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# Modelling multilateral trade resistance in a gravity model with exchange rate regimes*

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**ABSTRACT**

In estimating a gravity model it is essential to analyse not just bilateral trade resistance, the barriers to trade between a pair of countries, but also multilateral trade resistance (MTR), the barriers to trade that each country faces with all its trading partners. Without correctly modelling MTR, it is impossible either to obtain accurate estimates of the effects on trade of exchange rate regimes and other variables or to perform accurate counterfactual simulations of trade patterns under other assumptions about exchange rate regimes or other variables. In this paper we implement a number of different ways of modelling MTR – both for a standard gravity model and for an extended model which includes a full range of bilateral exchange rate regimes – notably several variants of the technique developed by Baier and Bergstrand (2006), which turn out to produce broadly similar results. We then illustrate our preferred approach by carrying out simulations of the effects of the creation of an East African currency union and the effects of a withdrawal from EMU by Italy.

**JEL Classification**: F10, F33, F49

**Key Words:** gravity, geography, trade, exchange rate regime, currency union, transactions costs, multilateral trade resistance

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In the modern version of the empirical gravity model trade flows between countries are determined not only by the conventional Newtonian factors of economic mass and distance, but also by the ratio of ‘bilateral’ to ‘multilateral’ trade resistance. Bilateral trade resistance (BTR) is the size of the barriers to trade between countries *i* and *j*, while multilateral trade resistance (MTR) refers to the barriers which each of *i* and *j* face in their trade with *all* their trading partners (including domestic or internal trade). The presence of multilateral trade resistance is what distinguishes this ‘new’ version of the gravity model, as developed by Anderson and van Wincoop (2003, 2004), from the ‘empirical’ or ‘traditional’ version used by earlier researchers such as Rose (2000). It introduces a substitutability between trade with a country’s different partners which was previously lacking.

For example, trade between France and Italy depends on how costly it is for each to trade with the other relative to the costs involved for each of them in trading with other countries. Hence a reduction in the bilateral trade barrier between France and a third country such as the UK would reduce France’s multilateral trade resistance. Although the bilateral trade barrier between France and Italy is unaffected, the fall in France’s MTR caused by the decline in the UK-France bilateral barrier leads to a diversion of bilateral trade away from France-Italy trade and towards France-UK trade. Moreover, as Baier and Bergstrand (2006) show, there is a further effect which operates in the opposite direction: the fall in France’s MTR generates a (small) fall in the average of all countries’ MTRs, which they call world trade resistance (WTR), and this encourages international trade instead of internal or domestic trade. The consequence of the reduction in the France-UK BTR for trade between France and Italy is the net of the bilateral trade diversion effect away from France-Italy trade and towards France-UK trade and the smaller multilateral trade creation effect away from internal France-France trade towards France's trade with all its international trading partners including Italy.

It follows, therefore, that these third-party effects need to be properly taken into account in an accurate evaluation of the effect on trade flows of changes in, for example, exchange rate regimes. Indeed, one of the major criticisms of earlier uses of the gravity models to examine the effects of currency unions on trade, such as Rose (2000) and Frankel and Rose (2002), was that the failure to control for multilateral trade resistance imparted a severe upward bias to the estimated effect of currency unions on trade, thereby leading to the implausibly large point estimates emerging from these early studies (see Baldwin and Taglioni, 2006).

In this paper we build on previous work (Adam and Cobham, 2007) in which we examined the impact on trade flows of exchange rate arrangements using a more detailed classification of bilateral exchange rate regimes than either the simple currency union effect used in Rose (2000) or the currency union/direct peg/indirect peg classification used by Klein and Shambaugh (2004). As already argued, a proper modelling of MTR is essential for the correct estimation of the effects of exchange rate regimes on trade: in Adam and Cobham (2007), following Feenstra (2005), we controlled for MTR effects using country-level fixed effects. However, this approach offers only a partial solution to the problem of modelling MTR in panel-data, for two reasons. The first is that, unless they are interacted with time, country fixed effects control for *average* trade resistance over time, even though key elements of trade resistance, such as the exchange rate regime, may be time-varying. Second, we are also interested in developing the capacity to simulate the effects on trade between countries of different exchange rate regimes, and for that we need to be able to estimate MTR in such a way that we can then take account of the consequences of varying the individual components of trade resistance.[1]

In section 1 we briefly introduce the canonical gravity model in order to define MTR formally and to discuss the alternative methods of modelling trade resistance found in the literature. In section 2 we report the results of estimating a basic empirical model with standard control variables, and then supplement it with our classification of exchange rate regimes. Initially we omit MTR (so that the model represents a 'traditional' version of the gravity model). In section 3 we then add, first, country fixed effects, which have been widely used in the literature as one way of dealing with MTR, and then (instead) country pair fixed effects. In section 4 we introduce various versions of a method of estimating MTR through linear-approximation pioneered by Baier and Berstrand (2006), and in section 5 we consider the sensitivity of the estimates of the exchange rate regime effects to these alternative specifications of MTR. In section 6 we present, as an example of the method, simulations of the effect of the formation of a currency union in East Africa covering Kenya, Tanzania and Uganda, and of the departure of Italy from EMU. Section 7 concludes.

## 1 Modelling multilateral trade resistance

*A formal gravity model*

We use a model developed by Anderson and van Wincoop (2003) in which each country $i = 1...n$ produces a single good and consumes a constant elasticity of substitution composite defined over all $n$ goods, including home production.[2] For the moment, we suppress any dynamic aspects so that the model describes trade flows across a single time period. All countries trade with each other, but because of natural and other barriers, cross-border trade is costly. Utility maximization by each country, subject to its budget constraint, the structure of trade costs and the set of market clearing conditions for each good, leads to the following equation for bilateral trade between countries *i* and *j*

$$F_{ij} = \frac{y_i y_j}{y^W} \left( \frac{t_{ij}}{P_i P_j} \right)^{1-\sigma} \tag{1}$$

where $F_{ij}$ denotes the volume of trade between countries *i* and *j*, $y_i$ and $y_j$ are their respective total expenditures (proxied by GDP), and $y^W$ is global GDP. Bilateral trade resistance is denoted by $t_{ij}$ which represents the gross mark-up in country *j* of country *i's* good over its domestic producer price: trade resistance is assumed to be symmetric so that $t_{ij} = t_{ji}$. $P_i$ and $P_j$ are the CES consumer price indices for *i* and *j* respectively and are defined as

$$P_i = \left[ \sum_j \left( \beta_j p_j t_{ji} \right)^{1-\sigma} \right]^{1/(1-\sigma)} \quad \text{and} \quad P_j = \left[ \sum_i \left( \beta_i p_i t_{ij} \right)^{1-\sigma} \right]^{1/(1-\sigma)} \tag{2}$$

where $\beta_j^{1-\sigma} = \theta_{ij}$ denotes the share of country *j* in country *i's* consumption. Anderson and van Wincoop (2003) refer to $P_i$ and $P_j$ as 'multilateral trade resistance' since each is a function of that country's full set of bilateral trade resistance terms (including internal trade resistance which is normalised to $t_{ii} = 1$). Finally, σ is the elasticity of substitution between all goods (assumed to be greater than one so that, for example, an increase in bilateral trade costs has a negative effect on bilateral trade flows).

