following Anderson and Yotov (2010), I estimate a gravity equation for exports in a specific class of goods, k, from country i to country j of the following form:

[1]Data on trade in services are not sufficiently and widely available for developing countries. Hence, this chapter ignores trade in services.

$$X_{ij}^k = \frac{Y_i^k E_j^k}{Y^k} \left(\frac{b_{ij}^k}{\Pi_i^k P_j^k} \right)^{1-\sigma_k} + \epsilon_{ij}^k \quad \sigma_k > 1 \tag{2.1}$$

where X_{ij}^k represents exports, Y_i^k represents the production of goods in class k, E_j^k represents expenditures on goods in class k, and Y^k is the sum of Y_i^k over all i: $Y^k \equiv \sum_i Y_i^k$. As in the previous chapter, b_{ij}^k represents bilateral trading costs. I will proxy for these costs with the rich set of controls used in the aggregate gravity equations. The dummy for currency union membership (CU) and the tariff rate variable are the primary variables of interest. $\left(\Pi_i^k, P_j^k\right)$ are price indices. I will follow the same practice as in the first chapter and control for these variables with time-varying country dummy variables. σ_k is the elasticity of substitution for class k. ϵ_{ij}^k is the error term.

E_j^k is not observed for most countries. Anderson and Yotov (2010) resolve this problem in their paper by including a country fixed effect for j in the regression. This fixed effect also controls for P_j^k. A separate country fixed effect for i controls for Π_i^k.

The data are a panel of country pairs at yearly frequency from 1976 to 2011 (for agricultural data) and from 1980 to 2011 (for manufacturing data). Data on trade come from UN COMTRADE while date on tariffs come from UNCTAD TRAINS, both part of World Integrated Trade Solutions (WITS). When possible, agricultural and manufacturing are defined according to ISIC Revision 3, first introduced in 1988. For data from earlier years and for countries that maintained ISIC Revision 2 as the nomenclature for classifying industrial activity, the ISIC Revision 2 classification is used (1976-1995). Data on tariffs are collected under the Harmonized System nomenclature. Data on world agricultural and manufacturing output come from the the World Bank's *World Development Indicators* and from the UNIDO INDSTAT databases. The sources for other variables (bilateral resistances such as geographic distance, political relationships, currency union membership) are those cited in the first chapter.

A preliminary look at the trade data shows a common pattern across currency unions and important variations in this pattern. Table 2.1 reports averages over time of agricultural exports as a share of merchandise exports and average of manufacturing exports as a share of merchandise exports for the member countries of the currency unions studied in this chapter.[2] In general, trade in manufacturing goods represents a large portion of exports for currency union countries, especially compared to agriculture. The exceptions to this pattern are the Cemac and Waemu. The significance of manufacturing trade varies widely, accounting for between 30% and 40% of merchandise exports for the Dollairzed zone, the Eccu, and India-Bhutan while accounting for well over half of exports for the Eurozone, the Rand zone, and India-Bhutan.

The volatility of these shares over time differs noticeably across unions. Figures 2.1 and 2.2 show exports in each sector, agricultural and manufacturing, as a percent of total merchandise exports for currency unions over time. The series for agricultural exports in the Cemac and Waemu display substantial volatility while agricultural exports represent consistently small shares of exports from other currency union countries. Consequently, the data suggest that if a common currency has an effect on facilitating trade in a particular sector, the sector is likely to be the manufacturing sector.

The tariff data indicate distinct levels of tariff rates across different classes of goods (see table 2.2). However, unlike the conclusion in Cline et al. (2004), agricultural tariffs are not uniformly higher over countries and over time than are manufacturing tariffs. Table 2.2 shows that only the Eccu member countries possess an average tariff rate on agricultural imports over time that is consistently higher than is the average tariff rate on manufacturing imports. Figures 2.3 - 2.9 present the time series of tariff rates over time for each currency union. The Cemac, Eccu, and India-Bhutan all have agricultural tariff rates that are higher than are the tariff rates on manufacturing goods for a large share of time. In contrast, the Waemu, Dollarized countries, Singapore-Brunei, and Australian zone have tariffs on manufacturing goods that are generally higher than are the tariffs on agricultural goods. Both agricultural tariffs and manufacturing tariffs follow a generally downward trend.

[2]These shares are for all export destinations, not just to fellow currency union countries. Additionally, according to the *World Development Indicators*, "Merchandise export shares may not sum to 100 percent because of unclassified trade."

2.3 RESULTS FROM ONE LEVEL OF DISAGGREGATION: AGRICULTURE VERSUS MANUFACTURING

Models that are multiplicative in the levels of variables, such as gravity equations, have been estimated traditionally wiht Ordinary Least Squares (OLS), following a logarithmic transformation. As noted in the first chapter, most work by Andrew Rose and others on currency unions and trade has used the OLS estimation procedure. Tables 2.4 and 2.5 show the coefficients obtained from estimating a logarithmic transformation of equation 2.1. The results suggest almost no effect of a common currency on agricultural trade and a large effect of a common currency on manufacturing trade. Note that the result for manufacturing trade resembles the result found in the first chapter for aggregated trade when estimated by OLS.

OLS yields a clear distinction between agricultural trade and manufacturing trade. However, is the distinction shown in tables 2.4 and 2.5 the correct distinction? As stated in chapter 1, Santos Silva and Tenreyro (2006) would say no. In particular, the authors note that applying a logarithm to the variables for the regression fundamentally distorts the stochastic properties of the data and leads to inconsistent estimators. Santos Silva and Tenreyro (2006) propose PPML as a convenient way to estimate non-linear trade models in levels.

Since the PPML estimation is a non-linear estimation procedure, the estimated coefficients are not the estimated marginal effects of the level of the regressors on the level of trade. The marginal effect of a regressor on the dependent variable is the statistic of interest. However, ratios of coefficients are ratios of marginal effects. This chapter follows the procedure used in the first chapter regarding the reporting of results from regressions. Unless otherwise indicated, the values reported in the tables are not coefficients but ratios of coefficients. In linear and in non-linear models, ratios of coefficients are ratios of marginal effects. In particular, the value for any variable x is given as $-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$ and is referred to as the *relative* effect. The negative sign preserves the intuition regarding the influence of x on trade, given that the log of distance has a negative, significant effect on trade in all regressions. The reported p-values are associated Wald tests of the null hypothesis that the afore-mentioned ratio is equal to 0.

In contrast to the OLS results of tables 2.4 and 2.5, the PPML results reported in tables

2.6 and 2.7 show that the effect of a common currency on trade is positive and significant for agricultural trade but negative and significant for manufacturing trade. Regardless of estimation technique, the results show that there exists a clear distinction between a common currency facilitating trade in the agricultural sector and trade in the manufacturing sector. Consequently, there is an inherent economic difference in the effect of a common currency on trade depending on the nature of the goods being traded. This difference merits further consideration by examining different, intraunion patterns of trade across the set of currency unions.

Tables 2.6 and 2.7 show that agricultural trade and manufacturing trade differ as to the effect of a common currency on the costs to engage in trade. Are these differences systematic across currency unions? The results in tables 2.8 and 2.9 suggest that the answer is "yes." First, the relative effects of variables on manufacturing trade generally resemble those of aggregate trade for most individual conferences. Second, the relative effects of variables on agricultural trade are generally lower than are the relative effects of variables on manufacturing trade. The currency union effects in manufacturing trade are generally larger than are those for agricultural trade. The Eccu, the Waemu, the Australia zone, the Eurozone, and India-Bhutan all have relative effects on manufacturing that are of comparable magnitudes to the relative effects to aggregate trade. Variables other than currency union membership also have similar relative effects for aggregate and manufacturing trade. Such variables include output (the product of GDPs from countries i and j for in aggregate trade, sectoral output for country i in sectoral trade), contiguity, and sharing a common language.

The Cemac and dollarized zone are exceptions to the stylized fact that manufacturing and aggregate relative effects resemble each other. The Cemac has an insignificant relative effect for aggregate and agricultural trade, while it is significant and positive for manufacturing trade. The Cemac includes petroleum-rich countries such as Equatorial Guinea and Chad that tend to export unrefined petroleum products outside the Cemac for processing (Masson and Pattillo (2005) and Gulde and Tsangarides (2008)). The inclusion of these exports in aggregate trade and the exclusion of the same exports from either agricultural or manufacturing trade likely explain the different results. Other instances where the agricultural relative effects resemble the relative effects for aggregate trade include the effect of a regional trade accord, the effect of a colonizer-colonized relationship, and the variable for a country pair where one country remains a colony in an empire while another has left the empire.

The second stylized fact, that the relative effects of variables on agricultural trade are generally lower than are the relative effects of variables on manufacturing trade, applies to most currency unions except the Dollar zone and the Eurozone. Both of those currency unions have positive, significant relative effects for agricultural trade but negative (for both zones) and significant (for the Dollar zone only) relative effects for manufacturing trade. For variables other than currency union membership, the colonizer-colonized variable has a larger and significant effect in agricultural trade whereas it has an insignificant relative effect for manufacturing trade. These results may not be too surprising for two reasons. First, the U.S. dollar is generally the currency used for pricing and then purchasing agricultural goods (see Pick and Carter (1994)). Second, as agricultural products are often homogeneous across producers, the gravity equation, often motivated through the supposition of a CES objective function, may not be appropriate, owing to the lack of "love-of-variety"-like motivation.

Recall that the significance of tariffs may arise from a combination of two factors. Suppose that a common currency has a differential impact on trade by commodity type, a particular case of the general situation suggested by Anderson and Yotov (2010) regarding trade costs. Note that in chapter 1, the tariff variable is the sole variable able to distinguish the composition of a trade flow. If a common currency does have a differential impact on trade by commodity type, then studying agricultural trade separately from manufacturing trade should reduce the significance of tariffs in explaining trade within a currency union.

Controlling for all trade costs by including tariffs reduces the magnitude of the statistical significance and/or the magnitude of the relative effects of currency union membership, similar to the case for aggregate trade (see tables 2.10 and 2.11). For agricultural trade, the Waemu and Dollar zones lose their significance. All stand-alone or inherent currency union relative effects become insignificant. The tariff and currency union membership interactions for the Eccu and India-Bhutan are positive and significant. For manufacturing trade, the Eccu retains a large, significant relative effect when controlling for tariffs. The relative of effect of the Cemac retains its significance and increases in magnitude. The Waemu, Dollar zone, and India-Bhutan lose significance and/or decrease in relative effect. The log of tariffs is significant and negative for agricultural goods but insignificant and negative for manufactured goods.

The interactions between currency union membership and tariff rates for disaggregated trade are generally positive, as is the case with aggregate trade. Yet unlike the case for aggregate trade, the interactions are generally insignificant or less significant, especially for agricultural trade. Two tariff interactions between currency unions and tariff rates for agricultural trade are positive and significant (the Eccu and India-Bhutan). However, only one currency union, the Waemu, has a tariff interaction with a negative effect. Recall that the Waemu-tariff interaction for aggregate trade also was negative and significant. Two tariff interactions between currency unions and tariff rates for manufacturing trade are positive and significant (the Australian zone and India-Bhutan). Most others are positive and insignificant, though manufacturing trade in the Dollar zone has a negative and significant interaction. Comparing the point estimates of the relative effects within the same currency union but across goods type shows that agricultural trade has larger effects than does manufacturing trade.

How do these results inform our assessment of the results in the first chapter? Does the interpretation of the role of tariffs change, given fewer instances of statistical significance for tariff and currency union membership interactions? Recall that the results from tables 2.8 and 2.9 show that the currency effects are larger for manufacturing trade than are the for agricultural trade. Tariffs represent the only variable that can distinguish the composition of a trade flow. Suppose that two trade flows are of equal, pre-tariff value, but differ in their composition. If one trade flow contains a greater share of high-tariffed goods than does the other trade flow, then the common currency facilitates the former trade flow to a greater extent than does the latter trade flow. Hence, the interactions on common currency and the level of tariff rates are significant in a regression of aggregate trade flows as no other variable reveals heterogeneity in trade flow composition. Separating trade flows by composition in a way that leads to a relatively high-tariff rate type of trade (agricultural) and a relatively low-tariff rate type of trade (manufacturing) necessarily reduces the variance of tariff rates within the trade flow of each type. Thus, the tariff rate itself becomes less significant in predicting trade within a currency union as the common currency's effectiveness at facilitating trade in the presence of high tariffs is preempted by the separation of trade flow regressions by commodity, and, tariff-rate (low versus high) type. Recall also that the particular class of high tariffed goods in this decomposition, agricultural goods, contains goods that are generally transacted in a particular currency, the U.S. dollar. Therefore, variables pertaining to the sharing of a common currency other than the U.S. dollar across countries are unlikely to have a significant influence in determining trade. The point estimates of the relative effects for currency union-tariff interactions are generally larger for agricultural trade than for manufacturing trade. Hence, though the estimates be insignificant, they are consistent with the pattern of a currency union being used more extensively for trade in high-tariffed goods than in low-tariffed goods.

2.4 RESULTS FROM A SECOND LEVEL OF DISAGGREGATION

The results in tables 2.9 and 2.11 indicate a non-negligible currency union effect in the manufacturing industry, an effect not fully explained by tariffs. This section of the chapter investigates a further disaggregation but restricted to the manufacturing sector. Using the ISIC 3 classifications, I disaggregate manufactured products into two types. The first type consists of the 2-digit manufacturing codes, 15-19.[3] The second type consists of all other 2-digit manufacturing codes, 20-37.[4] The regressions in this section do not include Y_i^k, the sales of goods at destination prices from i in goods class k, as such variables are not sufficiently available for currency union countries. As the time-varying importer fixed effects control for E_j^k, the time-varying exporter fixed effects will control for Y_i^k.

[3]food products and beverages; tobacco products; textiles; wearing apparel; dressing and dyeing of fur; tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear

[4]wood and products of wood and cork, except furniture; articles of straw and plaiting materials; paper and paper products; publishing, printing and reproduction of recorded media; coke, refined petroleum products and nuclear fuel; chemicals and chemical products; rubber and plastics products; other non-metallic mineral products; basic metals; fabricated metal products, except machinery and equipment; machinery and equipment n.e.c.; office, accounting and computing machinery; electrical machinery and apparatus n.e.c.; radio, television and communication equipment and apparatus; medical, precision and optical instruments, watches and clocks; motor vehicles, trailers and semi-trailers; other transport equipment; furniture; manufacturing n.e.c.; recycling

Table 2.12 shows clear distinctions in the tariff rates for the two divisions of manufacturing products. Industries with codes 15-19, industries that process primary products, tend to have higher tariffs than do more advanced industries classified with codes ranging from 20-37. This difference is consistent with Cline regarding higher tariffs for agricultural-related and low skilled-intensive manufacturing industries. These differences are persistent over time, as indicated by figures 2.10 through 2.14. Thus, manufacturing trade alone likely creates an aggregation bias regarding the effect of a common currency on trade. A further disaggregation will eliminate this bias.

Tables 2.13 through 2.20 report the results from estimating equation 2.1 for the classes of goods defined by ISIC 3 manufacturing codes 15-19 and 20-37. As was the case in the previous section, there exists a clear distinction between the effect of a common currency on trade for products with industry codes 15-19 and for products with industry codes 20-37, regardless of the estimation technique used. Unlike the case with OLS, the nature of the distinction is one of magnitude, not one of sign. For OLS, the effect of a common currency under the assumption of homogeneous integration is positive and significant. For PPML, the effect is negative and insignificant.

The results in tables 2.17 and 2.18 assume heterogeneous integration and indicate generally stronger currency union effects for products in codes 20-37. Exceptions include the Dollarized zone and India-Bhutan. Given that products with codes 15-19 are closely linked to agricultural production, it is not surprising to find stronger effects for trade in products coded 20-37, particularly for the Dollarized zone where the common currency predicted a significant, positive effect on intra-union, agricultural trade but a significant, negative effect on intra-union, manufacturing trade.

Controlling for tariffs in tables 2.19 and 2.20 reveals more heterogeneity among the types of manufactured goods and among currency unions. For goods with codes 15-19, the Eccu and Dollarized zones demonstrate a higher direct level of integration after controlling for tariffs as is evidenced by the currency union specific dummy variables. In contrast, the Waemu, Cemac, and India-Bhutan zones lose significance after controlling for tariffs. Tariff interactions with currency union membership are generally negative (except for the Cemac) and significant (except for the Cemac and India-Bhutan). Surprisingly, the log of tariff rates, without interaction, is positive and significant. I interpret this result to mean that goods with higher tariffs are traded more frequently than are goods with lower tariffs.

Comparing tables 2.18 and 2.20 shows that controlling for tariffs has a similar effect for trade in goods with codes 20-37 as does it for aggregate trade. In table 2.18, only the Dollarized zone and the Eurozone are not both positive and significant. Controlling for tariffs in table 2.20 leaves only one currency union, the Waemu, with a positive and significant direct effect. Unlike the results for aggregate trade controlling for tariffs, the interactions between tariff rates and currency union membership are largely insignificant, except for the dollarized zone where the interaction is negative and significant. The point estimates for the currency union-tariff interactions are larger for trade in codes 15-19 than for trade in codes 20-37, similar to the pattern in the agricultural versus manufacturing comparison.