Bilateral trade resistance is defined as a function of a vector of continuous variables, including some measure of distance and population (where the latter reflects the ease of domestic rather than international trade), and a set of binary indicator variables reflecting, for example, whether two countries have a common border, the nature of their prior and existing colonial relations, and whether they have some particular trade or exchange rate arrangement. The seminal paper by Rose (2000) focussed in particular on the role of currency unions, while more recent work by Klein and Shambaugh (2004) widens the net to examine the contribution of fixed exchange rate regimes on trade flows. Adam and Cobham (2007) introduce a much more detailed classification of *de facto* bilateral exchange rate arrangements. A variant of that classification is used in this paper and is explained in section 2. For the moment we note that each bilateral exchange rate regime, $h = 1 \ldots 1$ can be denoted by an indicator variable $D_{ij}^{h} = 1$ if the bilateral regime between countries $i$ and $j$ is $h$ and zero otherwise. Combining these three groups of variables we specify the bilateral trade cost function as

$$\ln t_{ij} = \delta_1 \ln d_{ij} + \delta_2 \ln(pop_i . pop_j) + \boldsymbol{\alpha}\mathbf{b}_{ij} + \sum_{h=1}^{l} \gamma^h D_{ij}^{h} + v_{ij} . \qquad (3)$$

where $d$ denotes a measure of distance, $pop$ is population and $\mathbf{b}$ is the vector of indicator variables reflecting other barriers to trade. Taking logs of (1) and substituting from (3), we obtain the following estimating equation for the gravity model:

$$\begin{aligned} \ln(F_{ij}) = {} & \beta_0 + \beta_1 \ln(y_i . y_j) + \delta_1 (1-\sigma) \ln d_{ij} + \delta_2 (1-\sigma) \ln(pop_i . pop_j) \\ & + (1-\sigma)\boldsymbol{\alpha}\mathbf{b}_{ij} + (1-\sigma) \sum_{h=1}^{l} \gamma^h D_{ij} + \ln(P_i)^{\sigma-1} + \ln(P_j)^{\sigma-1} + (1-\sigma)\varepsilon_{ij} \end{aligned} \qquad (4)$$

where the constant term $\beta_0 = \ln y^W$ represents world GDP, and the error term $\varepsilon_{ij}$ is a composite of the stochastic error in (1) and the residual term in the trade cost function (3). Notice, also, that the theory underpinning equation (1) implies $\beta_1 = 1$, although we do not impose this restriction.

*Estimating the gravity model*

Empirical estimation of (4) has to take account of the fact that $P_i$ and $P_j$ are not directly observable. Three approaches have been developed to address this problem. First, Anderson and van Wincoop (2003) solve for $P_i$ and $P_j$ in terms of the observable determinants of the trade barrier (equation (3)) and then estimate (1) using a customised non-linear estimation technique designed for their particular model. Although this approach is feasible for the model with which Anderson and van Wincoop (2003) work, where both the number of observations and the number of variables are relatively limited, and where the model is estimated on a single cross-section only, it becomes infeasible in our case where (see below) our regression includes a vector of 11 control variables covering countries' geographical and cultural features, colonial relationships and trade arrangements and 30 indicator variables for the different exchange rate regimes, and is estimated over an unbalanced panel of 165 countries over 32 years. A second, widely-used and less cumbersome, alternative, adopted by Rose and van Wincoop (2001) and Mélitz (e.g. 2007) amongst others, is to proxy the multilateral terms by country-specific fixed effects. The multilateral trade resistance terms are therefore replaced by a vector of $N$ country-specific indicator variables $C_i$ and $C_j$, each taking the value of 1 for trade flows between $i$ and $j$ and zero otherwise. The coefficients on these indicators ($\kappa_i = \ln(P_i)^{(1-\sigma)}$ and $\kappa_j = \ln(P_j)^{(1-\sigma)}$) measure the common element in each country's trade with every other country, which is precisely the notion of multilateral trade resistance. As Feenstra (2005) and others make clear, OLS estimation of (4) under this modification generates consistent estimates of the multilateral trade resistance.

Third, Baier and Bergstrand (2006) have proposed the use of a first-order Taylor series expansion to generate a linear approximation to the multilateral trade resistance terms in (2). This allows for the separate components of the $P_i$ and $P_j$ functions to be estimated by OLS rather than by non-linear estimation. Baier and Bergstrand show that in the context of Anderson and van Wincoop's (2003) model of border effects on trade between Canada and the US the bias involved in using these linear approximations relative to non-linear estimation is small. The approximation also introduces a third term, in addition to the two countries' multilateral trade resistance, which they call 'world trade resistance', and which is a function of the multilateral trade resistance faced by every country in the world. The intuition is that the importance of the average trade barrier one country faces depends on the average trade barriers all countries face. Thus, French-Italian trade, for example, is affected by the specific bilateral barrier between them, relative to the average trade barrier which each of them faces, which in turn has to be considered relative to the average trade barrier all countries in the world face.

*Extending the basic model for panel-data estimation*

In this paper we exploit a large panel data set. However, equation (4) is correctly specified for estimation only in the case of a single cross section of data – as is done by Anderson and van Wincoop (2003). When estimated on panel data two potential sources of bias need to be considered. The first and less serious arises from the use of constant price trade data. In keeping with much of the literature in this area we measure trade flows in constant US dollars, but as Baldwin and Taglioni (2006) note, any trend in US inflation will generate an omitted variable bias in the parameter estimates. Since all trade data are deflated in the same way, however, a vector of time dummies controls for this (and any other) source of common time-varying variation.

The second and potentially more serious problem arises when some elements of the multilateral trade resistance terms vary over time. While many of the elements of the trade-cost function such as geographical, cultural or historical characteristics are intrinsically time-invariant, others, most notably exchange rate arrangements, are not.[3] It follows that proxying for unobserved MTR using only country-specific dummy variables controls for only the *average over time* of multilateral trade resistance and not the time-varying component. The time-varying component becomes part of the equation error and hence represents a potential source of bias if it is correlated with the variables of interest. Since the time-varying component of multilateral trade resistance – that is, the evolution of the vector of pair-wise exchange rate regimes – is necessarily correlated with the vector of bilateral exchange rate regimes, this bias is highly likely to be present. We therefore see it as essential to allow for relevant time variation in the multilateral trade resistance terms. In principle, country fixed effects could be interacted with time to remove this source of bias, but this would entail adding an additional *NT* regressors (over 5,000 in this case) to the model, rendering estimation difficult if not impossible.

Even if it were feasible to estimate the model in this fashion, it would still not allow us to compute the specific variation in the MTR terms if we wished to simulate the consequences for trade of varying one or more than one country's exchange rate regime. For both reasons, therefore, the approach of Baier and Bergstrand (2006), is preferable (though fairly complex in a model of this size) and in what follows we present below a number of estimations using techniques based on it. For comparison, however, we also report results from estimates with constant CFEs, and we use them later on in a different context.

*Estimating Equation*

In the light of the above we define our estimating equations for panel data. We first index the log of equation (1) and the trade cost function (3) by *t*. In the case where we control for MTR solely by including country fixed effects, our estimating equation then takes the form

$$\begin{aligned} \ln(F_{ijt}) = \beta_0 + \beta_1 \ln(y_{it}.y_{jt}) + \tilde{\delta}_1 \ln d_{ij} + \tilde{\delta}_2 \ln(pop_{it}.pop_{jt}) + \tilde{\boldsymbol{\alpha}}\mathbf{b}_{ijt} \\ + \sum_{h=1}^{l-1} \tilde{\gamma}^h D_{ijt}^h + \sum_{t=1}^{T-1} \lambda_t yr_t + \sum_{s=1}^{N-1} \mu_s C_s + \varepsilon_{ijt} \end{aligned} \tag{5}$$

where the vector **b** includes both time-varying and time-invariant control variables and a tilde (~) above a coefficient denotes the product of the coefficient as it appears in the trade cost function (3) and $(1-\sigma)$ where $\sigma$ is the elasticity of substitution in consumption between commodities of different origins. Thus $\tilde{\delta}_i = (1-\sigma)\delta_i$, $\tilde{\boldsymbol{\alpha}} = (1-\sigma)\boldsymbol{\alpha}$ and $\tilde{\gamma}^h = (1-\sigma)\gamma^h$. A set of *T-1* year dummies, denoted $yr_t$, are also included to capture excluded or unobserved common time-varying effects. Country-fixed effects are represented by the set of indicator variables $\sum_{s=1}^{N-1} C_s$ where $C_s = 1$ if $s = i$ or $j$ , otherwise $C_s = 0$ .

Representing multilateral trade resistance solely in terms of linear approximations to equation (2) as in Baier and Bergstrand (2006) leads to an estimating equation in which the vector of indicator variables $\sum_{s=1}^{N-1} C_s$ is eliminated. Instead, each element of the trade cost function is defined to reflect its contribution to the bilateral and multilateral trade resistance. Hence for any variable, $x_{ijt}$ , which is defined on a country-pair basis (by year), its contribution to overall trade between *i* and *j* consists of three components: a direct impact on bilateral trade, $x_{ijt}$ ; an effect operating through the impact on the multilateral trade resistance of country *i* and country *j* defined as $\sum_j \theta_{jt} x_{ijt}$ for country *i* and $\sum_i \theta_{it} x_{ijt}$ for country *j* respectively; and a final effect from the impact on world trade resistance, defined as $\sum_i \sum_j \theta_{it} \theta_{jt} x_{ijt}$ where $\theta_{it}$ denotes either country *i's* share in world GDP at time *t* or is assumed equal (i.e. $\theta_{it} = \frac{1}{N_t}$ ) depending on the point around which the linear approximation to MTR is taken (see Section 4 and Appendix B).

Collecting these terms, our estimating equation takes the form

$$
\begin{aligned}
\ln(F_{ijt}) = \beta_0 + \beta_1 \ln(y_{it}.y_{jt}) + \tilde{\delta}_1 \ln d_{ij} + \tilde{\delta}_2 \ln(pop_{it}.pop_{jt}) \\
+\tilde{\boldsymbol{\alpha}}\left[\mathbf{b}_{ijt} - \left(\sum_j \theta_{jt}\mathbf{b}_{ijt} + \sum_i \theta_{it}\mathbf{b}_{ijt}\right) + \sum_j\sum_i \theta_{jt}\theta_{it}\mathbf{b}_{ijt}\right] \qquad (6) \\
+\sum_{h=1}^{I-1}\tilde{\gamma}^h\left[D_{ijt}^h - \left(\sum_j \theta_{jt}D_{ijt}^h + \sum_i \theta_{it}D_{ijt}^h\right) + \sum_j\sum_i \theta_{jt}\theta_{it}D_{ijt}^h\right] + \sum_{t=1}^{T-1}\lambda_t yr_t + \varepsilon_{ijt}
\end{aligned}
$$

Finally, where we allow for the possibility that there may be country specific factors determining trade that are not otherwise captured by the linear approximation to the MTR terms we add the terms $\sum_{s=1}^{N-1} C_s$ to equation (7).

In either case the gravity model is estimated by ordinary least squares. Given that the data are defined for country-pairs by year basis we report, and base our inference on, standard errors which are robust to both arbitrary heteroscedasticity and potential intra-group correlation.

## 2 Adding exchange rate regimes to a standard model

In this section we present results without including any MTR terms, but including year dummies throughout.[4] We start with a standard model which includes GDP, population, distance and the standard control variables used by Rose (2000) and others in this literature. The latter cover geographic and cultural features – log product of area, whether one or both countries is landlocked, whether either or both are islands, whether the two countries share a common border, whether they share a common language; features that refer to history and colonial status – whether the two countries have been colonised by the same colonial master, whether one is or ever was a colony of the other, whether they form part of the same country; and trade arrangements – whether the two countries are members of a regional trade agreement and whether one has extended GSP preferences to the other (full details of these variables are given in Appendix A). We then extend the standard model by adding a set of dummy variables for the exchange rate regimes between each pair of countries.

The latter are based on the Reinhart and Rogoff (2004; see also 2003a, 2003b) classification of exchange rate regimes on a *de facto*, rather than *de jure*, basis. Reinhart and Rogoff's 15 (unilateral) regimes are aggregated into six: currency union/currency board; peg; managed float with a reference currency; managed float without a reference (where we include currencies managed with only a rather loose relationship to the reference currency, in line with Reinhart and Rogoff's 'fine codes'); free fall; and free float. Table 1 shows this aggregation. A set of 29 zero-one dummy variables are then defined for the (bilateral) regimes between countries, taking account of the specific anchor or reference currencies being used by different countries.[5] Table 2 sets out the definitions of each of these variables (in the regressions below the default category is MANMAN where both countries are managing floats without reference currencies).

In line with the literature spawned by Rose (2000), we expect that (the coefficient on) SAMECU, where two countries are members of the same currency union, will be strongly positive, and we expect positive but successively smaller effects for SAMEPEG, where two countries are pegging to the same anchor, and SAMEREF, where they are both managing their floats with reference to the same currency. For exchange rate regimes which cross the main categories or involve different anchors, pegs or reference currencies, we distinguish three different effects:

(i) any exchange rate regime between two countries which reduces uncertainty and transactions costs relative to the default regime will tend to increase the trade between them: this is a positive direct effect;

(ii) an exchange rate regime between two countries may affect their trade negatively (relative to the default regime) by encouraging one country to replace trade with the other by trade with a third country with which it has a 'closer' exchange rate regime: this is a (negative) substitution effect; and

(iii) a regime may affect trade positively via an indirect reduction in transactions costs, in the case where the producers of a country which trades with more than one user of a single currency, or (to a lesser extent) with more than one country that pegs to the same vehicle currency, can economise on working balances in the single or the vehicle currency; this is a positive indirect effect.

Table 3 presents the results for estimating the two models on our dataset without any MTR terms. The coefficients on the basic regressors accord reasonably well with theory, with cross-border trade increasing in the log-product of GDP and decreasing in the log product of population and the log of distance between countries.[6] The coefficients on the standard control variables also have signs and magnitudes in line with theory and results elsewhere, and all except *island* and *common country* are significant. The time-dummies are jointly significant. When we add the exchange rate regime dummies in equation [2], the coefficients on the basic and standard control variables are little changed. The exchange rate dummies are jointly significant, and 22 out of 29 of the individual regimes are significantly different from zero. We discuss the results for the different exchange rate regimes further in section 5, but it is worth noting here that SAMECU has clearly the largest coefficient, while regimes involving a freely falling rate, e.g. MANFALL, FALLFALL, tend to have the lowest. The adjusted R-squared rises from 0.667 in equation [1] to 0.671 in equation [2].

## 3 Adding country fixed effects and country pair fixed effects

We now add country fixed effects (CFEs) to each of the models in Table 3. As noted above, these effects can be thought of theoretically as approximations to MTR terms. Strictly, they control for the *average* MTR, but because many of the trade cost factors change over time this approximation may not be accurate. The country fixed effects also control for any other time-invariant country-specific determinants of trade not otherwise picked up by the vector of controls (e.g. if countries vary in their propensity to trade internationally for reasons not otherwise reflected in the trade cost function).

Table 4 presents the results. In each case the country effects are jointly significant, and inspection of the individual results shows that a high proportion of the individual country dummies are significant. Furthermore the adjusted R-squareds are higher in each case, by just over 0.03, which is large relative to the variation between the results within Table 3 (or Table 4).[7] At the same time the coefficients on the basic and standard control variables and on the constant are in most cases a little smaller in absolute terms than those in Table 3. 19 of the 29 exchange rate effects are now significant. In general the pattern of the coefficients is closer to what might have been expected: for example, DIFFREF is now below SAMEREF, and the lowest regime is now FALLFALL.

Next we replace the CFEs by country pair fixed effects (CPFEs). In contrast to CFEs, country-pair fixed effects do not emerge directly from the Anderson-van Wincoop

(2003) model. However, they can be motivated from a purely econometric perspective as a means of controlling for unobserved or unobservable country-pair specific factors not picked up elsewhere in the model (see, for example Carrère (2006) and Egger (2007).

Table 5 presents the results of adding CPFEs (in place of CFEs) to the two equations in the previous tables. Many of the control variables are dropped, since they are country pair-specific and constant over time. The coefficients on the other basic and standard control variables are all lower than in Table 3 (with the GDP coefficient now less than unity and regional trade agreement now significantly negative). The exchange rate regime dummies are also mostly smaller in magnitude, and only 10 are individually significant. On the other hand the year dummies, the CPFE dummies and the exchange rate regime dummies are each jointly significant in each equation. However, what is most striking about these results – which recur in any other equations where we have tried CPFEs – is the low value of the within-groups R-squared, which indicates the extent to which the variation in bilateral trade flows can be explained by the model once we have controlled for country-pair fixed effects. The fact that the within-groups R-squared is less than 0.1 across all such variants of the model indicates that when CPFEs are included they do nearly all of the work, because many of the control variables (including the exchange rate regimes) are relatively constant over time on a country-pair basis. But that means that including CPFEs does not allow us to identify the effects in which we are interested, notably the effects of the exchange rate regimes. In addition, the overall R-squareds in these cases are well below those in any of the other regressions which we report.