2.5 CONCLUSION

Theoretical and empirical literature supports the hypothesis that a group of countries sharing a common currency demonstrate higher degree of integration than does a group of otherwise similar countries lacking a common currency. The first chapter of this dissertation shows that currency unions differ in the extent of integration by trade and that tariffs tend to be positively correlated with with the extent of integration.

This chapter analyzes the results in the first chapter of this dissertation. Both tariffs and a common currency affect trade through their impact on the costs to trade. Anderson and Yotov (2010) note that trade costs have different impacts on the volume of trade. Consequently, understanding the interaction of two prominent trade costs requires a disaggregated trade analysis. In order to identify particular sectors a common currency enhances trade, this chapter uses the sector-specific gravity equation developed by Anderson and Yotov (2010) to analyze bilateral trade flows in particular sectors. Trade within the Eurozone and the Dollarized countries tends to be in agricultural products. For other unions, intra-union trade tends to be in manufacturing products. Tariffs tend to facilitate agricultural trade for the Eccu and India-Bhutan while the same statement is true for manufacturing trade in the

Rand zone, the Australian dollar zone, and India-Bhutan.

This finding is consistent with the finding in chapter 1 that tariffs play a key role in determining the extent of intra-union trade. As tariffs tend to differ across sectors, it is not surprising that intra-currency union agricultural trade differs from intra-currency union manufacturing trade. A common currency tends to predict more trade within manufacturing industries classified according to ISIC Revision 3 codes 20-37 than in industries classified with codes 15-19. Tariff rates for these industries with codes 15-19 tend to be higher than are tariff rates for industries with codes 20-37. After controlling for tariffs, the Eccu and the Dollarized countries display a significant, inherent extent of trade in industries coded 15-19 while only the Waemu displays such effect for industries coded 20-37.

Figure 2.1: Average share of agricultural exports by currency union

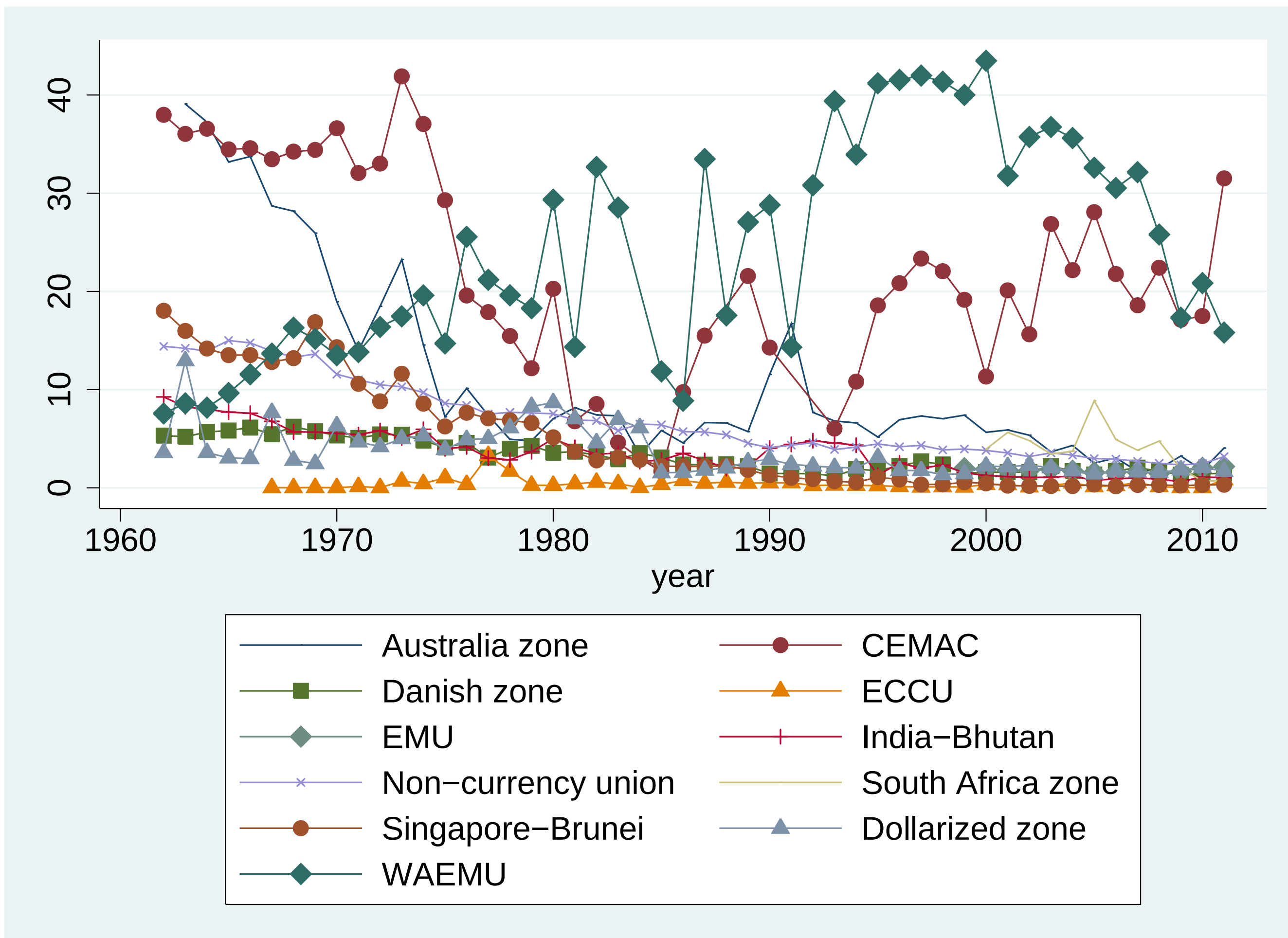


Figure 2.2: Average share of manufacturing exports by currency union

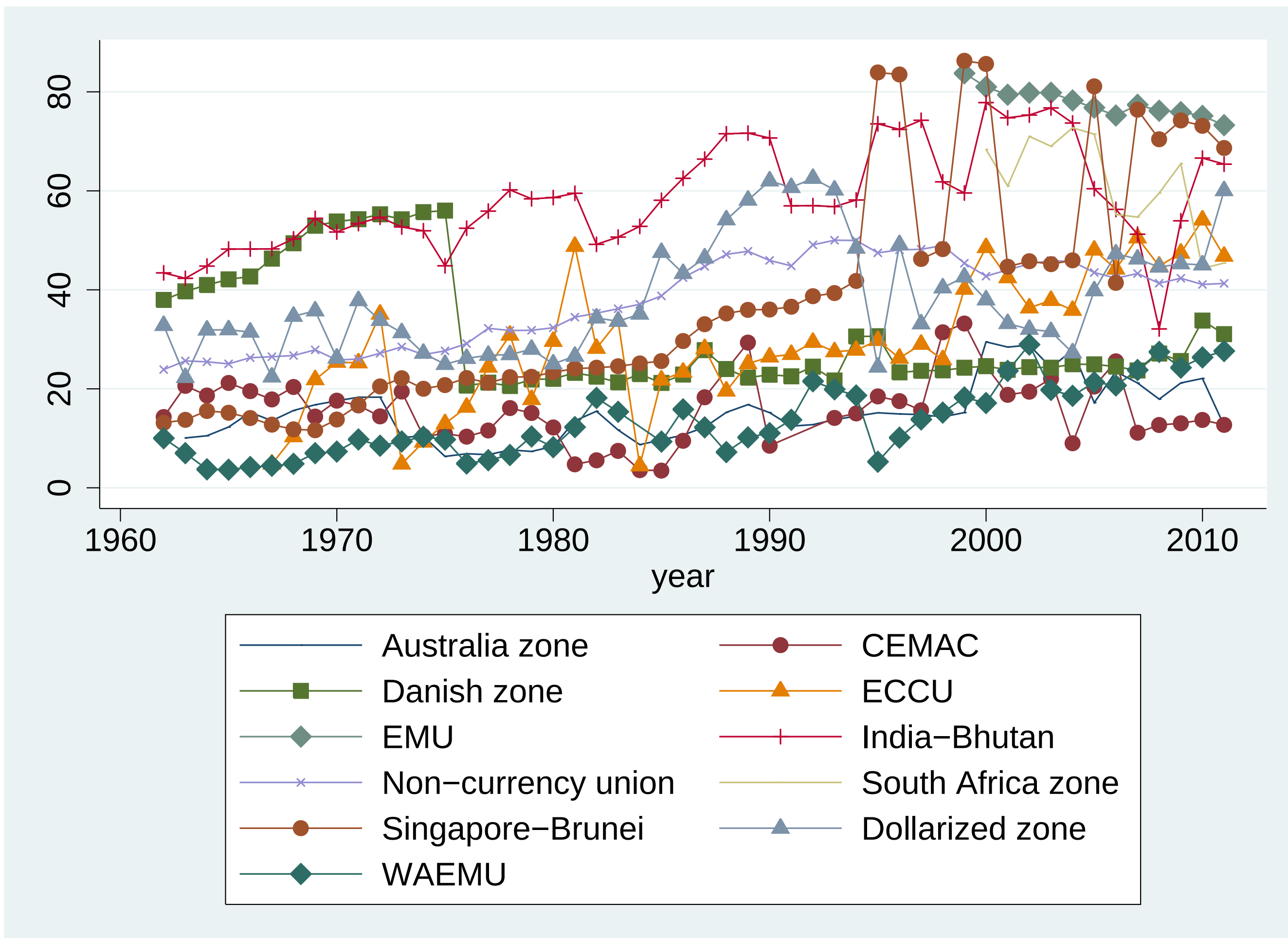


Figure 2.3: Average tariff rates across currency union countries for agricultural and manufacturing goods

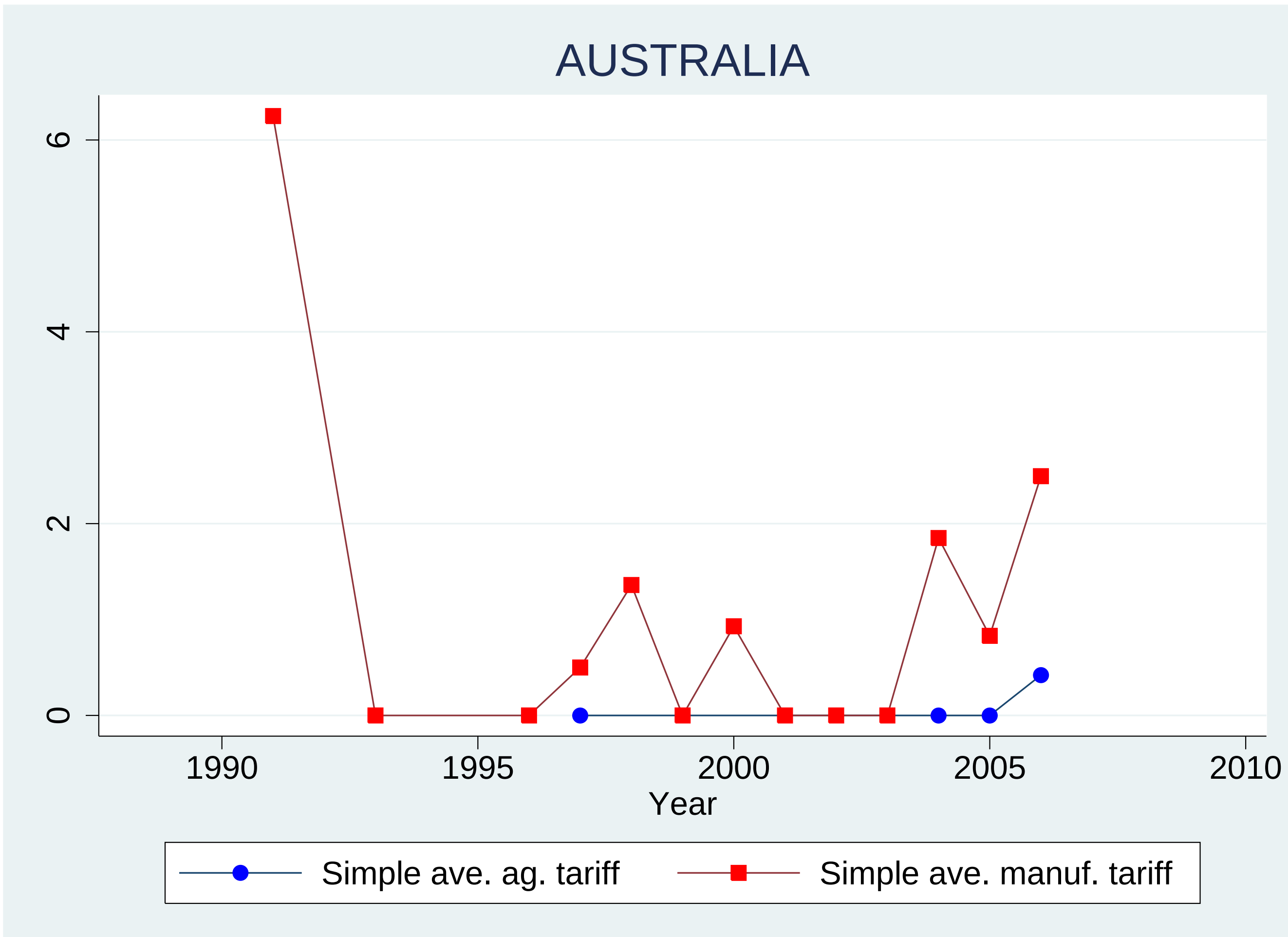


Figure 2.4: Average tariff rates across currency union countries for agricultural and manufacturing goods

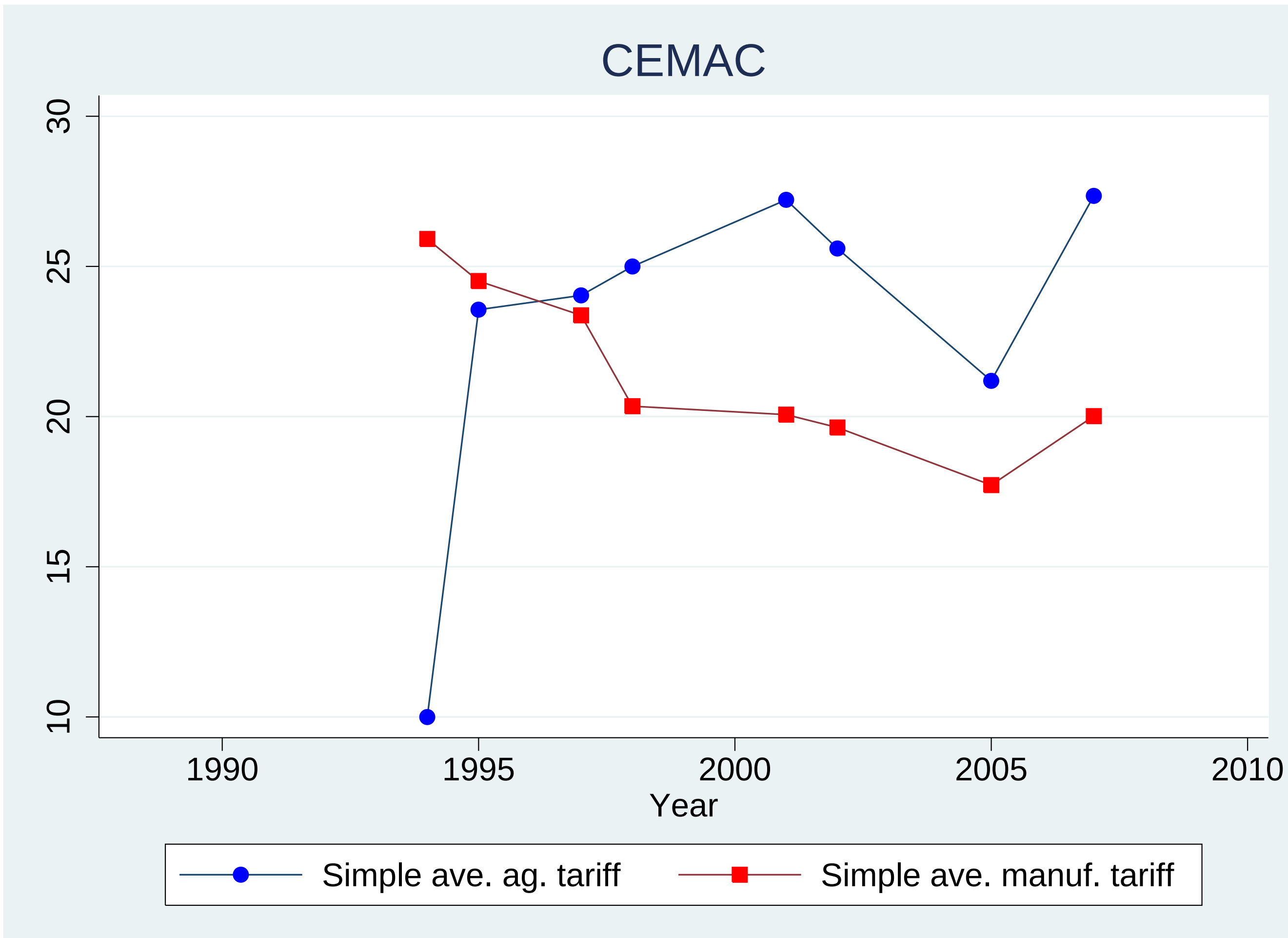


Figure 2.5: Average tariff rates across currency union countries for agricultural and manufacturing goods