## 4 Modelling MTRs via Taylor approximations

We now turn to the third approach to modelling MTR, that proposed by Baier & Bergstrand (2006). This approach uses a first-order Taylor series expansion to approximate the multilateral price resistance terms, which makes it possible to separate out the different terms in the $P_i$ and $P_j$ functions presented in equation (2) and use OLS rather than non-linear estimation. Baier and Bergstrand show that (in some cases at least) the bias involved in their approximation is small. Their technique also introduces a third term, 'world trade resistance', which is a function of the multilateral trade resistance faced by every country in the world.[8]

Baier and Bergstrand discuss two alternative centres for their Taylor expansion. The first is a frictionless equilibrium, i.e. one where the trade cost factor $t_{ij} = t = 1$ for all i,j = 1…N. The second – which they prefer – is a symmetric equilibrium, where $t_{ij} = t > 1$ for all i,j = 1…N and the shares in world GDP of all countries are the same, $\theta_i = 1/N$ for all i,j = 1…N. It turns out that in the first case the trade cost factors are weighted by the GDP shares in the expressions for the MTR terms in the final estimating equation, while in the second case the trade cost factors are equally weighted. Neither of these centres is intuitively attractive in our case, where there are substantial trade costs and countries' GDP shares vary enormously (as between, say, the US and Grenada). However, we show in Appendix B that it is possible to implement the Taylor expansion around a centre where there are common trade costs and also common MTRs between countries, and this generates the same estimating equation as in Baier and Bergstrand's frictionless equilibrium case. Accordingly in what follows we present results for the cases where (a) the trade costs are weighted by GDP shares (Baier and Bergstrand's frictionless centre or our common trade costs and common MTRs centre) and (b) the trade costs are equally weighted (their symmetric equilibrium).[9]

Table 6 reproduces equation [1], the simplest case for the basic model, and contrasts it with the results of including MTR (and WTR) terms, using first GDP weights (equation [8]) and then equal weights ([9]). Population, distance and the standard controls are all included in the MTR terms. There is some variation in the constant term, but little variation in the other coefficients or in the R-squared.

Table 7 presents the corresponding estimates for the full model including exchange rate regimes. Here all the regimes enter into the MTR terms, as well as the other variables. With respect to the constant and the basic and standard control variables the results are comparable to those in Table 6: some variation in the constant term but not much in the other coefficients or in the R-squared. For the exchange rate effects, however, there are some small variations in the relative pattern, particularly as between the GDP weights case (equation [11]) and either the without-MTR case (equation [10] = [2] in Table 2) or the equal-weights case (equation [12]).

Theoretically equations [11] and [12] allow fully for multilateral trade resistance. It is possible, however, that there remains some variation in the data which is country specific and constant over time. We therefore rerun the equations with CFEs in addition to the treatment of MTR, with the results shown in Table 8. Here equation [13] is the without-MTR specification of equation [4] in Table 3, while [14] and [15] have GDP-weighted MTRs and equally-weighted MTRs respectively. As between these three equations the differences are comparable to those in Table 7: some variation in the constant terms but little in the basic and standard control variables or in the R-squared. As between Tables 7 and 8 the results in Table 8 involve substantially higher R-squareds, of the order of 0.705 as opposed to the 0.670 in Table 7, which suggests that even when the MTR terms are included there are substantial country-specific factors determining trade patterns not captured by the factors included in the empirical trade cost function; the general pattern of the regime effects is also more plausible, as with the results of Table 4 relative to those of Table 3.[10]

## 5 Robustness and plausibility

So far we have presented a variety of estimates made in different ways. Here we consider the robustness of these estimates and the plausibility of the preferred results. A first point to note is that, with the exception of the inclusion of country pair fixed effects, the various approaches used on the standard model (without exchange rate regimes) make little difference to the results for that model: the findings are robust, in the sense that adding CFES or including the MTR/WTR terms do not change the estimates significantly.

When we supplement the basic model with exchange rate regimes the estimated coefficients move rather more, particularly as between when CFEs are and are not included. But how we choose to control for MTR, whether by using country fixed effects or by means of an explicit linear approximation, makes little difference to the estimated coefficients, as can be seen in Figure 1, which shows the coefficients from the three regressions in Table 8. It is clear that the three sets of coefficients are very close, which has two important implications. First, modelling the MTRs or simply controlling for them through dummy variables makes surprisingly little difference to the estimated coefficients – but without explicit modelling, it is not possible to carry out proper simulations or, indeed, to identify the 'marginal' effects of the exchange rate regimes. Second, when a linear approximation to the true MTR is employed, the choice of centre for the Taylor expansion has little effect on the estimated exchange rate coefficients. Baier and Bergstrand's frictionless centre, or our common trade costs and common MTRs centre, which imply trade cost factors being weighted by GDP, generate virtually the same coefficient estimates as their symmetric equilibrium centre which implies equal-weighting across countries. However, in the present dataset the differences in country sizes are so large that the common trade costs and common MTRs centre seems clearly more appropriate. For this reason we focus in what follows mainly on the results of equation [14].

Figure 2 adds to Figure 1 the coefficients from the three equations in Table 7, where no CFEs are included in the regressions. These results are again very close to each other, but they differ somewhat from those in Table 8. There are two points worth making here. First, on econometric grounds the inclusion of CFEs is preferable, because of the considerable rise in the adjusted R-squared. Second, as already noted, the pattern of the exchange rate regime coefficients is much more plausible in the CFE case: SAMECU > SAMECUPEG > SAMEPEG, though SAMEPEG is still < SAMEREF; SAME– coefficients are now invariably > DIFF– coefficients; FALLFALL is now the lowest coefficient; the –FLOAT coefficients are smaller than in Table 7 though still significantly positive, and so on.

Figure 3 shows, in descending order, the point estimates for the exchange rate regime coefficients from equation [14] in Table 8, together with 95% confidence intervals.

Much the largest coefficient is that for SAMECU, which offers some support for Rose's (2000) initial intuition. At the other end MANFALL, PEGFALL and FALLFALL are all negative, though not significantly below the default regime, MANMAN, while CUFALL, CUMAN and PEGMAN are positive but not significant. In between there is a range of regimes with coefficients between 0.15 and 0.56, nearly all significantly different from zero but some more precisely defined than others.[11]

One way of summarising the effect of the exchange rate regimes is to take (unweighted) averages of the coefficients for each type of regime in association with itself and each other regime (ignoring DIFF– and ANCHOR– coefficients): for example, the average of SAMECU, SAMECUPEG, SAMECUREF, CUMAN, CUFLOAT and CUFALL is 0.39, while the corresponding average for the –PEG regimes is 0.28, that for the –REF regimes is 0.33, that for the –MAN regimes is 0.07, that for the –FALL regimes is 0.05, and that for the FLOAT regimes is 0.36. Our prior expectation was that the –REF regimes would have smaller positive effects on trade than the –PEG regimes; the fact that the comparison goes (slightly) the other way may suggest that the distinction Reinhart and Rogoff make between their coarse codes 2(peg)-4 and 5-9 is not really watertight. We also would have expected a larger difference between the –MAN regimes and the –FALL regimes. The –FLOAT regimes, it should be noted, are relatively small categories (see Table 2) which are dominated by a small number of developed countries (three quarters of the observations involve one or more of the US, Australia, Japan and pre-EMU Germany). Those countries are relatively intense participants in international trade, so when CFEs are included they have relatively high CFEs; when the CFEs are not included the effect goes partly into the –FLOAT coefficients.

## 6 The size of exchange rate effects: some illustrative simulations

We turn finally to the size of the effects of exchange rate regimes on trade. A first point to note is that, although the partial r-squareds reported for equation [14] in Table 8 emphasise that in general exchange rate effects explain a much lower proportion of the variation in trade compared to the core Newtonian determinants, these effects are both jointly and individually significant. Nonetheless, a direct comparison of our results with other similar estimates is difficult. While our point estimate for SAMECU of 0.96 (equation [14]) is a little larger than the corresponding point estimate (of 0.86) by Rose and van Wincoop (2001), the comparison is not very informative. Our estimate measures the result of two countries which had both previously been managing their currencies without a reference joining the same currency union, whereas Rose and van Wincoop's estimate measures the effect of two countries joining the same currency union from a starting position represented by the *average* of all other exchange rate arrangements. Hence, the true difference between the two estimates is substantial.[12] In addition, these numbers give the 'average' or partial equilibrium impact, and need to be combined with the associated MTR and WTR effects in order to generate accurate 'marginal' estimates of the effect of such a regime change. To illustrate this, we present the results of two specific simulations, which are strictly designed to illustrate our method rather than to intervene in particular policy debates: we consider the impact on their trade of the formation of a new East African currency union (with a brand new currency) between Kenya, Tanzania and Uganda; and the impact on Italy's trade of its withdrawal from EMU. We report the change in a country's overall trade, and the distribution of that trade between various currency/regional blocs: the US $ bloc (the US plus countries which are in a currency union with the dollar or have a currency board on the dollar); Europe; (the rest of) Latin America; (the rest of) Asia; Africa, divided into the East African Community (Kenya, Tanzania and Uganda) and the rest; and other.

The trade volumes and shares were generated by (i) assuming the country concerned switched its exchange rate regime in the way indicated, (ii) finding the value of the implied change in the dummy variable referring to that country's bilateral exchange rate regime with each of its partners, (iii) calculating the implied change in the multilateral trade resistance of each country, (iv) calculating the corresponding implied change in world trade resistance, and (v) applying the changes under (ii), (iii) and (iv) to the actual trade patterns of each country in 2003.[13]

As of 2003 Kenya and Tanzania each have managed floats (without reference currencies), while Uganda has a free float. Case I of Table 9 considers a currency union between Kenya and Tanzania only. Kenya and Tanzania experience increases in their total trade of 13% and 15.4% respectively; these overall effects are made up of direct effects of 13.2% and 15.6% which are offset by (negative) MTR effects of 0.5% and 0.6% and (positive) WTR effects of 0.3% and 0.4%. The MTR and WTR effects here are relatively small; the reason for this is that Kenya and Tanzania each account for very small shares of world GDP (as shown at the bottom of Table 9), so the changes in their exchange rate regimes have quite small effects both on their own MTRs and on the MTRs of their trading partners. In terms of the distribution of trade, Kenya and Tanzania each trade significantly more with each other (the shares more than double), and there are a range of different effects on their trade with other countries.

In case II Kenya, Tanzania and Uganda all make a currency union together. The overall effects are larger – e.g. Kenya's trade increases by 19.8% - and the MTR and WTR effects are slightly larger: the three countries account for 0.23% of world GDP (as opposed to 0.175% in case I). In terms of the distribution of their trade, there are much larger increases in inter-EAC trade, and larger falls or smaller rises in the shares of trade with other trading blocs: with three countries involved in the currency union there are stronger substitution effects towards inter-union trade and away from trade with non-members.

In case III we consider a roughly opposite change in which Italy leaves an existing large currency union and its currency is now managed (without a reference currency). The direct effect is a fall in Italian trade of 36.1%, offset by a positive MTR effect of 4.4% and a negative WTR effect of 1.7%, to give an overall fall in Italian trade of 33.4%. Here the MTR and WTR effects are considerably larger than in the previous cases, since Italy accounts for 2.7% of world GDP and the change in its exchange rate regime therefore has a larger impact on its own and other countries' MTRs. Italy's trade with Europe naturally experiences a very large fall, while its trade with other blocs is (in absolute terms) relatively unchanged.

## 7 Conclusion

In this paper we have estimated different versions of a gravity model, from the most basic to one which includes a full menu of exchange rate regimes, using a variety of techniques. First, we have shown that when country pair fixed effects are included they do most of the work and it is not possible to identify the effects which interest us, notably those of exchange rate regimes. On the other hand country fixed effects seem to improve the explanatory power of the equations without having major impacts on the coefficients estimated for the other explanatory variables.

Second, we have implemented the Baier and Bergstrand (2006) method of dealing with multilateral (and world) trade resistance, which employs a Taylor expansion to obtain an estimable linear equation from the non-linear equation which comes out of the theoretical model. We have done this using both GDP weights – which can be motivated either by Baier and Bergstrand's frictionless centre or by our common trade costs and common MTR centre – and equal weights, which can be motivated by Baier and Bergstrand's symmetric centre. The results do not differ much, but for our dataset, with its enormous differences in country sizes, we believe that our common trade costs and common MTRs centre, which leads to GDP weights on the trade cost factors in the MTR terms, is clearly preferable. When we implement the Baier and Bergstrand method we still find that adding country fixed effects improves the explanatory power, without greatly affecting the individual coefficient estimates. It also produces a pattern of exchange rate regime effects which is much closer to a priori expectations. CFEs should therefore be included.

Third, we have shown that the exchange rate regime effects estimated without MTR/WTR terms or with them under different weights are very close to each other. However, in order to identify the 'marginal' effect of exchange rate regimes it is essential to include the MTR terms and take account of how they vary in response to a counterfactual change in a regime.

Finally, we have shown that it is possible to analyse the effect of a counterfactual change in a country's exchange rate regime, by simulating the change in its trade with each of its trading partners in a way that takes account of the change in regime with each partner and the associated changes in MTRs and WTR. Our illustrations, for the East African countries and for Italy, show that when the countries concerned are large relative to world GDP the MTR/WTR effects are large enough to make the 'average' numbers embodied in the estimated coefficients misleading.[14]

**Notes**

[1] A recent paper by Egger (2007, forthcoming) – which we saw only after completing the first draft of this paper – uses a similar approach to examine the impact of increased exchange rate regimes on bilateral trade, finding that moves towards greater 'fixity' of exchange rate arrangements have a positive impact on trade. Our results are broadly consistent with this general finding but, as we indicate below, our more detailed exchange rate classification allows us to distinguish more clearly how different pair-wise exchange rate regimes affect trade through their impact on exchange rate uncertainty, transactions costs and economies of scope arising from arrangements linking individual countries with supranational currency arrangements.

[2] Anderson and van Wincoop (2004) derive comparable results for a model in which each country produces a product within each product class.

[3] Some geographical measures such as distance may appear to be time-invariant even though the notion of 'economic' distance which they aim to reflect is not. See, for example, Brun *et al* (2005).

[4] Year dummies can be thought of as allowing for any common time-varying effects such as trends in US inflation (and/or in the dollar exchange rates used to convert other countries' trade into dollars).

[5] The classification used here is the same as that in Adam and Cobham (2007), where a more detailed explanation is given, except that here we distinguish the cases where two countries are, respectively, in the same currency union, or pegged to the same anchor currency, or managing their currencies with respect to the same reference currency, from the cases where one country is in a currency union which uses the currency of the other as its anchor (ANCHORCU), or one country is pegged to the

currency of the other (ANCHORPEG), or one country is managing its currency with respect to the currency of the other (ANCHORREF).

[6] The relatively large value of the income elasticity of trade relative to the theoretical prior of one may reflect the fact that the dependent variable is calculated as the log of average bi-directional trade rather than the average of log bi-directional trade (Baldwin and Taglioni, 2006).

[7] A similar rise in the adjusted R-squared when CFEs are added can be found in Mélitz (2003).

[8] The world trade resistance terms are the same for all countries in any year but may differ between years; they are therefore perfectly collinear with the year dummies. However we need to include them in the estimation in order to be able to vary them in any simulations.

[9] We have also experimented with weighting the trade costs by (country pair) shares in world trade, which may have some intuitive merit but cannot be motivated theoretically. The results have the same general pattern as, but are rather more erratic than, those for either GDP or equal weights. Given this variability, together with the lack of theoretical basis, we do not present any results from such regressions.

[10] We have also experimented with restricting the modelling of the MTR and WTR terms to the exchange rate regimes only. The results are close to those where the standard control variables are included in the MTR/WTR terms as well.

[11] The regimes with large confidence intervals are typically those where the number of observations (see Table 2) is relatively small, e.g. the ANCHOR– regimes.

[12] In addition it should be noted that our SAMECU variable differs from Rose's strict currency union dummy insofar as (a) SAMECU is 1 but Rose's *custrict* is 0 where two countries each have (institutionally separate) currency unions or currency board

arrangements with the same anchor currency, eg Argentina and Hong Kong in the 1990s, and (b) SAMECU is 0 and *custrict* is 1 in some post-independence years when, according to Reinhart and Rogoff and other sources, some of the colonial currency board arrangements became pegs rather than currency boards.

[13] We use 2003 rather than 2004, the latest year for which we have data, because the dataset is less complete in the final year.

[14] Rose and van Wincoop (2001) also report some marginal effects which are smaller than their average effects, but their results are not properly comparable with ours.