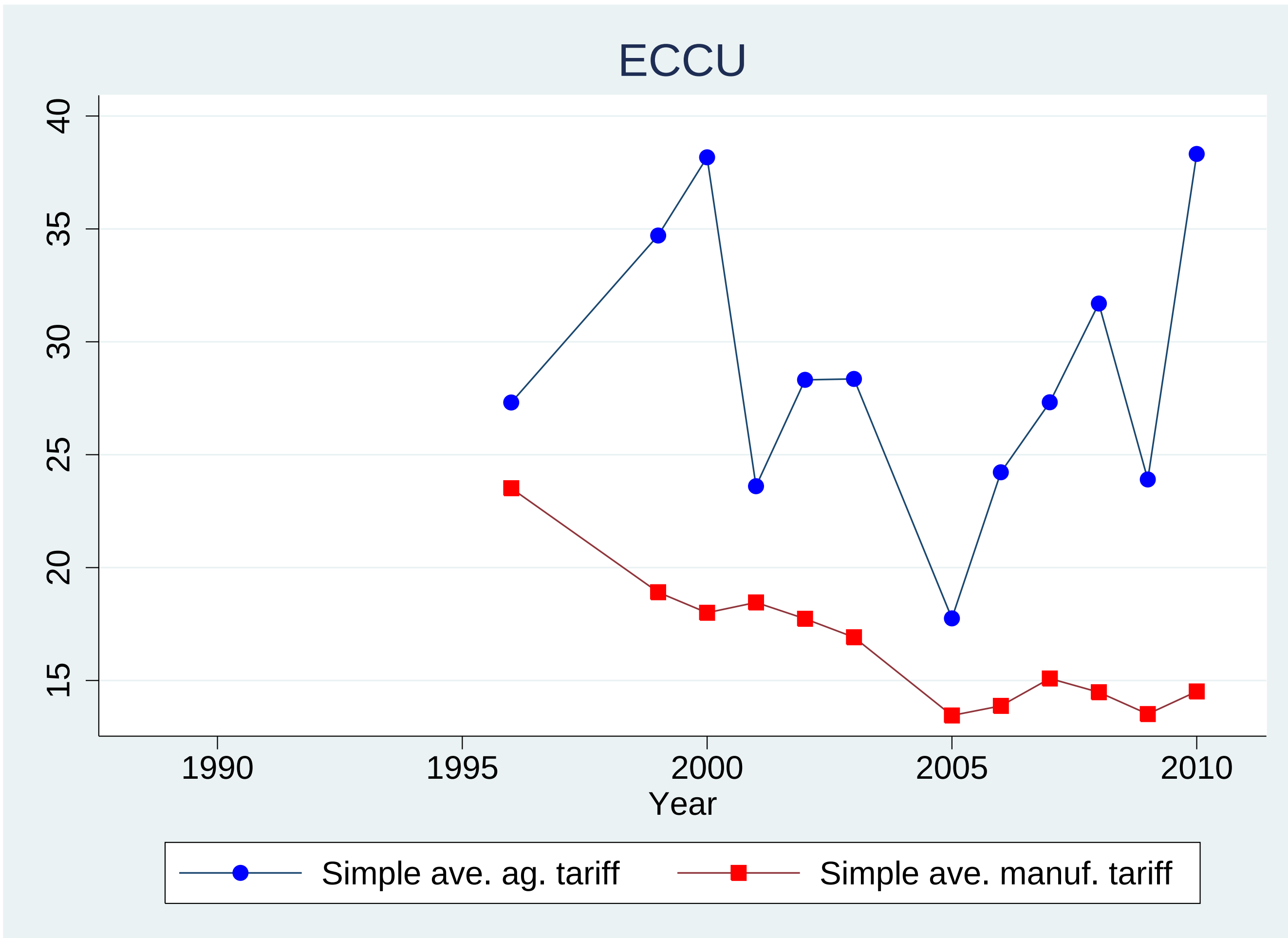


Figure 2.6: Average tariff rates across currency union countries for agricultural and manufacturing goods

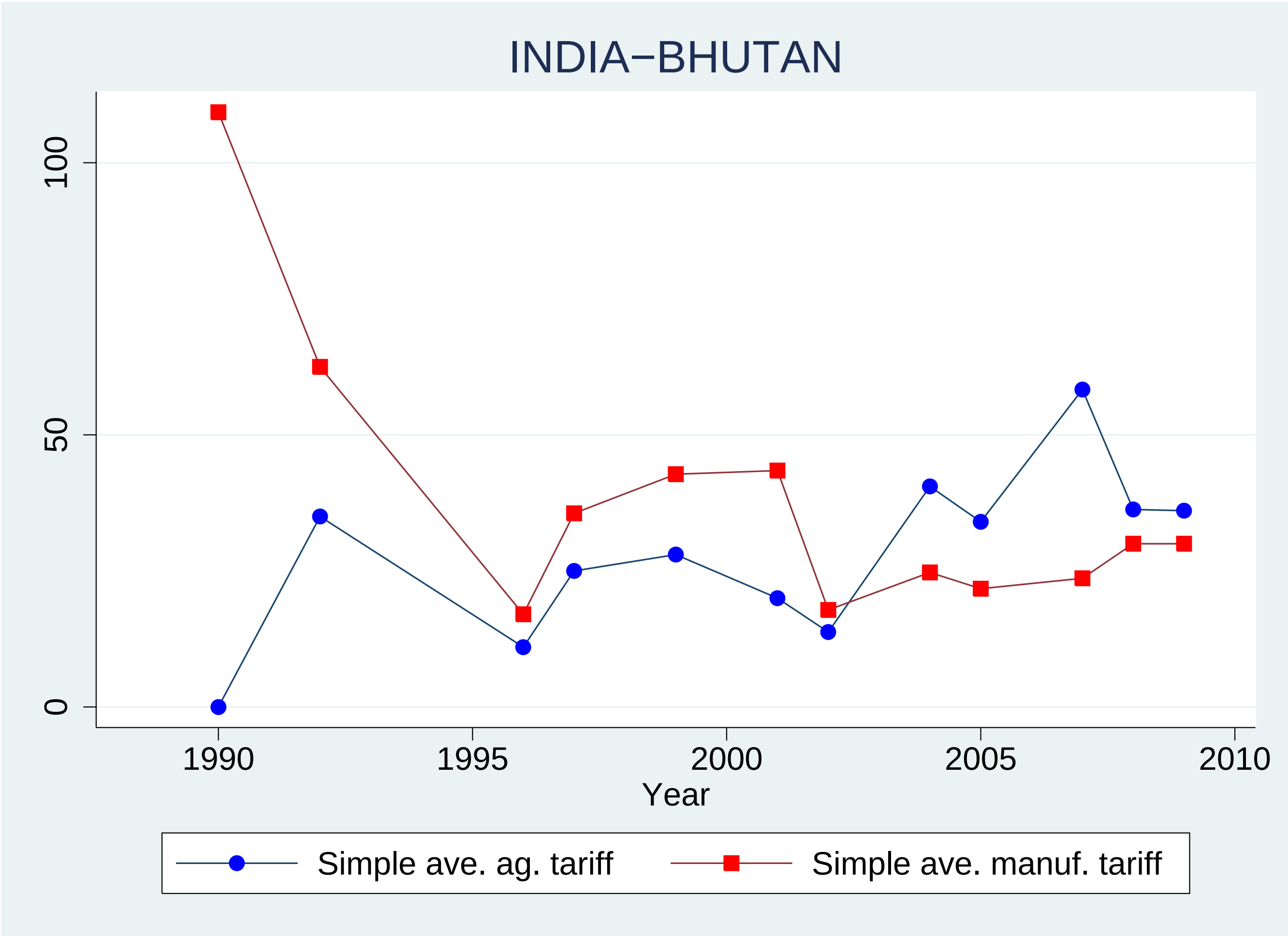


Figure 2.7: Average tariff rates across currency union countries for agricultural and manufacturing goods

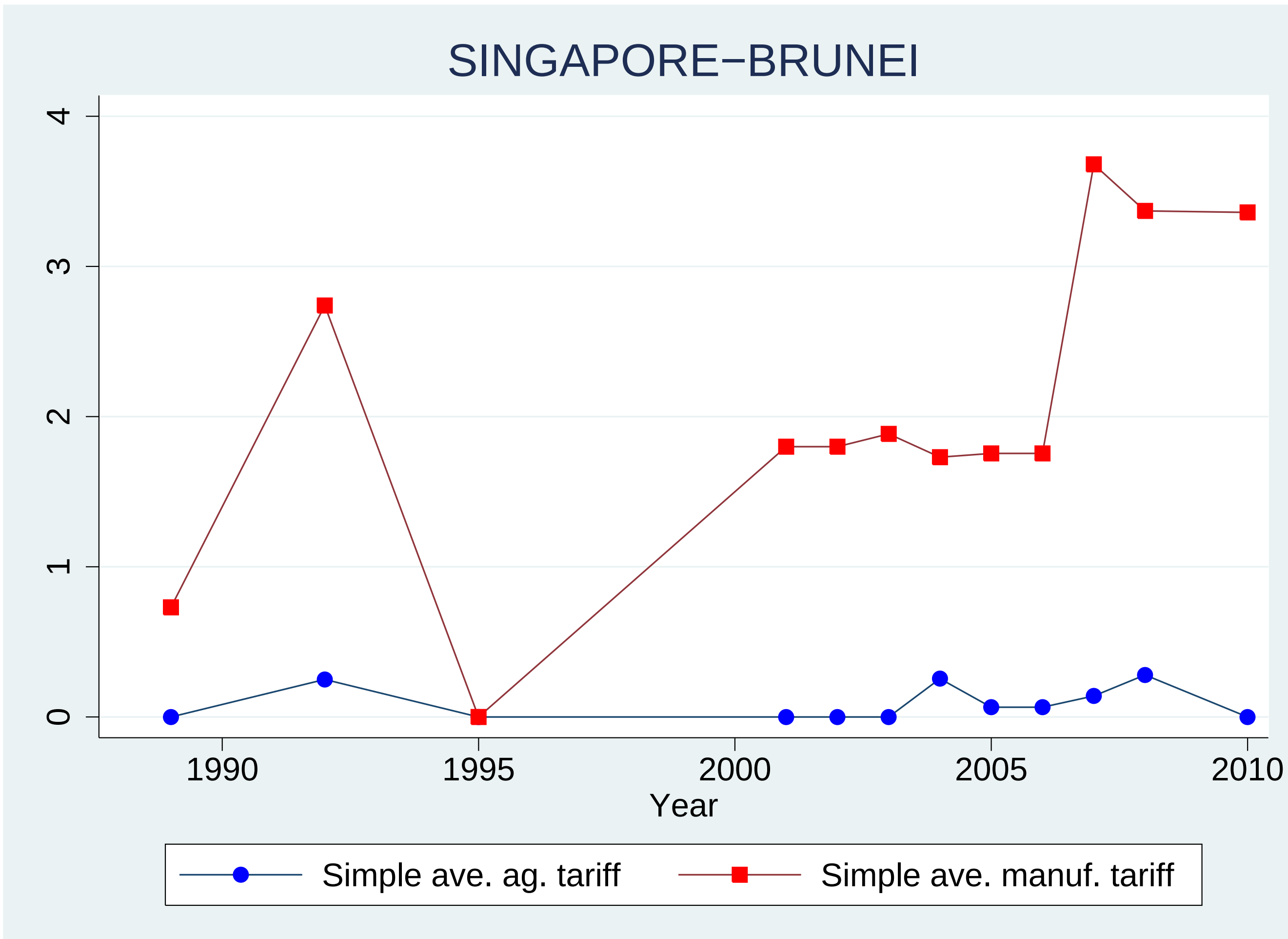


Figure 2.8: Average tariff rates across currency union countries for agricultural and manufacturing goods

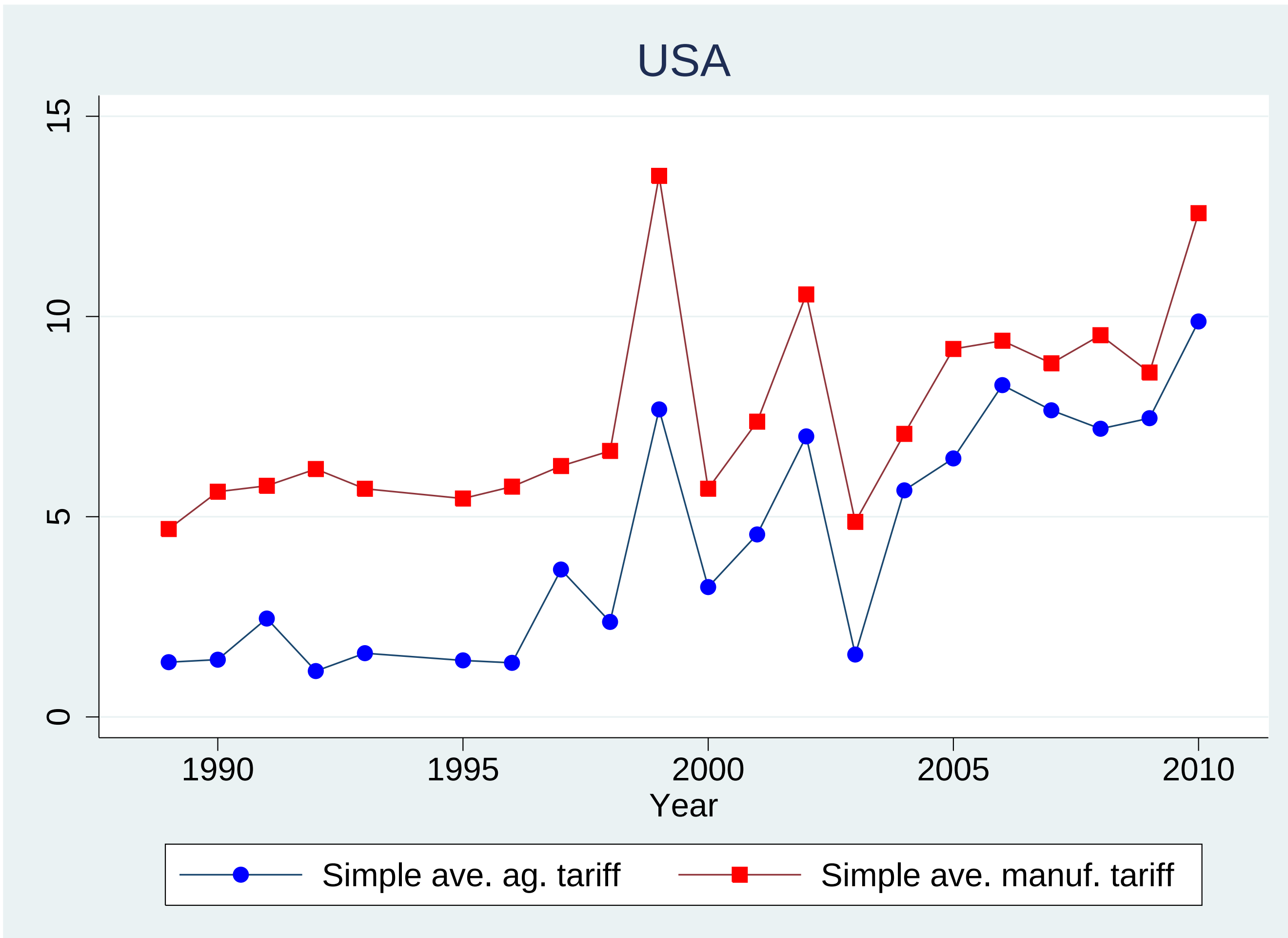


Figure 2.9: Average tariff rates across currency union countries for agricultural and manufacturing goods