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## Appendix A

**Data definitions:**

| | |
|---|---|
| *F* | the average value of real bilateral trade (constant US dollars) |
| *D* | the great circle distance between most populous cities (standard miles) |
| *Y* | real GDP (constant US dollars) |
| *Pop* | the population of the country |

*Elements of vector* **b**:

| | |
|---|---|
| *Area* | the area of the country (square kilometres) |
| *Lang* | a dummy with value 1 if the two countries have the same language, and 0 otherwise |
| *ComBord* | a dummy variable with value 1 if the two countries have a common border |
| *Landl* | the number of landlocked countries in the pair (0, 1 or 2) |
| *Island* | the number of countries in the pair which are islands (0, 1 or 2) |
| *Comcol* | a dummy with value 1 if i and *j* were ever colonies after 1945 with same coloniser, and 0 otherwise |
| *Colony* | a dummy with value 1 if *i* ever colonised *j* or vice versa |
| *Curcol* | a dummy with value 1 if *i* and *j* are colonies at time *t* |
| *ComNat* | a dummy with value 1 if *i* and *j* are part of the same nation at time *t* |
| *Regional* | a dummy with value 1 if *i* and *j* belong to the same regional trade agreement at time *t* |
| *GSP* | a dummy with value 1 if *i* extended a GSP concession to *j* at time *t* or vice versa |

| | |
|---|---|
| $\{yr_t\}$ | a set of time fixed effects |
| $\{Ci\}$ | a set of country fixed effects. |

**Data sources:**

Data on variables from *F* above to *GSP* taken from Rose (2003) and extended by us from 1998 to 2004, except for data on distance most of which was given to us by Jacques Mélitz.

Data on exchange rate regimes constructed by us, see section 2 above and Adam and Cobham (2007).

## Appendix B: A modification to Baier and Bergstrand's (2006) method

Baier and Bergstrand (BB) have two centres for their Taylor expansions:

(a) frictionless, i.e. $t_{ij} = t = 1$ for all i,j = 1…N

(b) symmetric, i.e. $t_{ij} = t > 1$ for all i,j = 1…N and GDP shares of all countries are the same, $\theta_i = 1/N$ for all i,j = 1…N

We propose a third centre:

(c) common trade costs and multilateral resistances,

i.e. $t_{ij} = t > 1$ for all i,j = 1…N and $P_i = P_j = P$ for all i,j = 1…N

On this basis their equation (8)

$$P_i = \left[ \sum_{j=1}^{N} \theta_j (t_{ij} / P_j)^{1-\sigma} \right]^{1/1-\sigma}$$

becomes

$$P = \left[ \sum_{j=1}^{N} \theta_j (t / P)^{1-\sigma} \right]^{1/1-\sigma} = (t / P)\left[\sum \theta_j\right]^{1/1-\sigma} = t / P$$

=> $P = t^{1/2}$ [A1]

Taylor expansion of BB's equation (14) using this centre gives equation [A2]:

$$\begin{aligned} &P^{1-\sigma} + (1-\sigma)P^{1-\sigma}(\ln P_i - \ln P) \\ &= \sum_j \theta_j P^{\sigma-1} t^{1-\sigma} + (\sigma-1)\sum_j \theta_j P^{\sigma-1} t^{1-\sigma}(\ln P_j - \ln P) + (1-\sigma)\sum_j \theta_j P^{\sigma-1} t^{1-\sigma}(\ln t_{ij} - \ln t) \end{aligned}$$

Substituting $t = P^2$ into [A2], we get [A3]:

$$\begin{aligned} &P^{1-\sigma} + (1-\sigma)P^{1-\sigma}(\ln P_i - \ln P) \\ &\quad = \sum_j \theta_j P^{1-\sigma} + (\sigma-1)\sum_j \theta_j P^{1-\sigma}(\ln P_j - \ln P) + (1-\sigma)\sum_j \theta_j P^{1-\sigma}(\ln t_{ij} - 2\ln P) \end{aligned}$$

Cancelling $-(1-\sigma)\ln P$ from both sides, and dividing them by $P^{1-\sigma}$, we get [A4]:

$$1 + (1-\sigma)\ln P_i = \sum_j \theta_j + (\sigma-1)\sum_j \theta_j \ln P_j + (1-\sigma)\sum_j \theta_j \ln t_{ij}$$

Using $\sum_j \theta_j = 1$ and dividing both sides by $1 - \sigma$, we get

$$\ln P_i = -\sum_j \theta_j \ln P_j + \sum_j \theta_j \ln t_{ij} \qquad \text{[A5]}$$

Multiply both sides by $\theta_i$ and sum over N:

$$\sum_i \theta_i \ln P_i = -\sum_j \theta_j \ln P_j + \sum_i \theta_i \sum_j \theta_j \ln t_{ij}$$

So we have $\sum_j \theta_j \ln P_j = 0.5 \sum_i \theta_i \sum_j \theta_j \ln t_{ij}$ [A6]

Substitute [A6] into [A5], we have

$$\ln P_i = \sum_j \theta_j \ln t_{ij} - 0.5 \sum_i \theta_i \sum_j \theta_j \ln t_{ij} \qquad \text{[A7]}$$

Substituting from [A7] and correspondingly for ln *Pj* in equation (4) of the text, and collecting terms, gives equation (6) of the text as our estimating equation.

**Table 1: Classification of exchange rate regimes**

| R&R fine code | R&R description | New classification |
|---|---|---|
| 1 | No separate legal tender | Currency board or currency union |
| 2 | Currency board arrangement or | |
| 2 | Pre-announced peg | Currency peg |
| 3 | Pre-announced horizontal band that is narrower than or equal to +/-2% | |
| 4 | De facto peg | |
| 5 | Pre-announced crawling peg | Managed floating with a reference currency |
| 6 | Pre-announced crawling band that is narrower than or equal to +/-2% | |
| 7 | De facto crawling peg | |
| 8 | De facto crawling band that is narrower than or equal to +/-2% | |
| 9 | Pre-announced crawling band that is wider than or equal to +/-2% | |
| 10 | De facto crawling band that is narrower than or equal to +/-5% | Managed floating (without a reference currency) |
| 11 | Moving band that is narrower than or equal to +/-2% (i.e. allows for both appreciation and depreciation over time) | |
| 12 | Managed floating | |
| 13 | Freely floating | Freely floating |
| 14 | Freely falling | Freely falling |
| 15 | Dual market in which parallel market data is missing | [allocated elsewhere] |

Sources: Reinhart and Rogoff (2004); text.

**Table 2: Classification and distribution of exchange rate regimes by country pair**

| **Description of exchange rate regime by country pair** | **Dummy variable** | **Percent of Total** |
|---|---|---|
| both countries use the same currency in a currency union and/or as the anchor for a currency board | SAMECU | 1.3 |
| one country is in a currency union/currency board for which the other country's currency is the anchor | ANCHORCU | 0.8 |
| both countries are in currency unions or operate currency boards, but with different anchors | DIFFCU | 1.1 |
| one country is in a currency union/currency board with an anchor to which the other pegs | SAMECUPEG | 0.9 |
| one country is in currency union/currency board with one anchor while the other pegs to different anchor | DIFFCUPEG | 3.4 |
| both countries peg to the same currency | SAMEPEG | 1.8 |
| one country is pegging to the other country's currency | ANCHORPEG | 0.4 |
| both countries peg but to different anchors | DIFFPEG | 1.3 |
| one currency is in currency union/board with anchor with reference to which the other is managed | SAMECUREF | 3.0 |
| one currency is in currency union/board with anchor other than reference to which the other is managed | DIFFCUREF | 6.5 |
| one country is pegged to the currency with reference to which the other's currency is managed | SAMEPEGREF | 5.3 |
| one country is pegged to a currency other than that with reference to which the other's is managed | DIFFPEGREF | 5.8 |
| both countries have managed floats with the same reference currency | SAMEREF | 4.7 |
| one country is managing its float with reference to the currency of the other | ANCHORREF | 0.7 |
| both countries are managing their floats, but with different reference currencies | DIFFREF | 5.4 |
| one country is in currency union/board, the other has a managed float with no specified reference currency | CUMAN | 6.2 |
| one country pegs, the other has a managed float with no specified reference currency | PEGMAN | 6.7 |
| both countries have managed floats, one with and one without a specified reference currency | REFMAN | 13.1 |
| both countries have managed floats, with unspecified reference currencies | MANMAN [default regime] | 4.5 |
| one country is in a currency union/currency board, the other has a floating currency | CUFLOAT | 2.1 |
| one country pegs, the other has a floating currency | PEGFLOAT | 1.5 |
| one country is managing its currency with a specific reference, the other has a floating currency | REFFLOAT | 3.2 |
| one country is managing its currency without a specific reference, the other has a floating currency | MANFLOAT | 2.5 |
| one country is in currency union/board, the other's currency is freely falling | CUFALL | 2.6 |
| one country pegs, the other's currency is freely falling | PEGFALL | 3.0 |
| one country pegs has a managed float with a specified | REFFALL | 5.9 |

| | | |
|---|---|---|
| reference, the other's currency is freely falling | | |
| one country pegs has a managed float with no reference, the other's currency is freely falling | MANFALL | 3.7 |
| both countries' currencies are freely falling | FALLFALL | 1.0 |
| one country has a floating currency, the other's currency is freely falling | FALLFLOAT | 1.1 |
| both countries have a flexible exchange rate | FLOATFLOAT | 0.4 |
| **Total Observations** | | 183,692 |