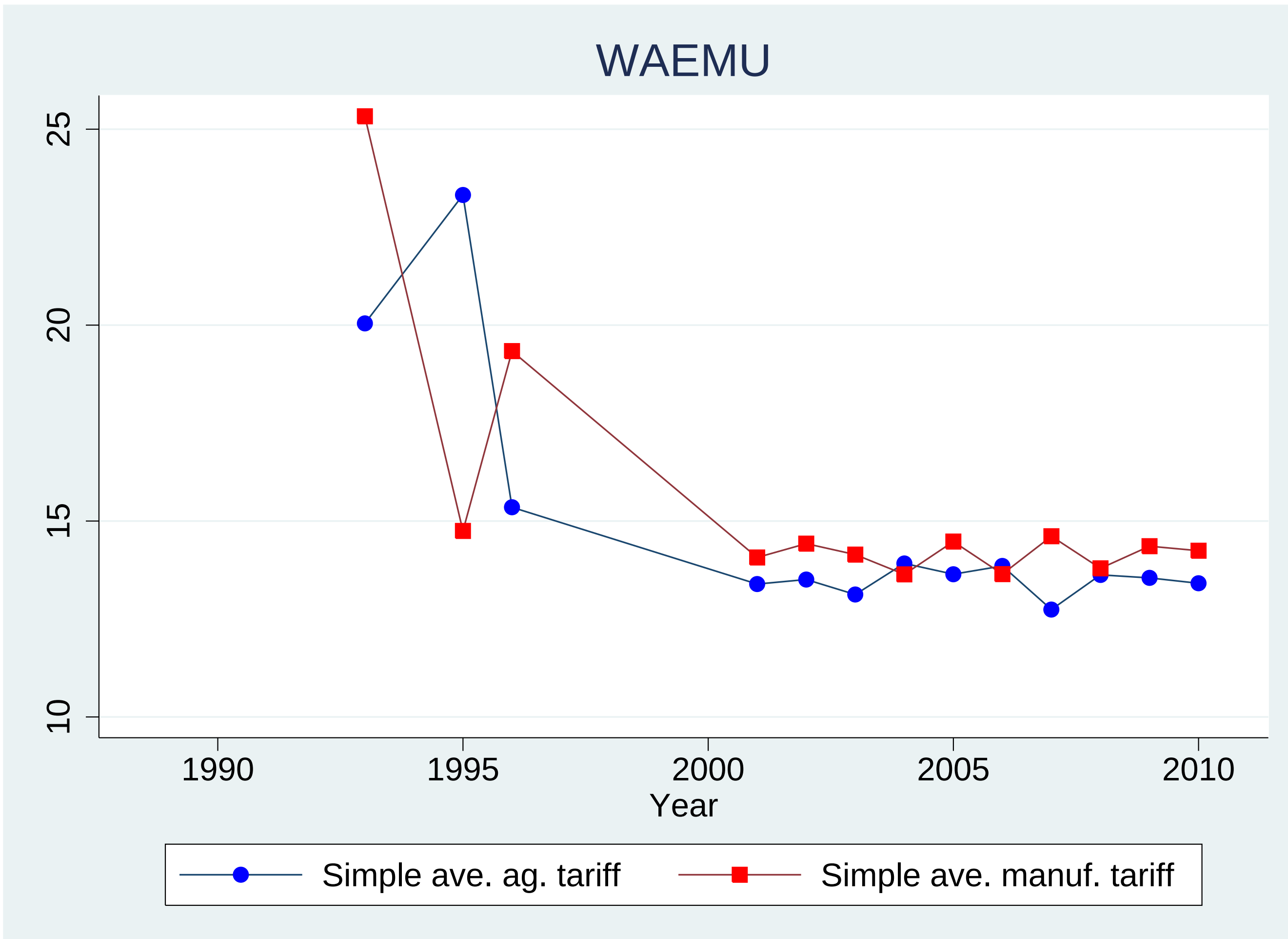


Figure 2.10: Average tariff rates across currency union countries for disaggregated manufacturing goods

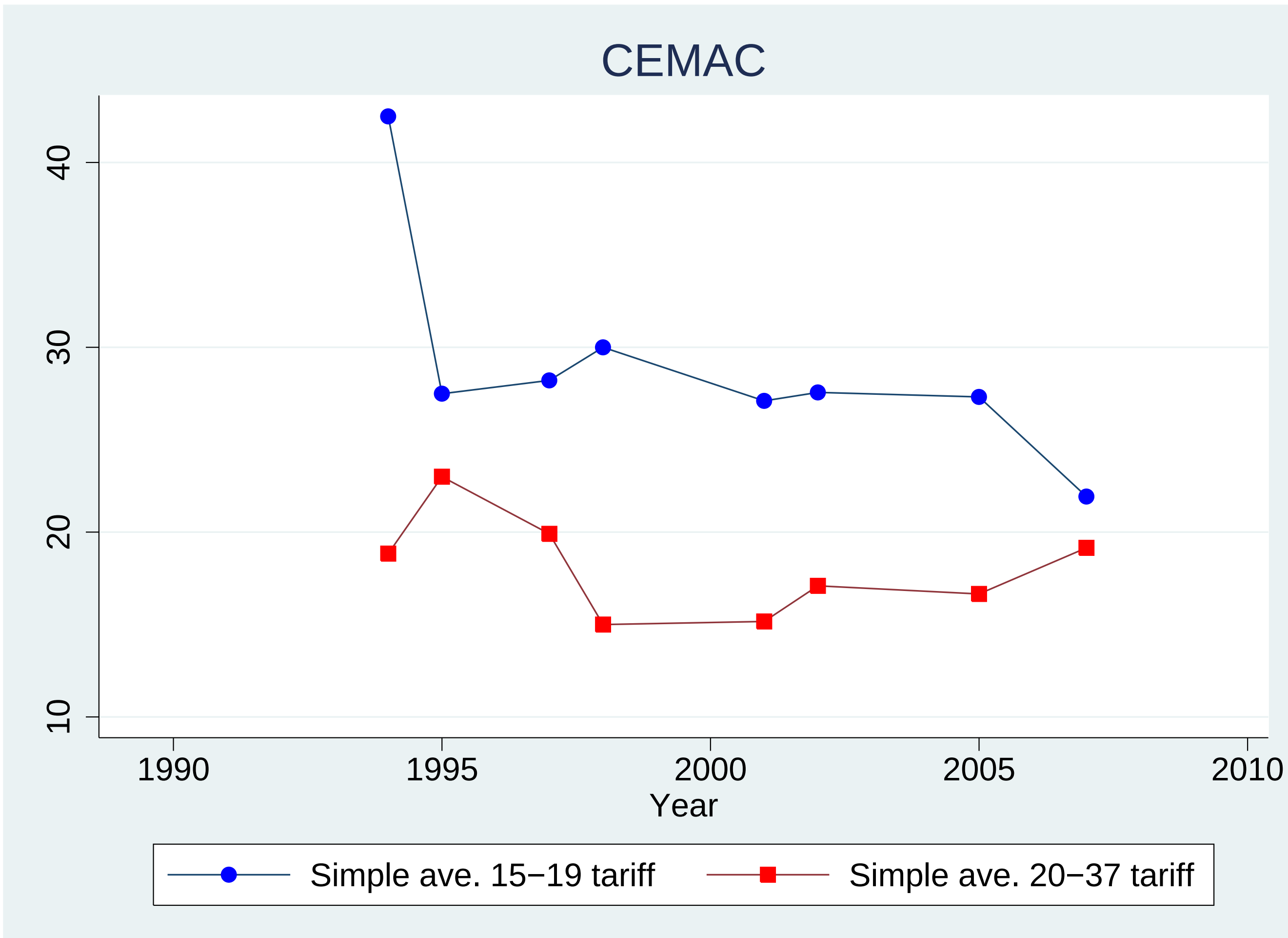


Figure 2.11: Average tariff rates across currency union countries for disaggregated manufacturing goods

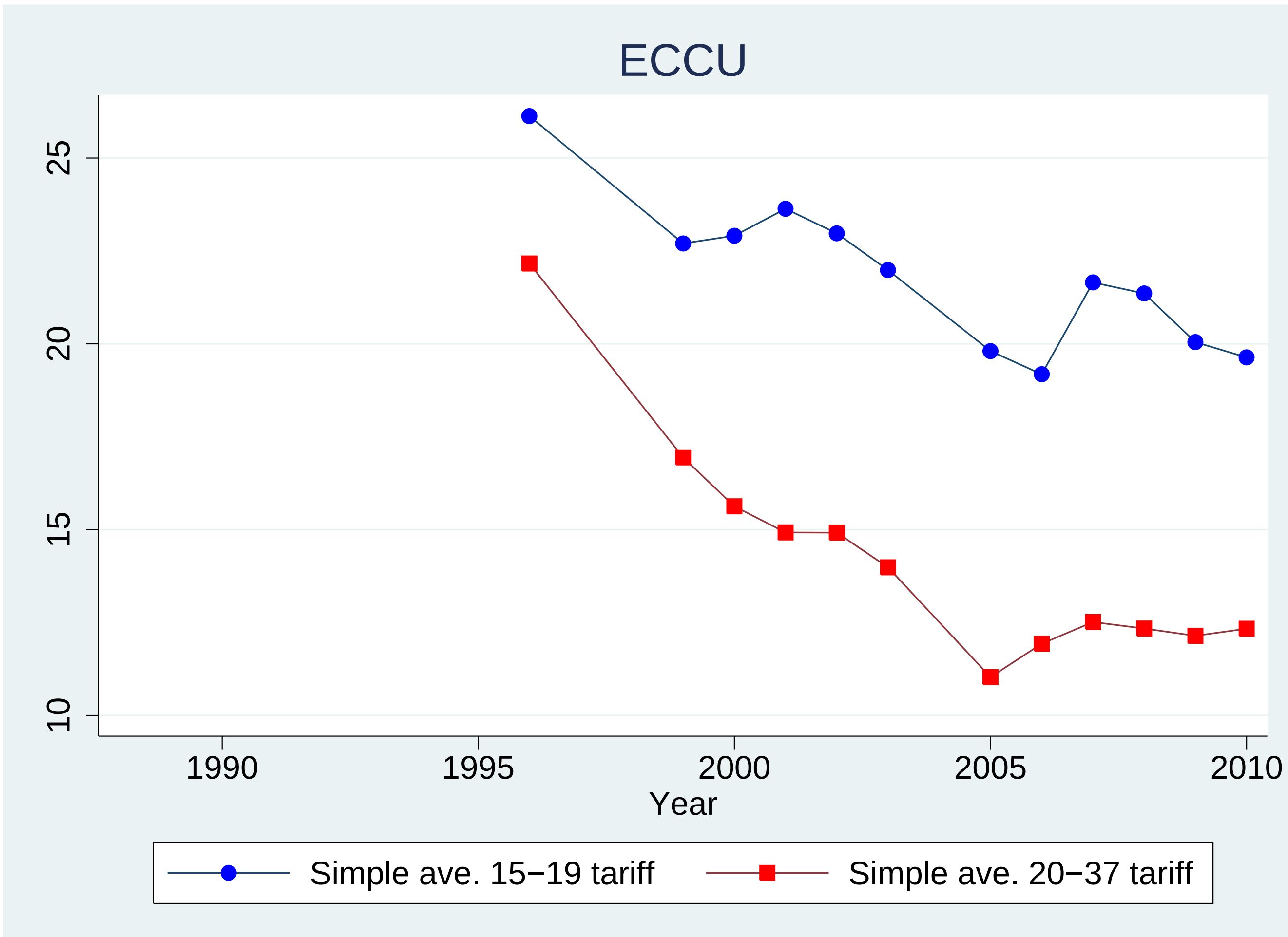


Figure 2.12: Average tariff rates across currency union countries for disaggregated manufacturing goods

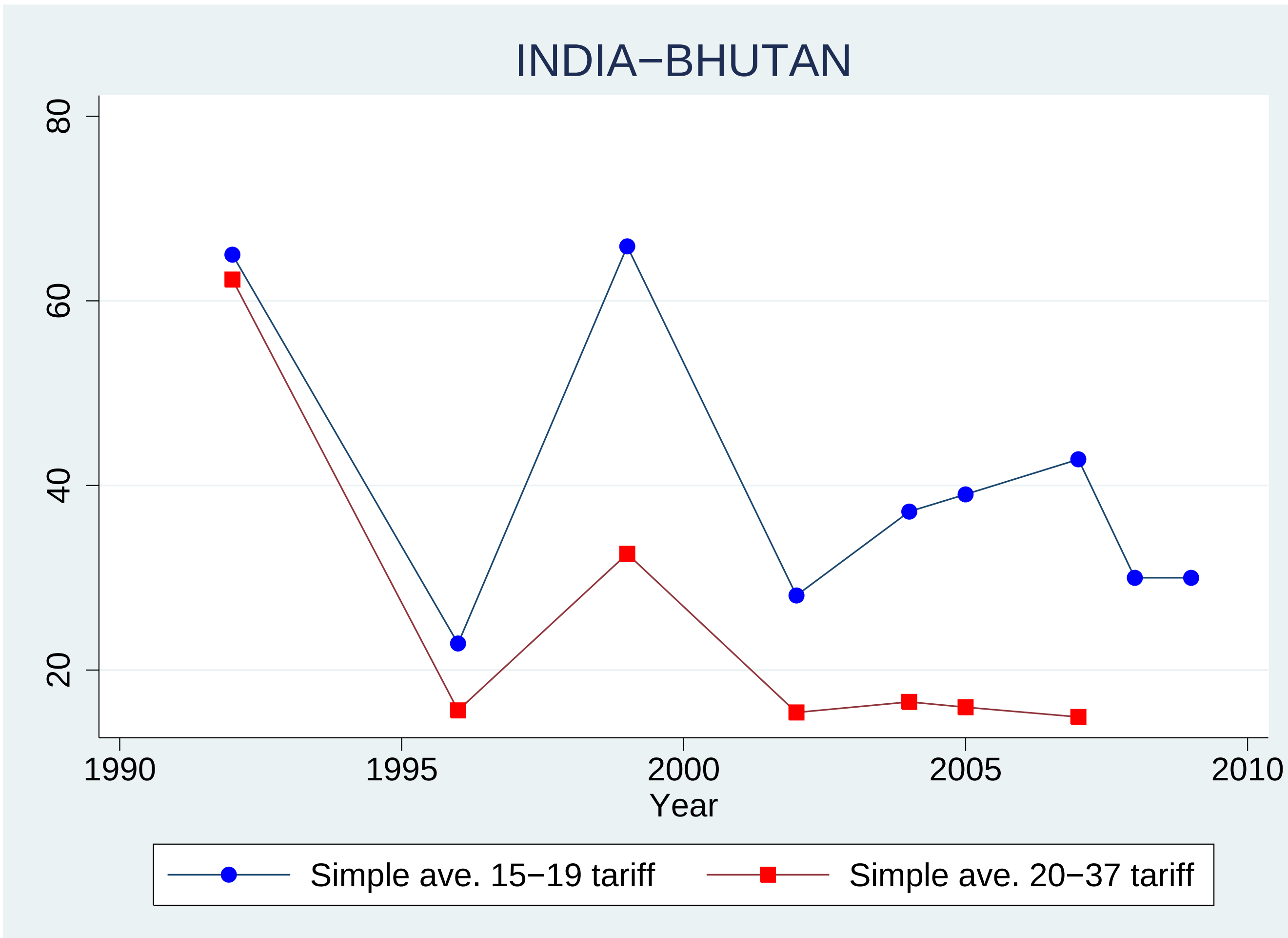


Figure 2.13: Average tariff rates across currency union countries for disaggregated manufacturing goods

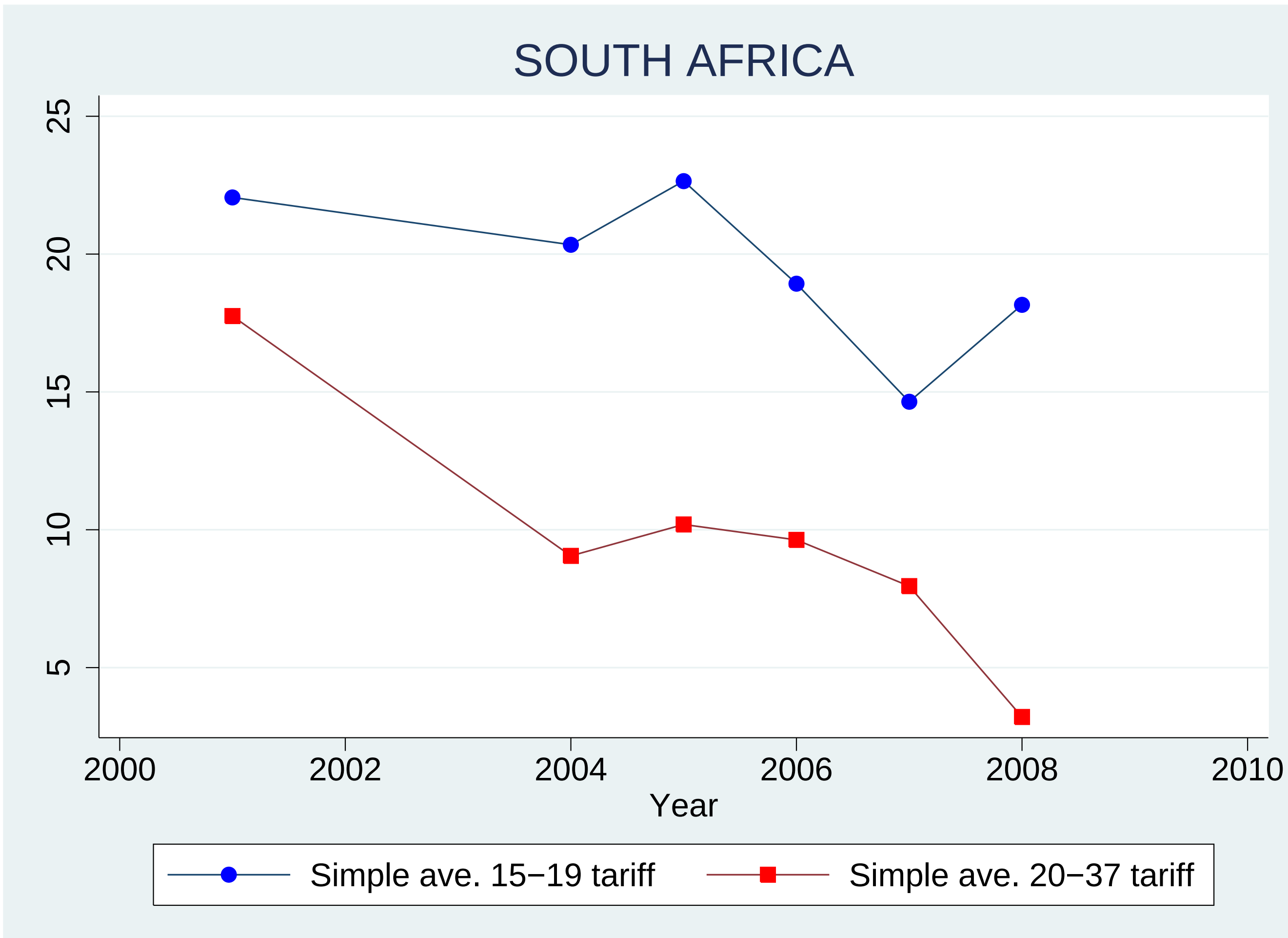
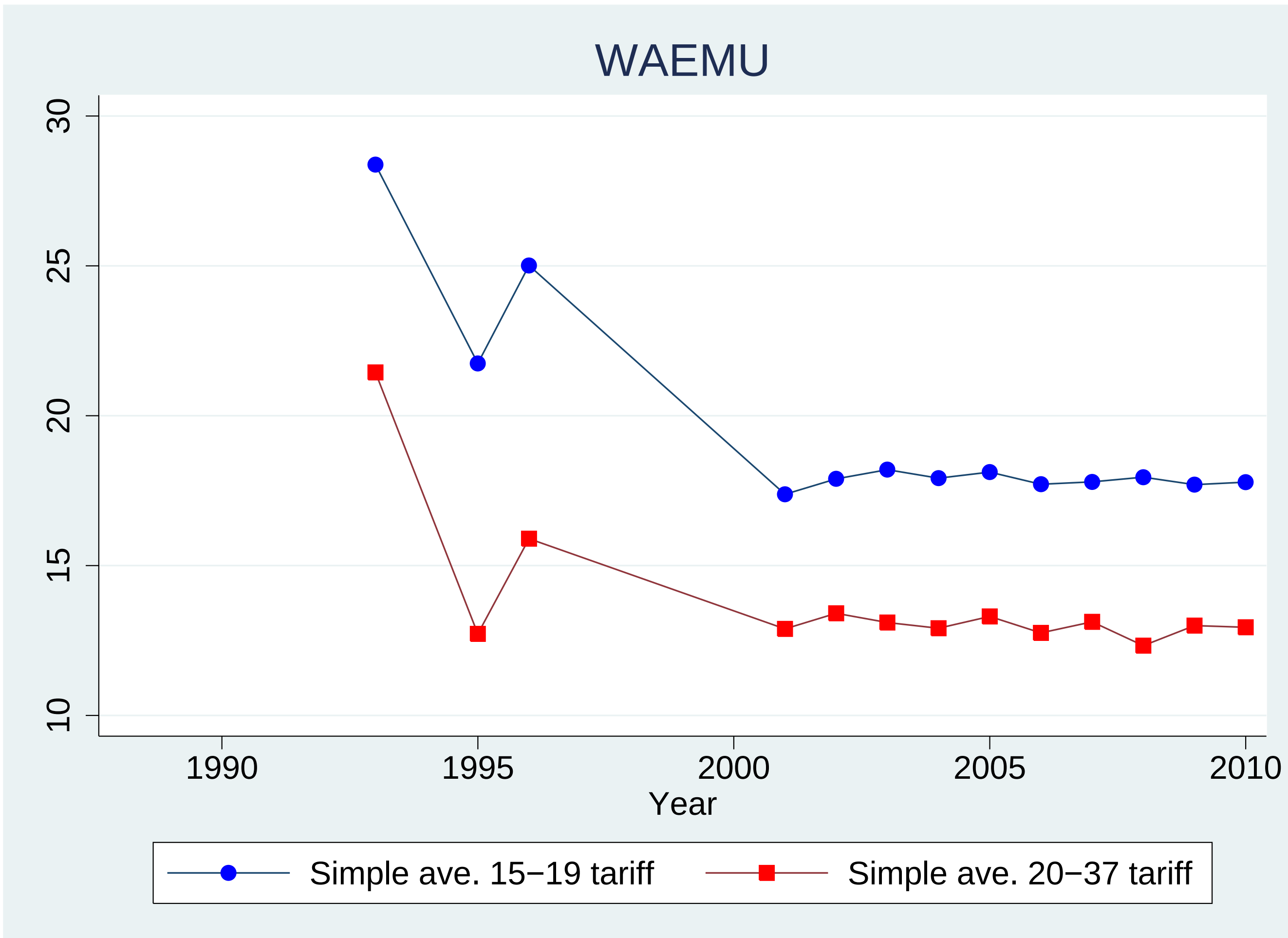


Figure 2.14: Average tariff rates across currency union countries for disaggregated manufacturing goods



2.6 APPENDIX: TABLES

Table 2.1: Average shares of merchandise exports for currency unions, 1960-2011 (standard deviations in parentheses)

Currency Union	Agricultural exports	Manufacturing exports
Australia zone	10.997	15.183
	(10.012)	(5.898)
Cemac	22.058	15.765
	(10.633)	(6.643)
Danish zone	3.178	31.131
	(1.636)	(11.875)
Dollaried zone	3.583	38.217
	(2.416)	(11.499)
Eccu	0.402	29.514
	(0.543)	(12.863)
Eurozone	1.785	77.849
	(0.204)	(2.86)
India-Bhutan	3.61	58.463
	(2.28)	(10.39)
Rand zone	3.941	61.524
	(2.231)	(9.901)
Singapore-Brunei	4.909	37.686
	(5.539)	(23.182)
Waemu	24.211	13.542
	(10.939)	(7.262)

Table 2.2: Average tariffs (%) for currency unions, 1988-2011 (standard deviations in parentheses)

Currency Union	Agricultural imports	Manufacturing imports
Australia	0.105	1.09
	(0.19)	(1.7)
Cemac	22.69	21.55
	(5.32)	(2.7)
Eccu	28.29	16.91
	(5.8)	(2.9)
India-Bhutan	25.97	39.69
	(14.23)	(26.44)
Singapore-Brunei	0.76	1.72
	(0.10)	(0.88)
Rand Zone	4.3	11.86
	(1.99)	(2.82)
Dollarized zone	4.29	7.41
	(2.62)	(2.28)
Waemu	14.75	15.3
	(2.89)	(3.05)

Table 2.3: Estimation results : Baseline model, heterogeneous common currency effects, 1950-2008
Dependent variable is the level of exports.

Variable	PPML	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
East Caribbean Currency Union	3.945**	(0.000)
West African Economic and Monetary Union	3.285**	(0.000)
Central African Economic and Monetary Union	0.069	(0.911)
Australia zone	1.655**	(0.001)
Dollarized zone	-0.509	(0.183)
Euro zone	0.095	(0.454)
Danish zone	8.013**	(0.000)
India-Bhutan	4.214**	(0.000)
Singapore-Brunei	1.35*	(0.014)
$\ln(Y_{it} \times Y_{jt})$	0.892**	(0.000)
$\ln Y_t^W$	0.068	(0.411)
Pair belongs to a Regional Trade Accord	0.545**	(0.000)
Countries are contiguous	0.793**	(0.001)
Colonizer-colonized relationship	0.763**	(0.001)
Countries are colonies of same country	-1.511*	(0.047)
Country pair transitioning from colonialism	-0.612†	(0.081)
Countries were colonies of same country	0.332*	(0.041)
Shared common or official language	0.364*	(0.011)
Number of observations	346254	
Number of pairs	14912	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 2.4: Estimation results: Agricultural trade, 1976-2010
Dependent variable is the log of exports.

Variable	OLS			
	$\hat{\beta}_x$	p-value	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
Countries share a common currency	-0.015	(0.91)	-0.012	(0.909)
$\ln Y_{it}^{ag}$	0.359	$(0.000)^{**}$	0.287	$(0.000)^{**}$
$\ln Y_{world,t}^{ag}$	0.116	$(0.069)^{\dagger}$	0.093	$(0.069)^{\dagger}$
Pair belongs to a Regional Trade Accord	0.373	$(0.000)^{**}$	0.299	$(0.000)^{**}$
Colonizer-colonized relationship	1.499	$(0.000)^{**}$	1.2	$(0.000)^{**}$
Countries are colonies of same country	2.566	$(0.014)^{*}$	2.054	$(0.014)^{*}$
Country pair transitioning from colonialism	0.493	$(0.044)^{*}$	0.395	$(0.044)^{*}$
Countries were colonies of same country	0.333	$(0.000)^{**}$	0.266	$(0.000)^{**}$
Countries are contiguous	0.962	$(0.000)^{**}$	0.77	$(0.000)^{**}$
Shared common or official language	0.41	$(0.000)^{**}$	0.329	$(0.000)^{**}$
Number of observations	186103			
R^2	0.5965			
Number of pairs	17079			

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 2.5: Estimation results: Manufacturing trade, 1980-2010
Dependent variable is the log of exports.

Variable	**OLS**			
	$\hat{\beta}_x$	p-value	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
Countries share a common currency	0.79	$(0.000)^{**}$	0.472	$(0.000)^{**}$
$\ln Y_{it}^{manuf}$	0.347	$(0.000)^{**}$	0.207	$(0.000)^{**}$
$\ln Y_{world,t}^{manuf}$	1.087	$(0.000)^{**}$	0.65	$(0.000)^{**}$
Pair belongs to a Regional Trade Accord	0.402	$(0.000)^{**}$	0.24	$(0.000)^{**}$
Colonizer-colonized relationship	1.234	$(0.000)^{**}$	0.737	$(0.000)^{**}$
Countries are colonies of same country	1.852	$(0.012)^{*}$	1.107	$(0.012)^{*}$
Country pair transitioning from colonialism	0.271	(0.114)	0.162	(0.113)
Countries were colonies of same country	0.648	$(0.000)^{**}$	0.387	$(0.000)^{**}$
Countries are contiguous	0.634	$(0.000)^{**}$	0.379	$(0.000)^{**}$
Shared common or official language	0.575	$(0.000)^{**}$	0.344	$(0.000)^{**}$
Number of observations	256644			
R^2	0.7407			
Number of pairs	23022			

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 2.6: Estimation results: Agricultural trade, 1976-2010
Dependent variable is the level of exports.

Variable	PPML	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
Countries share a common currency	0.313	(0.001)**
$\ln Y_{it}^{ag}$	0.41	(0.000)**
$\ln Y_{world,t}^{ag}$	0.554	(0.000)**
Pair belongs to a Regional Trade Accord	0.575	(0.000)**
Colonizer-colonized relationship	0.605	(0.000)**
Countries are colonies of same country	1.118	(0.345)
Country pair transitioning from colonialism	-0.983	(0.009)**
Countries were colonies of same country	0.289	(0.016)*
Countries are contiguous	0.546	(0.000)**
Shared common or official language	-0.002	(0.982)
Number of observations	307064	
Number of pairs	24472	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 2.7: Estimation results : Manufacturing trade, 1980-2010
Dependent variable is the level of exports.

Variable	PPML	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
Countries share a common currency	-0.145	(0.085)†
$\ln Y_{it}^{manuf}$	0.8	(0.000)**
$\ln Y_{world,t}^{manuf}$	0.917	(0.000)**
Pair belongs to a Regional Trade Accord	0.833	(0.000)**
Colonizer-colonized relationship	0.161	(0.347)
Countries are colonies of same country	-0.085	(0.941)
Country pair transitioning from colonialism	-0.361	(0.189)
Countries were colonies of same country	0.441	(0.000)**
Countries are contiguous	0.599	(0.000)**
Shared common or official language	0.41	(0.982)
Number of observations	277684	
Number of pairs	24356	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 2.8: Estimation results : Agricultural trade, 1976-2010
Dependent variable is the level of exports.

Variable	PPML	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
East Caribbean Currency Union	-0.32	(0.767)
West African Economic & Monetary Union	1.154*	(0.025)
Central African Economic & Monetary Union	-0.893	(0.245)
Rand zone (South Africa)	2.281*	(0.028)
Australia zone	-0.505	(0.318)
Dollarized zone	0.621*	(0.012)
Eurozone	0.332**	(0.000)
Krone zone (denmark)	3.581**	(0.000)
India-Bhutan	2.517**	(0.007)
benelux	-1.809**	(0.000)
$\ln Y_{it}^{ag}$	0.4**	(0.000)
$\ln Y_{world,t}^{ag}$	0.536**	(0.000)
Pair belongs to a regional trade agreement	0.541**	(0.000)
Colonizer-colonized relationship	0.81**	(0.000)
Countries are colonies of same country	1.109	(0.341)
Country pair transitioning from colonialism	-0.96**	(0.009)
Countries were colonies of same country	0.285*	(0.017)
Countries are contiguous	0.548**	(0.000)
Pair share a common language	-0.005	(0.963)
Number of observations	307064	
Number of pairs	24472	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 2.9: Estimation results : Manufacturing trade, 1980-2010
Dependent variable is the level of exports.

Variable	PPML	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
East Caribbean Currency Union	4.485**	(0.000)
West African Economic & Monetary Union	3.022**	(0.000)
Central African Economic & Monetary Union	3.082**	(0.000)
Rand zone (South Africa)	1.742**	(0.004)
Australia zone	3.288**	(0.000)
Dollarized zone	-1.534**	(0.001)
Eurozone	-0.004	(0.959)
Krone zone (denmark)	6.45**	(0.000)
India-Bhutan	4.201**	(0.000)
benelux	-0.691*	(0.024)
$\ln Y_{it}^{manuf}$	0.832**	(0.000)
$\ln Y_{world,t}^{manuf}$	1.0**	(0.000)
Pair belongs to a regional trade agreement	0.822**	(0.000)
Colonizer-colonized relationship	0.242	(0.229)
Countries are colonies of same country	-0.555	(0.6)
Country pair transitioning from colonialism	-0.306	(0.258)
Countries were colonies of same country	0.465**	(0.000)
Countries are contiguous	0.619**	(0.000)
Pair share a common language	0.333**	(0.000)
Number of observations	277684	
Number of pairs	24356	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 2.10: Estimation results : Agricultural trade with tariffs, 1988-2010
Dependent variable is the level of exports.

Variable	**PPML**	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
East Caribbean Currency Union	-3.959	(0.119)
West African Economic & Monetary Union	1.329	(0.262)
Central African Economic & Monetary Union	-32.179	(0.278)
Rand zone (South Africa)	-1.212†	(0.098)
Dollarized zone	0.487	(0.158)
India-Bhutan	-2.937	(0.148)
Log of tariffs on agricultural goods	-0.122**	(0.000)
Eccu $\times \ln \text{tariffs}_{ijt}$	1.937**	(0.004)
Waemu $\times \ln \text{tariffs}_{ijt}$	-0.186	(0.685)
Cemac $\times \ln \text{tariffs}_{ijt}$	9.337	(0.285)
USA $\times \ln \text{tariffs}_{ijt}$	0.076	(0.609)
India-Bhutan $\times \ln \text{tariffs}_{ijt}$	1.909**	(0.004)
$\ln Y_{it}^{ag}$	0.272**	(0.000)
$\ln Y_{world,t}^{ag}$	0.719**	(0.000)
Pair belongs to a regional trade agreement	0.169	(0.161)
Colonizer Variant	0.951**	(0.000)
Transitional colonial relationship	-1.216**	(0.000)
Former subjects of a colonial empire	0.435**	(0.000)
Countries are contiguous	0.14	(0.286)
Pair share a common language	-0.305*	(0.024)
$\ln \sigma_{tariff}$	0.196**	(0.000)
Number of observations	31308	
Number of pairs	6646	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 2.11: Estimation results : Manufacturing trade with tariffs, 1988-2010
Dependent variable is the level of exports.

Variable	PPML	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
East Caribbean Currency Union	4.024**	(0.008)
West African Economic & Monetary Union	4.562	(0.105)
Central African Economic & Monetary Union	8.167*	(0.034)
Rand zone (South Africa)	-0.822	(0.15)
Australia zone	5.551**	(0.000)
Dollarized zone	0.73	(0.33)
India-Bhutan	-2.929*	(0.036)
Log of tariffs on manufactured goods	-0.03	(0.582)
Eccu $\times \ln \text{tariffs}_{ijt}$	0.106	(0.814)
Waemu $\times \ln \text{tariffs}_{ijt}$	-0.523	(0.653)
Cemac $\times \ln \text{tariffs}_{ijt}$	-1.52	(0.216)
South Africa $\times \ln \text{tariffs}_{ijt}$	0.729**	(0.000)
Australia $\times \ln \text{tariffs}_{ijt}$	2.197**	(0.000)
USA $\times \ln \text{tariffs}_{ijt}$	-0.832*	(0.023)
India-Bhutan $\times \ln \text{tariffs}_{ijt}$	2.61**	(0.000)
$\ln Y_{it}^{manuf}$	0.772**	(0.000)
$\ln Y_{world,t}^{manuf}$	0.911**	(0.000)
Pair belongs to a regional trade agreement	0.946**	(0.000)
Colonizer Variant	-0.13	(0.664)
Transitional colonial relationship	-1.845*	(0.011)
Former subjects of a colonial empire	0.562**	(0.000)
Countries are contiguous	0.87**	(0.000)
Pair share a common language	0.302**	(0.000)
$\ln \sigma_{tariff}$	0.121*	(0.01)
Number of observations	64799	
Number of pairs	13362	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 2.12: Average tariffs on manufacturing industries for currency unions, 1988-2011 (standard deviations in parentheses)

Currency Union	Industries 15-19	Industries 20-37
Cemac	28.49	18.3
	(5.47)	(2.47)
Eccu	21.96	14.36
	(1.88)	(2.96)
India-Bhutan	42.25	27.2
	(15.53)	(18.61)
South Africa	19.48	9.95
	(2.84)	(4.36)
USA	12.13	7.4
	(2.14)	(3.2)
Waemu	18.91	13.38
	(2.54)	(1.48)

Table 2.13: Estimation results : ISIC 15-19 trade, 1977-2010
Dependent variable is the log of exports.