**Table 3: The baseline gravity model**

**Dependent Variable: Log bilateral trade (constant US dollars)**

**Pooled OLS Estimation. Sample: 1973-2004 [unbalanced panel]**

| | [1] | | [2] | |
|---|---|---|---|---|
| | estimate | t-statistic | estimate | t-statistic |
| **Constant** | -28.28 | -70.47 | -27.74 | -65.78 |
| **Basic variables** | | | | |
| log product real GDP | 1.33 | 101.10 | 1.32 | 101.09 |
| log product population | -0.42 | 26.73 | -0.41 | -26.39 |
| log distance | -1.29 | -53.04 | -1.30 | -52.83 |
| **Standard controls** | | | | |
| log product area | -0.07 | -8.22 | -0.08 | -8.94 |
| landlocked | -0.31 | -9.13 | -0.33 | -9.74 |
| island | 0.04 | 1.02 | -0.02 | -0.42 |
| common language | 0.38 | 8.60 | 0.34 | 7.67 |
| common border | 0.58 | 4.47 | 0.54 | 4.24 |
| common colony | 0.56 | 7.67 | 0.51 | 7.01 |
| current colony | 1.79 | 6.42 | 1.83 | 6.49 |
| ever colony | 0.99 | 8.69 | 1.04 | 8.94 |
| common country | -0.76 | -0.52 | -0.71 | -0.49 |
| regional trade agreement | 1.10 | 6.75 | 0.96 | 5.62 |
| GSP preferences | 0.71 | 19.61 | 0.68 | 18.76 |
| **Exchange rate effects** | | | | |
| SAMECU | | | 1.04 | 6.72 |
| ANCHORCU | | | 0.56 | 3.42 |
| DIFFCU | | | 0.58 | 3.92 |
| SAMECUPEG | | | 0.34 | 2.33 |
| DIFFCUPEG | | | 0.19 | 2.10 |
| SAMEPEG | | | 0.05 | 0.47 |
| ANCHORPEG | | | 0.81 | 5.01 |
| DIFFPEG | | | 0.19 | 1.97 |
| SAMECUREF | | | 0.48 | 4.90 |
| ANCHORREF | | | 0.92 | 6.35 |
| DIFFCUREF | | | 0.34 | 4.43 |
| SAMEPEGREF | | | 0.13 | 1.72 |
| DIFFPEGREF | | | 0.21 | 2.98 |
| SAMEREF | | | 0.29 | 3.81 |
| DIFFREF | | | 0.29 | 4.08 |
| REFMAN | | | 0.19 | 3.03 |
| CUMAN | | | 0.09 | 1.15 |
| PEGMAN | | | -0.05 | -0.78 |
| MANMAN | | | | |
| CUFLOAT | | | 0.59 | 6.47 |
| PEGFLOAT | | | 0.69 | 7.31 |
| REFFLOAT | | | 0.60 | 7.38 |
| MANFLOAT | | | 0.60 | 7.44 |
| CUFALL | | | 0.04 | 0.41 |
| PEGFALL | | | -0.16 | -1.83 |
| REFFALL | | | 0.23 | 3.31 |
| MANFALL | | | -0.17 | -2.21 |
| FALLFALL | | | -0.11 | -0.89 |
| FALLFLOAT | | | 0.61 | 5.28 |
| FLOATFLOAT | | | 0.96 | 6.53 |
| year dummies | Yes | | Yes | |
| Adjusted $R^2$ | 0.667 | | 0.671 | |
| F[Year dummy effects=0] [2] | 80.65 | [0.000] | 252.17 | [0.000] |
| F[Exchange rate dummy effects=0] [3] | - | | 100.3 | [0.000] |
| No. observations | 183692 | | 183692 | |

**Notes:** [1] heteroscedastic and autocorrelation robust t-statistics in parentheses.
[2] F-test against joint significance of year dummies (probability in brackets).
[3] F-test against joint significance of exchange rate dummies (probability in brackets).

**Table 4: Adding CFEs**

**Dependent Variable: Log bilateral trade (constant US dollars)**

**Pooled OLS Estimation. Sample: 1973-2004 [unbalanced panel]**

| | [3] | | [4] | |
|---|---|---|---|---|
| | estimate | t-statistic | estimate | t-statistic |
| **Constant** | -25.28 | -51.54 | -25.46 | -50.37 |
| **Basic variables** | | | | |
| log product real GDP | 1.24 | 70.51 | 1.23 | 70.52 |
| log product population | -0.33 | -15.51 | -0.34 | -15.58 |
| log distance | -1.30 | -50.90 | -1.27 | -48.78 |
| **Standard controls** | | | | |
| log product area | -0.11 | -8.45 | -0.10 | -7.92 |
| landlocked | -0.56 | -13.52 | -0.56 | -13.43 |
| island | -0.09 | -1.62 | -0.07 | -1.36 |
| common language | 0.39 | 8.32 | 0.38 | 8.07 |
| common border | 0.50 | 4.00 | 0.49 | 4.00 |
| common colony | 0.60 | 8.44 | 0.54 | 7.66 |
| current colony | 1.53 | 5.61 | 1.56 | 5.68 |
| ever colony | 1.03 | 8.71 | 1.00 | 8.45 |
| common country | -0.67 | -0.50 | -0.63 | -0.47 |
| regional trade agreement | 0.98 | 4.87 | 0.92 | 4.55 |
| GSP preferences | 0.43 | 9.54 | 0.43 | 9.58 |
| **Exchange rate effects** | | | | |
| SAMECU | | | 0.92 | 6.29 |
| ANCHORCU | | | 0.33 | 2.17 |
| DIFFCU | | | 0.31 | 2.25 |
| SAMECUPEG | | | 0.48 | 3.49 |
| DIFFCUPEG | | | 0.11 | 1.34 |
| SAMEPEG | | | 0.28 | 3.00 |
| ANCHORPEG | | | 0.22 | 1.38 |
| DIFFPEG | | | 0.16 | 1.79 |
| SAMECUREF | | | 0.47 | 5.42 |
| ANCHORREF | | | 0.33 | 2.44 |
| DIFFCUREF | | | 0.15 | 2.04 |
| SAMEPEGREF | | | 0.29 | 4.23 |
| DIFFPEGREF | | | 0.11 | 1.83 |
| SAMEREF | | | 0.35 | 5.12 |
| DIFFREF | | | 0.17 | 2.72 |
| REFMAN | | | 0.14 | 2.52 |
| CUMAN | | | 0.01 | 0.18 |
| PEGMAN | | | -0.01 | -0.18 |
| MANMAN | | | | |
| CUFLOAT | | | 0.20 | 2.32 |
| PEGFLOAT | | | 0.44 | 5.06 |
| REFFLOAT | | | 0.32 | 4.45 |
| MANFLOAT | | | 0.27 | 3.68 |
| CUFALL | | | 0.01 | 0.07 |
| PEGFALL | | | -0.12 | -1.57 |
| REFFALL | | | 0.21 | 3.50 |
| MANFALL | | | -0.10 | -1.37 |
| FALLFALL | | | -0.14 | -1.27 |
| FALLFLOAT | | | 0.28 | 2.73 |
| FLOATFLOAT | | | 0.43 | 3.32 |
| year dummies | Yes | | Yes | |
| country dummies | Yes | | Yes | |
| Adjusted $R^2$ | 0.704 | | 0.705 | |
| F[Year dummy effects=0] [2] | 77.94 | [0.000] | 76.14 | [0.000] |
| F[country dummy effects=0] [3] | 18.7 | [0.000] | 18.08 | [0.000] |
| F[Exchange rate dummy effects=0] [4] | - | | 6.66 | [0.000] |
| No. observations | 183692 | | 183692 | |

**Notes:** [1] heteroscedastic and autocorrelation robust t-statistics in parentheses.
[2] F-test against joint significance of year dummies (probability in brackets).
[3] F-test against joint significance of CFE dummies (probability in brackets).
[4] F-test against joint significance of exchange rate dummies (probability in brackets).