Variable	OLS	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
Countries share a common currency	0.388	(0.000)**
$\ln Y^{15-19}_{world,t}$	0.047	(0.000)**
Countries are contiguous	0.39	(0.000)**
Shared common or official language	0.391	(0.000)**
Pair belongs to a Regional Trade Accord	0.299	(0.000)**
Colonizer-colonized relationship	0.925	(0.000)**
Countries are colonies of same country	0.819	(0.074)†
Country pair transitioning from colonialism	0.312	(0.001)**
Countries were colonies of same country	0.453	(0.000)**

Number of observations	190027	
R^2	0.7	
Number of pairs	17166	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 2.14: Estimation results : ISIC 15-19 trade, 1977-2010
Dependent variable is the level of exports.

Variable	PPML	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
Countries share a common currency	-0.038	(0.582)
$\ln Y_{world,t}^{15-19}$	0.075	$(0.009)^{**}$
Countries are contiguous	0.662	$(0.000)^{**}$
Shared common or official language	0.667	$(0.000)^{**}$
Pair belongs to a Regional Trade Accord	1.021	$(0.000)^{**}$
Colonizer-colonized relationship	0.697	$(0.000)^{**}$
Countries are colonies of same country	-1.391	$(0.086)^{\dagger}$
Country pair transitioning from colonialism	-1.107	$(0.001)^{**}$
Countries were colonies of same country	0.406	$(0.009)^{**}$
Number of observations	192017	
Number of pairs	17413	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 2.15: Estimation results : ISIC 20-37 trade, 1966-2010
Dependent variable is the log of exports.

Variable	OLS	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
Countries share a common currency	0.521	(0.000)**
$\ln Y^{20-37}_{world,t}$	0.237	(0.000)**
Countries are contiguous	0.277	(0.000)**
Shared common or official language	0.358	(0.000)**
Pair belongs to a Regional Trade Accord	0.192	(0.000)**
Colonizer-colonized relationship	0.745	(0.000)**
Countries are colonies of same country	0.483	(0.063)†
Country pair transitioning from colonialism	0.157	(0.073)†
Countries were colonies of same country	0.381	(0.000)**
Number of observations	210898	
R^2	0.758	
Number of pairs	18759	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 2.16: Estimation results : ISIC 20-37 trade, 1966-2010
Dependent variable is the level of exports.

Variable	PPML	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
Countries share a common currency	-0.1	(0.192)
$\ln Y_{world,t}^{15-19}$	0.523	$(0.000)^{**}$
Countries are contiguous	0.644	$(0.000)^{**}$
Shared common or official language	0.418	$(0.000)^{**}$
Pair belongs to a Regional Trade Accord	0.878	$(0.000)^{**}$
Colonizer-colonized relationship	0.209	(0.000)
Countries are colonies of same country	-1.645	$(0.000)^{**}$
Country pair transitioning from colonialism	-0.125	(0.626)
Countries were colonies of same country	0.32	$(0.024)^{*}$
Number of observations	213661	
Number of pairs	19123	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 2.17: Estimation results : ISIC 15-19 trade, 1977-2010
Dependent variable is the level of exports.

Variable	PPML	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
East Caribbean Currency Union	3.135**	(0.000)
West African Economic & Monetary Union	1.266*	(0.018)
Central African Economic & Monetary Union	2.913**	(0.001)
Australia zone	2.273*	(0.012)
Dollarized zone	0.632†	(0.089)
Eurozone	-0.056	(0.422)
Krone zone (denmark)	5.618**	(0.000)
India-Bhutan	4.986**	(0.000)
benelux	-1.204**	(0.000)
$\ln Y_{world,t}^{15-19}$	0.075**	(0.009)
Countries are contiguous	0.666**	(0.000)
Pair share a common language	0.664**	(0.000)
Pair belongs to a regional trade agreement	1.016**	(0.000)
Colonizer Variant	0.772**	(0.000)
Common colonizer	-1.289	(0.14)
Transitional colonial relationship	-1.095**	(0.001)
Former subjects of a colonial empire	0.413**	(0.008)
Number of observations	192017	
Number of pairs	17413	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 2.18: Estimation results : ISIC 20-37 trade, 1966-2010
Dependent variable is the level of exports.

Variable	PPML	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
East Caribbean Currency Union	5.101**	(0.000)
West African Economic & Monetary Union	3.766**	(0.000)
Central African Economic & Monetary Union	3.218**	(0.000)
Australia zone	2.368**	(0.000)
Dollarized zone	-2.064**	(0.000)
Eurozone	-0.04	(0.635)
Krone zone (denmark)	6.732**	(0.000)
India-Bhutan	4.101**	(0.000)
benelux	-0.578†	(0.083)
$\ln Y_{world,t}^{20-37}$	0.695**	(0.000)
Countries are contiguous	0.623**	(0.000)
Pair share a common language	0.405**	(0.000)
Pair belongs to a regional trade agreement	0.835**	(0.000)
Colonizer Variant	0.226	(0.274)
Common colonizer	-1.864**	(0.000)
Transitional colonial relationship	-0.148	(0.553)
Former subjects of a colonial empire	0.302*	(0.032)
Number of observations	213661	
Number of pairs	19123	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 2.19: Estimation results : ISIC 15-19 trade with tariffs, 1988-2010
Dependent variable is the level of exports.

Variable	PPML	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
East Caribbean Currency Union	22.768**	(0.004)
West African Economic & Monetary Union	4.823	(0.177)
Central African Economic & Monetary Union	-24.891	(0.37)
Dollarized zone	2.289**	(0.000)
India-Bhutan	19.644	(0.368)
Log of tariffs	0.305**	(0.000)
Eccu $\times \ln \text{tariffs}_{ijt}$	-5.739*	(0.012)
Waemu $\times \ln \text{tariffs}_{ijt}$	-1.051	(0.411)
Cemac $\times \ln \text{tariffs}_{ijt}$	8.629	(0.3)
USA $\times \ln \text{tariffs}_{ijt}$	-0.72*	(0.04)
India-Bhutan $\times \ln \text{tariffs}_{ijt}$	-2.985	(0.602)
$\ln \sigma_{tariff}$	0.282**	(0.000)
$\ln Y^{15-19}_{world,t}$	-0.099	(0.196)
Countries are contiguous	0.864**	(0.000)
Pair share a common language	0.493**	(0.008)
Pair belongs to a regional trade agreement	1.008**	(0.000)
Colonizer Variant	0.17	(0.676)
Transitional colonial relationship	0.191	(0.815)
Former subjects of a colonial empire	0.797**	(0.000)
Number of observations	38445	
Number of pairs	8571	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

Table 2.20: Estimation results : ISIC 20-37 trade with tariffs, 1988-2010
Dependent variable is the level of exports.

Variable	PPML	
	$-\frac{\hat{\beta}_x}{\hat{\beta}_{\ln distance}}$	p-value
East Caribbean Currency Union	-4.197	(0.406)
West African Economic & Monetary Union	6.597*	(0.046)
Central African Economic & Monetary Union	4.973	(0.379)
Australia zone	-12.921**	(0.000)
Dollarized zone	0.697	(0.455)
India-Bhutan	-31.709	(0.239)
Log of tariffs	-0.218**	(0.002)
Eccu $\times \ln \text{tariffs}_{ijt}$	3.052	(0.11)
Waemu $\times \ln \text{tariffs}_{ijt}$	-1.405	(0.411)
Cemac $\times \ln \text{tariffs}_{ijt}$	-0.146	(0.938)
USA $\times \ln \text{tariffs}_{ijt}$	-1.059**	(0.003)
India-Bhutan $\times \ln \text{tariffs}_{ijt}$	13.618	(0.175)
$\ln \sigma_{tariff}$	0.126	(0.118)
$\ln Y^{20-37}_{world,t}$	0.561**	(0.000)
Countries are contiguous	0.961**	(0.000)
Pair share a common language	0.359**	(0.000)
Pair belongs to a regional trade agreement	1.022**	(0.000)
Colonizer Variant	-0.139	(0.623)
Transitional colonial relationship	-0.615	(0.123)
Former subjects of a colonial empire	0.374**	(0.004)
Number of observations	46457	
Number of pairs	10571	

P-values in parentheses are calculated from robust standard errors clustered on exporter-importer pair.
Time-varying country effects are not reported.

3.0 PRICE CO-MOVEMENTS WITHIN CURRENCY UNIONS

3.1 INTRODUCTION

Trade flows within a currency union have long been used to gauge the extent to which countries within that currency union are integrated.[1] However, Santos Silva and Tenreyro (2010) have suggested considering a wider range of criteria by which to characterize currency union formation and operation. One such criterion suggested by Cecchetti et al. (2002) and others for characterizing the emergence of the newest and largest currency union, the European Monetary Union (Eurozone), is the co-movement of aggregate price levels. Such co-movements would suggest the existence of a well-defined and unified market within the Eurozone, a hallmark of an integrated economy. In such an economy, price disturbances within one country more easily manifest themselves in another currency union member country than in a country outside the union, owing to a common currency and monetary policy operating throughout the currency area. The goal of this chapter is to investigate, for all currency unions, the extent to which the price index prevailing within a member country of a currency union co-moves with and can influence the price index of a fellow member of the same currency and to conduct this investigation.

Examining price co-movements as a measure of integration emerges easily from considering trade flows as a measure of integration. The previous chapters in this dissertation have shown that the extent of trade integration within a currency union varies across the set of unions, depends largely on the tariff structure operating within the currency union countries, and is greater for manufacturing goods than for agricultural goods. More opportunities for trade should permit more opportunities for low-cost producers in one currency union mem-

[1]See Rose (2000) and Glick and Rose (2002)

ber country to sell into relatively-higher cost producers, leading to greater trade. Thus, any beneficial price shocks to one country in a currency union that is well-integrated through trade should easily manifest themselves throughout the entire currency union.

This paper shows that the price levels within some currency unions are little cointegrated, suggesting that price levels are drifting apart over time. This result poses problems for the maintenance of the fixed exchange rate over time, given Purchasing Power Parity theory (PPP). At the same time, the aggregate price shocks of one country in a currency union are more important than are the price shocks of a country outside the currency union on any given country within the same currency union. Consequently, the currency union countries exhibit features of a well-integrated economy. However, as the previous chapters in this dissertation have noted, the extent of this integration differs tremendously across the set of unions. Therefore, the finding of currency unions with little cointegration may be unsurprising. It is surprising, however, that the currency unions appearing to lack a robust degree of cointegration should include the entire Eurozone as well as long-standing, anchor-client relationships such as Australia-Tonga, India-Bhutan, or Singapore-Brunei.

The prospect of a single European market prompted research that investigates inflation patterns across areas using a similar currency, often using American price behavior at the city or state level to provide a benchmark against which to compare the emergence of an integrated market within the Eurozone. Cecchetti et al. (2002) conduct unit root tests on regional CPIs within the U.S in order to envision "the likely nature of inflation convergence in the Euro area," (p. 1081). The authors find that the half-life of a price shock within the U.S. is approximately nine years, a surprisingly large amount of time for an economy thought to be as well-integrated as the United States. Canova and Pappa (2007) look at the dynamics of price indices in response to fiscal shocks in American states and European countries in order to obtain a benchmark standard of what constitutes integration. Rogers (2007) examines the dispersion of individual goods' prices as well as of price indices. Comparing the dispersion of prices in European cities with the dispersion of prices in American cities, the paper concludes that the preparations for the Euro reduced price dispersion, that dispersion has not decreased since 1998, and that price dispersion is still larger in the Eurozone than in the U.S. Faber and Stokman (2009) find slightly greater integration than does Rogers (2007) for both tradable and non-tradable goods.

The justification for using inflation patterns within the US to forecast, in a very general sense, the nature of inflation convergence in the Eurozone, arises from the US being "a mature common currency area of similar regional diversity, size, and industrial development," (Cecchetti et al. (2002), p. 1081). A similar examination using the other currency unions operating in the world as a benchmark also provides a useful comparison. Like the Eurozone countries, the member nations of other currency unions are sovereign states that retain fiscal autonomy to a large extent. Therefore, examining movements of price indices within a currency union and comparing those movements for all currency unions (Eurozone and others) provides an instructive lesson regarding price level convergence over an area using the same currency but consisting of multiple countries.

Surprisingly, no work has yet undertaken this task, or even examined carefully the pattern of price movements among the countries constituting a single currency union other than the Eurozone. Abdih and Tsangarides (2010) follow a methodology similar to methodology used in Berkowitz et al. (1998) and in this chapter in order to examine the two CFA zones (Cemac and Waemu), but at a union-wide level rather than for individual countries.

The organization of this paper is as follows. Section 3.2 describes the methodology and data used in this paper. Section 3.3 shows results when looking at the countries within a currency union, one union at a time. Section 3.4 looks at individual pairs of countries where the pair may contain two, one, or no countries inside a currency union, in order to see if the countries within a union have more in common with each other than do they with countries outside the union.

3.2 METHODOLOGY & DATA

The contribution of this chapter is to provide a single framework using PPP as a criterion to gauge the extent of integration within a currency union and to compare and contrast currency unions on this criterion. PPP is a long-standing theory that explains the long-run value of the nominal exchange rate between two countries by linking the exchange rate to the relative prices of goods in both countries (see Cassel (2010) and Mark (2001), for example). More precisely, the long-run value of the exchange rate is determined by the relative prices of goods in the two countries in question. In the context of fixed exchange rates, such as those that exist between two members of a currency union, PPP implies that the real exchange rate should possess a constant, long-run mean. Aboslute PPP in a currency union directly implies that the ratio of price levels equals the nominal exchange rate, 1, which is also the real exchange rate. Relative PPP permits the real exchange rate to be a number other than 1. In either case, PPP and fixed, stable, nominal exchange rates imply a constant real exchange rate over time.

When testing for PPP, price indices, such as a CPI, are commonly used instead of prices for a basket of goods (see Kim (1990), Lothian and Taylor (1996), and Coakley et al. (2005), for example). As a stylized fact, price indices are non-stationary (see Engel and West (2005)), a characteristic that undermines the likelihood that PPP will hold, as an arbitrary combination of two, non-stationary random variables is unlikely to be stationary. However, if there exists a particular linear combination of the price indices, the cointegrating vector, that is stationary, then PPP can hold (see Enders (1995)). The coefficients of the linear combination constitute the cointegrating vector. If Absolute PPP holds, all elements of the cointegrating vector are 1. Any other cointegrating vector implies the presence of Relative PPP. Therefore, testing the CPIs of the member countries of a currency union for cointegration provides a direct way to test for PPP. The presence of cointegration implies that PPP holds for a currency union. Yet, cointegration tests generally suffer from low power. Consequently, the inability to reject a null of no cointegration (which is to say, PPP does not hold) does not mean necessarily that there exists no stationary combination of the variables in question. For the cointegration tests, I use the `vecrank` command in Stata to implement the trace statistic test proposed by Johansen (1995). I conclude that there exists v cointegrating vectors if the trace statistic computed for v fails to exceed the critical value at 95% level of confidence.

Studying the extent to which PPP holds within a currency union requires as long of a panel of price data as is possible. However, there exists a tradeoff between length of data for a particular country and the number of countries in a given currency union for which data are available. This problem is exacerbated by entries and exits into currency unions, further reducing the time-span for which data for all countries might be available. Consequently, I perform multiple cointegration tests for each currency union, changing the composition of the countries included and the time period examined. First, I test for cointegration on the entire dataset available. For each subsequent cointegration test, I drop one country at a time, the country with the fewest number of observations, so as to check the sensitivity of the results and to obtain a longer sample period of data. The longer sample period should improve the power of the test, facilitating a rejection of the null hypothesis of no cointegration. I also use CPI data measured at quarterly frequencies and published by the IMF's International Financial Statistics. Using data measured at quarterly frequencies, as opposed to yearly frequencies, improves the power of the test by increasing the number of observations. However, the higher-frequency data are more susceptible to random shocks that may drive the price levels apart from the long-run ratio that supports PPP.

3.3 CURRENCY UNION-WIDE INVESTIGATION

This section reports results from cointegration tests for the log of the CPI for member countries within a currency union. The results are reported in tables 3.1 through 3.7. A blank entry in a column means that the country is not included in the test over the time-period specified by the column.

Most currency unions possess a cointegrating vector, though the results are sensitive to the composition of countries and time frame examined. Among the smaller unions described in table 3.1, none exhibit cointegrating relationships. The time span for which data are available may be small, particularly for India-Bhutan and Brunei-Singapore. Given that cointegration is a long-run property, the absence of cointegration for the India-Bhutan and for Singapore-Brunei may be a consequence of a small sample size. However, both of those unions have operated for several decades, during which price levels should have adjusted and converged to overcome any long-run disturbances, demonstrating the presence of PPP. Therefore, it is surprising that the price disturbances in each union are sufficient to prevent the rejection of the null of no cointegration even when examined with a short span of recent data.

The Rand zone, described in table 3.2, also shows few instances of cointegration, even when looking just at South Africa and Swaziland with over 40 years of data. Intriguingly, a cointegrating vector exists only during the time when Namibia adhered to this union, suggesting that Namibia, not the anchor nation of South Africa, plays a key role in the stability of the Rand zone's fixed exchange rate.

The Cemac, results for which are in table 3.3 has 3 cointegrating relationships. However, this result seems sensitive to the inclusion of a relatively new member of that union, Equatorial Guinea. Including Equatorial Guinea and using data from 1985Q3 to 2012Q1, the Johansen test finds at most 3 cointegrating vectors. Dropping Equatorial Guinea and using data from a nearly identical time span, the test indicates only 2 cointegrating relationships. Furthermore, the nature of the cointegrating vector changes. For 1985Q3 to 2012Q1, Gabon receives a weight of zero and Chad receives a weight of 0.23. For 1984Q4 to 2012Q2, the weight for Gabon shoots up to 48.52 while that for Chad increases (in absolute value) to -33.85. Removing Chad but increasing the time span to 1981Q1 - 2012Q2 lowers the number of cointegrating vectors to 1 and reduces Gabon's weight to -2.01. Cameroon and Gabon, two long-standing member countries with a long series of data available, do not demonstrate cointegration in the log of their CPIs with the remaining members, as the coefficients on the cointegrating vectors are 0.

Using data for all available Eccu countries from 1998 forward, there are 2 cointegrating vectors for the set of six countries (see table 3.4). However, using data beginning in 1979 for four of those countries, there appears to be no cointegration. Yet, dropping St Kitts & Nevis and starting just a few years earlier in 1976, the trace statistic test suggests that there is a cointegrating vector.

The results for countries using the Euro (the Eurozone and *ad hoc* adopters such as Montenegro) are even more surprising. Using the entire set of Eurozone members, there are no cointegrating relationships. Even after removing recent or small adopters of the Euro, such as Montenegro, San Marino, and Slovenia, the number of cointegrating vectors is 0. Upon removing Greece (not one of the original member countries from 1999) from the sample, the trace statistic test indicates 7 cointegrating vectors. However, all of these vectors necessitate that several countries have coefficients equal to 0. For the vector reported in table 3.5, the countries with coefficients of zero include key, long-standing members of the European community (such as Belgium and France), other “mainstream” countries (such as Austria and Finland), and countries now seen at the periphery of the Eurozone (such as Ireland and Spain) owing to the recent Eurozone crisis. However, Portugal, also arguably a peripheral country, does not require a weight equal to 0, but merely 0.24 in order to achieve a stationary combination of price levels.

The Dollarized zone displays 2 cointegrating vectors for the full sample of countries (see table 3.6). However, after removing two recent dollarizers, Timor-Leste and El Salvador, the number of cointegrating relationships increases to 3. Yet, for these three vectors, Ecuador requires a weight of zero, suggesting that its price movements do not contribute to stable exchange rates within the currency union. Further reducing the number of countries but increasing the time span produces unexpected results. The three oldest countries using the dollar (the US, Panama, and the Bahamas), exhibit a cointegrating relationship. However, removing the Bahamas but extending the sample back to 1957 leads to no cointegrating vector.

For the Waemu, longer time periods correspond to fewer cointegrating relationships (see table 3.7). It is important to note that a 100% devaluation of the Franc CFA took place in 1994 (see Parmentier and Tenconi (1996)). This regime change suggests the necessity to check for PPP both before and after the devaluation. Seven countries from 1988-1994 exhibit 3 cointegrating vectors. However, the vectors require zero weights on Mali and Côte d'Ivoire, the latter being seen as a center of economic power in the union. PPP also holds prior to the devaluation, from 1970-1994. Yet, there is only 1 cointegrating vector over this period, where Mali and Côte d'Ivoire again receive low weights in absolute value. Consequently, the period after the devaluation may have been one where the exchange rate and price levels moved more in harmony with each other for maintaining the fixed exchange rate than did they in the era prior to the devaluation.

The results in this section suggest that PPP holds for the member countries of most currency unions. However, the results are sensitive to the composition of countries and the time-span examined. Furthermore, for PPP to hold, the weights assigned to member countries must often be 0. Consequently, the ability for PPP to hold depends limited to a proper subset of the countries within the union. To understand more clearly which countries contribute to or detract from the ability of PPP to hold, the next section will examine cointegration on a bilateral basis. Testing for cointegration on a pairwise basis isolates particular co-movement behavior at a disaggregated level. In particular, the next section will follow the methodology in Berkowitz et al. (1998) of conducting cointegration tests followed by Granger Causality tests. To understand if a given country has particular influence on the price movements of another country within the union, I conduct the Granger Causality tests on bilateral country pairs. If the country pair exhibits a cointegrating relationship, the Granger Causality test will be performed on levels of the data. If there is no cointegrating vector, the Causality test will be performed on first differences of the data. See Berkowitz et al. (1998) for more details.

3.4 BILATERAL INVESTIGATION

This section reports results from pairwise tests of cointegration and Granger Causality for the log of the CPI. Table 3.8 shows the share of country pairs within each currency union that exhibit cointegration of the log of the CPI. The first column of results examines currency union country pairs only over a timer period when both countries belong to the same union. The second column of results examines the country pair for a currency union for all available time periods, regardless of changes in union membership.

A few unions (Cemac, Waemu, Dollarized zone) exhibit a rate of pairwise cointegration that is higher than is the rate of cointegration found among countries not in a currency union. The Eccu has a noticeably smaller rate of cointegration. Apart from the Rand zone, the anchor-client unions (Australia, India-Bhutan, Singapore-Brunei) generally exhibit zero rates of cointegration. Surprisingly, the rate for the Eurozone is quite low. This result may be a consequence of the relatively short time-frame (13 years) for which the Euro has existed. As cointegration is a long-run phenomenon and as other unions have existed for decades, it may not be surprising to find such a low rate in the recently-formed Eurozone. When the time-frame is extended to include all years for which quarterly data are available, the rate for the Eurozone increases to the mid-30s, though is still lower than is the rate of cointegration for the Cemac.

The interpretation of the results in table 3.8 is surprising. In well-established unions, such as the Eccu and Waemu, fewer than half of the country pairs have price levels that move together. Lacking cointegration, the price levels of a pair of countries are non-stationary and do not follow a common stochastic process. In order for PPP to hold in even a relative sense and for the currency union to survive in the long run, the ratio of the price levels must have a constant long run mean. However, if there exist multiple pairs of countries within a currency union such that the ratio of price levels for each pair is not cointegrated, then the ratio of price levels is *not* constant over time. Such results suggest that the currency union cannot continue operating in its current form in the future, but is likely to dissolve.

The results from table 3.8 not only describe the nature of price movements within a currency union. They also inform how Granger Causality tests should be conducted. If the price levels are cointegrated for a given country pair, then the Granger Causality test for the price levels of that country pair should be conducted on the levels themselves. Lacking cointegration, the Causality test is performed on first differences of the price levels. Table 3.9 shows the results of the Granger Causality tests. Some unions, such as the Cemac, Dollarized zone, and Rand zone, have rates of cointegration similar to the rates of Granger Causality. For the Eccu, the Waemu, and the Eurozone, the rates of Granger Causality are much higher than are the rates of cointegration.

To understand the results in tables 3.8 and 3.9 more clearly, tables 3.10 and 3.11 partition the above results into two tables. Table 3.10 presents country pairs where there exists *any* price co-movement or inflation causality. The column entitled "Coefficient for country 2" gives the cointegrating vector's coefficient for country 2 when the coefficient for country 1 is normalized to 1. A $\longleftarrow$ indicates that inflation in the second country indicated in the pair Granger causes inflation in the first country indicated in the pair. A $\longrightarrow$ indicates that inflation in the first country indicated in the pair Granger causes inflation in the second country indicated in the pair. A $\longleftrightarrow$ indicates causality in both directions. Table 3.11

presents country pairs lacking any link between inflation levels.

In general, most of the cointegrating coefficients for country 2 in table 3.10 are negative. This result makes sense, given that the coefficients for country 1 are normalized to 1. Recall that the theory of Relative PPP indicates that the ratio of price levels between countries 1 and 2, $\frac{P_1}{P_2}$, should equal some constant, k. For Absolute PPP, $k = 1$. Expressed in logs, Relative PPP becomes $\ln P_1 - \ln P_2 = \ln k$. The cointegrating vector for these country pairs is some (π_1, π_2) such that $\pi_1 \ln P_1 + \pi_2 + lnP_2 = 0$. If Relative PPP holds, then $\pi_2 < 0$. This sign restriction holds for all cointegrated pairs, except for Ireland and Germany in the Eurozone.

In the Cemac, Cameroon is cointegrated with only one other country, Equatorial Guinea, while it lacks cointegration with all other countries. Since Equatorial Guinea is a relative newcomer to the Cemac, it seems odd that a long-standing member would not be cointegrated with other long-standing members but would be cointegrated with a country whose fundamentals would be the least expected to move in harmony with those of other Cemac members. Interestingly, 2 of the 4 time periods investigated in section 3.3 for the Cemac had cointegrating vectors where the coefficient on Cameroon was 0. Consequently, it seems that PPP does not hold for Cameroon and any other member of the Cemac. Despite Cameroon's lack of cointegration, Cameroon Granger causes price movements in most other Cemac countries except Gabon.

In the Eccu, there exist few instances of cointegration but many instances of bidirectional Granger Causality. A country pair that includes either Dominica or Anguilla never demonstrates cointegration. Recall from table 3.4 that the coefficient on Anguilla for the cointegrating vector is 0. St. Vincent and the Grenadines is cointegrated with only one other country, St. Kitts and Nevis, yet demonstrates bidirectional Granger Causality with all other countries except Anguilla. Thus, PPP appears not to hold for Anguilla, Dominica, and St. Vincent and the Grenadines.

As is the case with the Eccu, the Eurozone has few instances of cointegration. As is the case with the Cemac, those instances generally involve relatively new countries (Slovenia and Montenegro, the latter having adopted the Euro *ad hoc*). Even the Benelux countries whose economic integration pre-dates the earliest conception of the EU show few instances of Granger Causality or cointegration. The Belgian price level Granger causes the price level in Luxembourg, though the two are not cointegrated. Surprisingly, the price level in small Luxembourg Granger causes the price level in the relatively larger Netherlands. Table 3.11 shows that the Netherlands and Belgium are neither cointegrated nor demonstrate Granger Causality.

In the Dollarized zone, four of the six cointegrating relationships are between small countries. Only two involve the US and are with the Bahamas and Ecuador. Interestingly, price levels in Panama and the US are not cointegrated, though Granger causality exists between both countries. The US Granger causes price levels in other countries (Ecuador, El Salvador, and The Bahamas). The country pairs that lack any co-movement all include Timor-Leste. This result is not too surprising as Timor-Leste adopted the US dollar relatively recently (2000) and is outside the traditional sphere of US influence in Latin America.

For the Waemu, every country pair is either cointegrated or exhibits Granger causality, though instances of the latter outnumber instances of the former. Relatively large economies in the union, such as Sénégal and Côte d'Ivoire, tend not to be cointegrated with other countries, though the two afore-mentioned countries have bivariate Granger causality for the price level. The remaining and relatively smaller members such as Bénin, Mali, Guinea-Buissau, Niger, and Togo, account for most instances of cointegration.

Among smaller unions, the results are generally as expected regarding causality if not cointegration. Inflation rates in Singapore and Brunei are not cointegrated though Singapore does Granger cause inflation in Brunei. In the Rand zone, South African price levels Granger causes price levels in Swaziland and Namibia. This result is unsurprising, given South Africa's dominance as an anchor in the union. Australia and Tonga exhibit neither cointegration nor Granger Causality.

Could a currency union country be more likely to demonstrate price co-movements with a country outside the currency union? If currency unions are well-integrated economies, the answer should be "no." The next two tables address this possibility. Table 3.12 reproduces the results in table 3.8 but also includes the share of country pairs that exhibit cointegration in their price movements where exactly one member of the pair belongs to a particular currency union while the other member does not belong to that currency union.

For the anchor-client unions (Australia zone, Dollarized Zone, India-Bhutan, Rand zone, and Singapore-Brunei), I exclude pairs that contain the anchor and any country outside the union. As an example, Tonga is the only country in the Australia zone for which data exist. Consequently, table 3.12 indicates that there exists no cointegration between Australia and Tonga while 14.02% of country pairs consisting of Tonga and any country *other* than Australia demonstrate cointegration.

The results in table 3.12 indicate for most unions a higher frequency of cointegration between countries where exactly one country is in a currency union and one country is outside the union than between countries where both belong to the same currency union. The Cemac, Dollarized zone, Rand zone, and Waemu are exceptions. However, this result seems to be driven by anchor-client type unions consisting of only 2 countries. Excluding the Australia zone, India-Bhutan, and Singapore-Brunei which are (in this example) unions consisting only of two countries, just over half of the unions have higher incidence of cointegration between union members than between one union member and one non-union member. Therefore, price level movements for two countries within the same, multi-country currency union are more likely to resemble each other than are the rates of inflation for one country inside a currency union and one country outside the same currency union. However, the likelihood seems to be not noticeably greater.

Table 3.13 repeats the examination made in table 3.12 but using Granger Causality results. Here, Granger Causality between two countries within the same union occurs more frequently than does Granger Causality between one country in a currency union and one country outside a currency union. Only two unions, the Australia zone and India-Bhutan, are exceptions to this result. Rates of Causality within the Rand zone and outside the Rand zone are almost equal, with a slightly higher rate of incidence for Causality within the Rand zone. In general, the inflation rate of a country within a currency union tends to be more responsive to the inflation rate of another country within the same currency union than to the inflation rate of a country outside the currency union.

3.5 CONCLUSION

In order to understand better currency union operations, recent articles have suggested expanding the criteria for characterizing currency unions beyond the value of intraunion trade (Santos Silva and Tenreyro (2010)). As a specific example, Cecchetti et al. (2002) suggests comovements in price levels between the currency area's constituent members as a criterion for evaluating the extent of integration of a currency union. This paper provides a comprehensive assessment of all currency unions based on the inflation patterns of the members of a currency union. In general, the Granger Causality results suggest that a country within a currency union responds more to price shocks from another currency union member than to price shocks from a country outside the currency union.

However, other indicators of price level comovement cast doubt on the sustainability of the fixed exchange rates among members of the union. The cointegration results suggest that price levels within the currency union are drifting apart, undermining the ability for PPP to hold in the long run and, consequently, the stability of the union. Although price shocks may be transmitted more easily between two countries within the same currency union than between a union and non-union country (evidenced by the Granger Causality results), the nature of these shocks may be putting excessive, long run pressure on the stability of the fixed exchange rate (evidenced by PPP theory and the cointegration results).

For many unions, there appears to exist countries which are "odd man out" in the sense that they are rarely if ever cointegrated with any other country: Dominica and Anguilla in the Eccu; Cameroon in the Cemac; Timor-Lest in the Dollarized zone; Sénégal and Côte d'Ivoire for the Waemu. In fact, given that rates of cointegration between a currency union country and a non-member of the currency union are higher than are rates between two countries within the same currency union, it seems likely that new, alternative monetary unions could be formed where the inflation rates would move in a more commensurate manner.

3.6 TABLES

Table 3.1: Cointegrating vectors for smaller currency unions

Time-period	1976Q3 - 1990Q4	2003Q4 - 2012Q4	2000Q3 - 2012Q1
Countries	Australia	Bhutan	Brunei Darussalam
	Tonga	India	Singapore
# of cointegrating vectors	0	0	0

Table 3.2: Cointegrating vectors for the Rand zone

	1973Q3 - 1997Q1	2002Q3 - 2012Q4	1965Q3 - 2012Q4
Lesotho			
Namibia		1.0	
South Africa		-0.45	
Swaziland		-0.51	
# of cointegrating vectors	0	1	0

Table 3.3: Cointegrating vectors for the Cemac

	1998Q3 - 2012Q1	1985Q3 - 2012Q1	1984Q4 - 2012Q2	1981Q1 - 2012Q2	1968Q3 - 2012Q4
Cameroon	-0.91	0.00	0.00	0.51	
Central African Republic	1.00	1.00	1.00	1.00	
Chad	-0.24	0.23	-33.85		
Equatorial Guinea	0.12	-0.72			
Gabon	-0.98	0.00	48.52	-2.01	
Republic of the Congo	0.28				
# of cointegrating vectors	1	3	2	1	0

Table 3.4: Cointegrating vectors for the Eccu

	1998Q3 - 2012Q4	1980Q3 - 2012Q4	1979Q3 - 2012Q4	1976Q3 - 2012Q4	1975Q3 - 2012Q4
Anguilla	0.00				
Dominica	-0.51				
Grenada	1.00			1.00	
St. Kitts & Nevis	-0.25				
St. Lucia	-0.19			-0.29	
St. Vincent & the Grenadines	-0.14			-0.57	
# of cointegrating vectors	2	0	0	1	0

Table 3.5: Cointegrating vectors for the Emu

	2007Q3 - 2012Q1	2005Q3 - 2012Q1	2003Q3 - 2012Q4	2001Q3 - 2013Q1	1999Q3 - 2013Q1
Austria					0.00
Belgium					0.00
Finland					0.00
France					0.00
Germany					1.00
Greece					
Ireland					0.00
Italy					0.97
Luxembourg					-0.69
Montenegro					
Netherlands					-1.29
Portugal					0.24
San Marino					
Slovenia					
Spain					0.00
# of cointegrating vectors	0	0	0	0	7

Table 3.6: Cointegrating vectors for the Dollarized zone

	2002Q3 - 2012Q3	2001Q3 - 2012Q3	2000Q3 - 2012Q3	1973Q3 - 2012Q3	1957Q3 - 2013Q1
The Bahamas	2.79	-0.41	-0.69	-2.03	
Ecuador	0.00	0.00	0.00		
Panama	0.84	-0.03	0.00	-0.41	
El Salvador	-2.32	-0.17			
Timor-Leste	-0.86				
United States	1.00	1.00	1.00	1.00	
# of cointegrating vectors	2	2	3	1	0

Table 3.7: Cointegrating vectors for the Waemu zone

	1997Q3 - 2012Q4	1988Q1 - 1994Q4	1970Q3 - 1994Q4	1988Q1 - 2012Q4	1968Q3 - 2012Q4
Bénin	0.00				
Burkina Faso	1.00	1.00	1.00	1.00	1.00
Côte d'Ivoire	-0.58	0.00	0.1	-0.86	-0.49
Guinea-Bissau	1.12				
Mali	-2.7	0.00	-0.47	-1.47	
Niger	-0.61	0.16	0.09	-0.05	-0.23
Sénégal	1.95	-1.15	0.14	1.66	-0.09
Togo		0.19	-0.48		
# of cointegrating vectors	2	3	1	1	1

Table 3.8: Share of country pairs exhibiting cointegration in ln CPI

Currency Union	Only during CU membership	Over entire length of sample
Australia zone	0.00	100.00
Cemac	58.82	64.71
Dollaried zone	40.0	20.0
Eccu	23.53	25.00
Eurozone	7.62	37.14
India-Bhutan	0.00	0.00
Rand zone	33.33	33.33
Singapore-Brunei	0.00	0.00
Waemu	46.43	35.71
Pair not in a currency union	33.91	34.01

Table 3.9: Share of country pairs exhibiting Granger Causality in ln CPI

Currency Union	Only during CU membership	Over entire length of sample
Australia zone	0.00	50.00
Cemac	55.88	61.76
Dollaried zone	36.67	33.33
Eccu	52.94	62.5
Eurozone	37.62	57.62
India-Bhutan	0.00	0.00
Rand zone	25.00	25.00
Singapore-Brunei	50.00	50.00
Waemu	71.43	62.5
Pair not in a currency union	33.79	33.98

Table 3.10: Cointegration and Granger Causality results

Currency Union	**Country Pair (country 1 & country 2)**	**Cointegrated**	**Coefficient for country 2**	**Granger Causality***
CEMAC	Gabon - Chad	Yes	-0.628	$\longrightarrow$
CEMAC	Congo, Rep. - Cameroon	No		$\longleftarrow$
CEMAC	Central African Republic - Cameroon	No		$\longleftarrow$
CEMAC	Gabon - Congo, Rep.	Yes	-0.577	$\longleftrightarrow$
CEMAC	Congo, Rep. - Chad	Yes	-1.313	$\longleftrightarrow$
CEMAC	Congo, Rep. - Central African Republic	Yes	-1.064	$\longleftarrow$
CEMAC	Equatorial Guinea - Cameroon	Yes	-1.659	$\longleftarrow$
CEMAC	Gabon - Central African Republic	Yes	-0.801	$\longleftrightarrow$
CEMAC	Equatorial Guinea - Chad	Yes	-1.549	$\longleftrightarrow$
CEMAC	Gabon - Cameroon	No		$\longrightarrow$
CEMAC	Chad - Cameroon	Yes	-1.087	$\longleftarrow$
CEMAC	Gabon - Equatorial Guinea	Yes	-0.418	$\longleftarrow$
CEMAC	Equatorial Guinea - Central African Republic	Yes	-1.806	$\longleftrightarrow$
CEMAC	Chad - Central African Republic	No		$\longrightarrow$
ECCU	St. Vincent and the Grenadines - Grenada	Yes	-1.146	$\longleftrightarrow$
ECCU	Dominica - Anguilla	No		$\longleftarrow$
ECCU	St. Vincent and the Grenadines - Dominica	No		$\longleftrightarrow$
ECCU	St. Lucia - Grenada	Yes	-1.281	$\longrightarrow$
ECCU	Grenada - Dominica	No		$\longrightarrow$
ECCU	St. Vincent and the Grenadines - Anguilla	No		$\longrightarrow$
ECCU	St. Kitts and Nevis - Anguilla	No		$\longrightarrow$
ECCU	St. Lucia - St. Kitts and Nevis	No		$\longleftrightarrow$
ECCU	St. Vincent and the Grenadines - St. Lucia	No		$\longleftrightarrow$
ECCU	St. Lucia - Dominica	No		$\longleftarrow$
ECCU	St. Vincent and the Grenadines - St. Kitts and Nevis	Yes	-0.786	$\longleftrightarrow$
ECCU	St. Kitts and Nevis - Grenada	Yes	-1.293	$\longleftrightarrow$

* The arrow's direction indicates which country's price level Granger causes the other country's price level. $\longleftrightarrow$ indicates bicausality.

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Table 3.10 – continued from previous page

Currency Union	**Country Pair (country 1 & country 2)**	**Cointegrated**	**Coefficient for country 2**	**Granger Causality***
EMU	Slovenia - France	Yes	-1.145	⟷
EMU	Ireland - Belgium	No		⟵
EMU	San Marino - Finland	No		⟶
EMU	Portugal - Belgium	No		⟵
EMU	San Marino - Italy	No		⟶
EMU	Ireland - Greece	No		⟵
EMU	Greece - Germany	No		⟷
EMU	Spain - Greece	No		⟷
EMU	France - Belgium	No		⟵
EMU	Ireland - Germany	Yes	0.589	⟵
EMU	Luxembourg - France	No		⟶
EMU	Montenegro - Ireland	Yes	-3.327	None
EMU	Slovenia - Luxembourg	Yes	-0.753	⟵
EMU	San Marino - Netherlands	No		⟶
EMU	Spain - Netherlands	No		⟷
EMU	Netherlands - Germany	No		⟶
EMU	Spain - Germany	No		⟵
EMU	Italy - France	No		⟶
EMU	Portugal - Netherlands	No		⟷
EMU	Netherlands - Italy	No		⟶
EMU	Luxembourg - Germany	No		⟷
EMU	Slovenia - Netherlands	Yes	-0.881	None
EMU	Slovenia - Italy	Yes	-0.823	⟵
EMU	Portugal - Italy	No		⟵
EMU	Italy - Austria	No		⟶
EMU	Netherlands - Luxembourg	No		⟵
EMU	Netherlands - Finland	No		⟶

* The arrow's direction indicates which country's price level Granger causes the other country's price level. ⟷ indicates bicausality.

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Table 3.10 – continued from previous page

Currency Union	Country Pair (country 1 & country 2)	Cointegrated	Coefficient for country 2	Granger Causality*
EMU	Greece - Belgium	No		$\longleftarrow$
EMU	Luxembourg - Finland	No		$\longrightarrow$
EMU	Spain - San Marino	No		$\longleftarrow$
EMU	San Marino - Portugal	No		$\longrightarrow$
EMU	Spain - Portugal	No		$\longrightarrow$
EMU	Germany - France	No		$\longleftrightarrow$
EMU	San Marino - Greece	No		$\longrightarrow$
EMU	Spain - Italy	No		$\longleftarrow$
EMU	Greece - Finland	No		$\longleftarrow$
EMU	Belgium - Austria	No		$\longrightarrow$
EMU	Netherlands - Austria	No		$\longrightarrow$
EMU	Germany - Finland	No		$\longleftarrow$
EMU	Portugal - Greece	No		$\longleftarrow$
EMU	Slovenia - Greece	No		$\longleftarrow$
EMU	Spain - Belgium	No		$\longleftarrow$
EMU	Spain - Ireland	No		$\longleftarrow$
EMU	Germany - Austria	No		$\longrightarrow$
EMU	Italy - Ireland	No		$\longrightarrow$
EMU	Slovenia - Germany	No		$\longleftarrow$
EMU	Portugal - Germany	No		$\longleftrightarrow$
EMU	Netherlands - Greece	No		$\longleftrightarrow$
EMU	Slovenia - Montenegro	Yes	-0.853	None
EMU	Spain - Austria	No		$\longleftrightarrow$
EMU	Italy - Greece	No		$\longrightarrow$
EMU	San Marino - Luxembourg	No		$\longrightarrow$
EMU	San Marino - France	No		$\longrightarrow$
EMU	Luxembourg - Greece	No		$\longleftarrow$

* The arrow's direction indicates which country's price level Granger causes the other country's price level. $\longleftrightarrow$ indicates bicausality.

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Table 3.10 – continued from previous page

Currency Union	Country Pair (country 1 & country 2)	Cointegrated	Coefficient for country 2	Granger Causality*
EMU	Italy - Germany	No		$\longrightarrow$
EMU	Finland - Austria	No		$\longrightarrow$
EMU	Montenegro - Germany	No		$\longrightarrow$
EMU	Netherlands - Ireland	No		$\longleftarrow$
EMU	Portugal - Finland	No		$\longleftarrow$
EMU	Spain - France	No		$\longleftrightarrow$
EMU	San Marino - Ireland	No		$\longrightarrow$
EMU	Spain - Slovenia	No		$\longrightarrow$
EMU	Luxembourg - Belgium	No		$\longleftarrow$
EMU	Ireland - Finland	No		$\longrightarrow$
EMU	Slovenia - Belgium	Yes	-0.735	$\longleftarrow$
EMU	Montenegro - Belgium	No		$\longrightarrow$
EMU	Luxembourg - Italy	No		$\longleftarrow$
EMU	Spain - Finland	No		$\longleftarrow$
EMU	Greece - France	No		$\longrightarrow$
EMU	Slovenia - San Marino	No		$\longleftrightarrow$
	Singapore - Brunei Darussalam	No		$\longrightarrow$
SOUTH AFRICA	Swaziland - Namibia	Yes	-1.117	$\longrightarrow$
SOUTH AFRICA	South Africa - Namibia	Yes	-0.964	$\longrightarrow$
SOUTH AFRICA	Swaziland - South Africa	No		$\longleftarrow$
USA	Panama - Bahamas, The	Yes	-1.94	$\longrightarrow$
USA	El Salvador - Ecuador	No		$\longleftarrow$
USA	El Salvador - Bahamas, The	No		$\longleftarrow$
USA	Ecuador - Bahamas, The	Yes	-1.725	$\longleftarrow$
USA	United States - Ecuador	Yes	-0.629	$\longrightarrow$
USA	United States - Panama	No		$\longleftrightarrow$
USA	Panama - El Salvador	Yes	-4.547	$\longrightarrow$

* The arrow's direction indicates which country's price level Granger causes the other country's price level. $\longleftrightarrow$ indicates bicausality.

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Table 3.10 – continued from previous page

Currency Union	**Country Pair (country 1 & country 2)**	**Cointegrated**	**Coefficient for country 2**	**Granger Causality***
USA	United States - El Salvador	No		$\longrightarrow$
USA	Panama - Ecuador	Yes	-0.982	$\longrightarrow$
USA	United States - Bahamas, The	Yes	-1.466	$\longrightarrow$
WAEMU	Togo - Senegal	No		$\longleftrightarrow$
WAEMU	Senegal - Guinea-Bissau	Yes	-0.744	$\longleftrightarrow$
WAEMU	Guinea-Bissau - Côte d'Ivoire	Yes	-0.963	$\longleftarrow$
WAEMU	Niger - Côte d'Ivoire	No		$\longleftarrow$
WAEMU	Mali - Guinea-Bissau	Yes	-0.885	$\longleftrightarrow$
WAEMU	Mali - Benin	No		$\longleftarrow$
WAEMU	Togo - Benin	Yes	-0.824	$\longleftarrow$
WAEMU	Togo - Niger	No		$\longleftrightarrow$
WAEMU	Togo - Burkina Faso	No		$\longrightarrow$
WAEMU	Senegal - Niger	No		$\longleftarrow$
WAEMU	Guinea-Bissau - Benin	Yes	-0.868	$\longleftarrow$
WAEMU	Senegal - Mali	Yes	-0.968	$\longleftrightarrow$
WAEMU	Niger - Guinea-Bissau	Yes	-0.991	$\longrightarrow$
WAEMU	Côte d'Ivoire - Benin	No		$\longleftarrow$
WAEMU	Mali - Côte d'Ivoire	No		$\longleftrightarrow$
WAEMU	Niger - Mali	Yes	-1.133	$\longrightarrow$
WAEMU	Togo - Côte d'Ivoire	No		$\longrightarrow$
WAEMU	Mali - Burkina Faso	No		$\longleftrightarrow$
WAEMU	Niger - Benin	No		$\longleftarrow$
WAEMU	Niger - Burkina Faso	No		$\longleftarrow$
WAEMU	Senegal - Benin	No		$\longleftarrow$
WAEMU	Togo - Mali	Yes	-1.144	$\longleftrightarrow$
WAEMU	Senegal - Burkina Faso	No		$\longleftrightarrow$
WAEMU	Côte d'Ivoire - Burkina Faso	Yes	-1.391	$\longleftrightarrow$

* The arrow's direction indicates which country's price level Granger causes the other country's price level. $\longleftrightarrow$ indicates bicausality.

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Table 3.10 – continued from previous page

Currency Union	**Country Pair (country 1 & country 2)**	**Cointegrated**	**Coefficient for country 2**	**Granger Causality***
WAEMU	Senegal - Côte d'Ivoire	No		$\longleftrightarrow$
WAEMU	Togo - Guinea-Bissau	Yes	-0.99	$\longleftrightarrow$
WAEMU	Burkina Faso - Benin	Yes	-0.782	$\longleftarrow$
WAEMU	Guinea-Bissau - Burkina Faso	Yes	-1.011	$\longleftarrow$

Table 3.11: Pairs lacking both Cointegration and Granger Causality

Currency Union	Country Pair
Australia	Tonga - Australia
Cemac	Madagascar - Cameroon
Cemac	Equatorial Guinea - Congo, Rep.
Cemac	Madagascar - Gabon
Eccu	St. Kitts and Nevis - Dominica
Eccu	Dominica - Barbados
Eccu	St. Lucia - Anguilla
Eccu	Grenada - Anguilla
Eccu	St. Lucia - Barbados
Eurozone	Slovenia - Ireland
Eurozone	San Marino - Montenegro
Eurozone	Slovenia - Portugal
Eurozone	San Marino - Belgium
Eurozone	Greece - Austria
Eurozone	Portugal - France
Eurozone	Luxembourg - Austria
Eurozone	Ireland - France
Eurozone	Montenegro - Italy
Eurozone	Ireland - Austria
Eurozone	Montenegro - Finland
Eurozone	Slovenia - Austria
Eurozone	Italy - Finland
Eurozone	Spain - Montenegro
Eurozone	France - Austria
Eurozone	Netherlands - Montenegro
Eurozone	San Marino - Germany
Eurozone	Portugal - Ireland
Eurozone	Montenegro - Austria
Eurozone	Slovenia - Finland
Eurozone	Netherlands - France
Eurozone	Italy - Belgium
Eurozone	Montenegro - France
Eurozone	Portugal - Montenegro
Eurozone	France - Finland
Eurozone	Germany - Belgium
Eurozone	Spain - Luxembourg
Eurozone	Montenegro - Greece
Eurozone	Netherlands - Belgium
Eurozone	San Marino - Austria

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Table 3.11 – continued from previous page

Currency Union	**Country Pair**
Eurozone	Portugal - Luxembourg
Eurozone	Luxembourg - Ireland
Eurozone	Finland - Belgium
Eurozone	Portugal - Austria
Eurozone	Montenegro - Luxembourg
India-Bhutan	India - Bhutan
South Africa	South Africa - Lesotho
South Africa	Swaziland - Lesotho
South Africa	Namibia - Lesotho
Dollarized	Timor-Leste - Ecuador
Dollarized	Timor-Leste - El Salvador
Dollarized	Timor-Leste - Bahamas, The
Dollarized	Timor-Leste - Panama
Dollarized	United States - Timor-Leste

Table 3.12: Share of country pairs exhibiting cointegration in ln CPI

Currency Union	Only during CU membership	With countries outside CU
Australia zone	0.00	14.02
Cemac	58.82	31.86
Dollaried zone	40.0	35.93
Eccu	23.53	35.27
Eurozone	7.62	16.34
India-Bhutan	0.00	7.14
Rand zone	33.33	29.56
Singapore-Brunei	0.00	9.52
Waemu	46.43	29.31

Table 3.13: Share of country pairs exhibiting Granger Causality in ln CPI

Currency Union	Only during CU membership	With countries outside CU
Australia zone	0.00	13.55
Cemac	55.88	31.08
Dollaried zone	36.67	29.71
Eccu	52.94	24.78
Eurozone	37.62	31.91
India-Bhutan	0.00	16.96
Rand zone	25.00	24.36
Singapore-Brunei	50.00	13.1
Waemu	71.43	39.85

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