**Table 5: Adding CPFEs**

**Dependent Variable: Log bilateral trade (constant US dollars)**

**Pooled OLS Estimation. Sample: 1973-2004 [unbalanced panel]**

| | [5] | | [6] | |
|---|---|---|---|---|
| | estimate | t-statistic | estimate | t-statistic |
| **Constant** | -23.12 | -27.82 | -22.69 | -12.15 |
| **Basic variables** | | | | |
| log product real GDP | 0.81 | 72.67 | 0.80 | 30.82 |
| log product populatior | -0.18 | -7.80 | -0.17 | -3.22 |
| log distance | - | | - | |
| **Standard controls** | | | | |
| log product area | - | | - | |
| landlocked | - | | - | |
| island | - | | - | |
| common language | - | | - | |
| common border | - | | - | |
| common colony | - | | - | |
| current colony | 1.53 | 3.61 | 1.38 | 2.47 |
| ever colony | - | | - | |
| common country | - | | - | |
| regional trade agreem | -0.65 | -3.65 | -0.65 | -1.83 |
| GSP preferences | 0.11 | 2.40 | 0.11 | 0.90 |
| **Exchange rate effects** | | | | |
| SAMECU | | | 0.15 | 1.78 |
| ANCHORCU | | | -0.32 | -3.28 |
| DIFFCU | | | -0.11 | -1.24 |
| SAMECUPEG | | | 0.03 | 0.43 |
| DIFFCUPEG | | | 0.01 | 0.24 |
| SAMEPEG | | | -0.19 | -2.99 |
| ANCHORPEG | | | 0.01 | 0.16 |
| DIFFPEG | | | 0.03 | 0.47 |
| SAMECUREF | | | 0.01 | 0.14 |
| ANCHORREF | | | 0.25 | 2.60 |
| DIFFCUREF | | | -0.08 | -1.54 |
| SAMEPEGREF | | | -0.05 | -1.18 |
| DIFFPEGREF | | | 0.02 | 0.45 |
| SAMEREF | | | 0.02 | 0.38 |
| DIFFREF | | | -0.07 | -1.53 |
| REFMAN | | | -0.03 | -0.89 |
| CUMAN | | | -0.14 | -2.78 |
| PEGMAN | | | -0.05 | -1.34 |
| MANMAN | | | | |
| CUFLOAT | | | 0.06 | 0.89 |
| PEGFLOAT | | | 0.15 | 2.42 |
| REFFLOAT | | | 0.08 | 1.69 |
| MANFLOAT | | | 0.06 | 1.19 |
| CUFALL | | | -0.18 | -2.95 |
| PEGFALL | | | -0.24 | -4.94 |
| REFFALL | | | -0.21 | -5.05 |
| MANFALL | | | -0.24 | -5.73 |
| FALLFALL | | | -0.45 | -6.68 |
| FALLFLOAT | | | -0.06 | -0.98 |
| FLOATFLOAT | | | 0.10 | 1.07 |
| year dummies | Yes | | Yes | |
| country pair fixed eff | Yes | | Yes | |
| $R^2$ overall | 0.518 | | 0.522 | |
| $R^2$ within | 0.072 | | 0.075 | |
| F[Year dummy effec | 50.81 | [0.000] | 46.53 | [0.000] |
| F[CPFE dummy effe | 27.84 | [0.000] | 27.41 | [0.000] |
| F[Exchange rate dui | - | | 8.97 | [0.000] |
| No. observations | 183692 | | 183692 | |

**Notes:** [1] heteroscedastic and autocorrelation robust t-statistics in parentheses.
[2] F-test against joint significance of year dummies (probability in brackets).
[3] F-test against joint significance of CPFE dummies (probability in brackets).
[4] F-test against joint significance of exchange rate dummies (probability in brackets).

**Table 6: Basic model plus standard controls with MTRs**

**Dependent Variable: Log bilateral trade (constant US dollars)**

**Pooled OLS Estimation. Sample: 1973-2004 [unbalanced panel]**

| | **[7=1]** | | **[8]** | | **[9]** | |
|---|---|---|---|---|---|---|
| | estimate | t-statistic | estimate | t-statistic | estimate | t-statistic |
| **Constant** | -28.28 | -70.47 | -29.70 | -74.09 | -29.07 | -72.39 |
| **Basic variables** | | | | | | |
| log product real GDP | 1.33 | 101.10 | 1.36 | 100.75 | 1.35 | 100.67 |
| log product population | -0.42 | 26.73 | -0.41 | -26.17 | -0.42 | -26.63 |
| log distance | -1.29 | -53.04 | -1.30 | -52.85 | -1.30 | -53.01 |
| **Standard controls** | | | | | | |
| log product area | -0.07 | -8.22 | -0.08 | -9.14 | -0.08 | -8.56 |
| landlocked | -0.31 | -9.13 | -0.34 | -9.88 | -0.32 | -9.25 |
| island | 0.04 | 1.02 | 0.03 | 0.88 | 0.04 | 1.00 |
| common language | 0.38 | 8.60 | 0.38 | 8.33 | 0.38 | 8.33 |
| common border | 0.58 | 4.47 | 0.57 | 4.34 | 0.57 | 4.40 |
| common colony | 0.56 | 7.67 | 0.56 | 7.69 | 0.56 | 7.66 |
| current colony | 1.79 | 6.42 | 1.74 | 5.80 | 1.77 | 5.97 |
| ever colony | 0.99 | 8.69 | 0.96 | 8.39 | 0.99 | 8.68 |
| common country | -0.76 | -0.52 | -0.70 | -0.48 | -0.75 | -0.51 |
| regional trade agreement | 1.10 | 6.75 | 1.12 | 6.86 | 1.10 | 6.76 |
| GSP preferences | 0.71 | 19.61 | 0.74 | 20.28 | 0.72 | 19.84 |
| year dummies | Yes | | Yes | | Yes | |
| country dummies | No | | No | | No | |
| MTRs (weights) | No | | Yes (GDP) | | Yes (equal) | |
| Adjusted $R^2$ | 0.667 | | 0.665 | | 0.666 | |
| F[Year dummy effects=0] [2 | 80.65 | [0.000] | 73.64 | [0.000] | 72.95 | [0.000] |
| No. observations | 183692 | | 183692 | | 183692 | |

**Notes:** [1] heteroscedastic and autocorrelation robust t-statistics in parentheses.
[2] F-test against joint significance of year dummies (probability in brackets).

**Table 7: The full model with MTRs**

**Dependent Variable: Log bilateral trade (constant US dollars)**

**Pooled OLS Estimation. Sample: 1973-2004 [unbalanced panel]**

| | [10=2] | | [11] | | [12] | |
|---|---|---|---|---|---|---|
| | estimate | t-statistic | estimate | t-statistic | estimate | t-statistic |
| **Constant** | -27.74 | -65.78 | -29.21 | -69.33 | -28.53 | -67.74 |
| **Basic variables** | | | | | | |
| log product real GDP | 1.32 | 101.09 | 1.34 | 100.36 | 1.33 | 100.65 |
| log product population | -0.41 | -26.39 | -0.40 | -25.54 | -0.41 | -26.23 |
| log distance | -1.30 | -52.83 | -1.30 | -52.48 | -1.30 | -52.77 |
| **Standard controls** | | | | | | |
| log product area | -0.08 | -8.94 | -0.09 | -9.72 | -0.08 | -9.25 |
| landlocked | -0.33 | -9.74 | -0.36 | -10.42 | -0.34 | -9.85 |
| island | -0.02 | -0.42 | -0.01 | -0.32 | -0.02 | -0.41 |
| common language | 0.34 | 7.67 | 0.34 | 7.66 | 0.34 | 7.62 |
| common border | 0.54 | 4.24 | 0.53 | 4.14 | 0.54 | 4.18 |
| common colony | 0.51 | 7.01 | 0.50 | 6.98 | 0.51 | 7.00 |
| current colony | 1.83 | 6.49 | 1.78 | 6.26 | 1.81 | 6.44 |
| ever colony | 1.04 | 8.94 | 1.02 | 8.70 | 1.04 | 8.93 |
| common country | -0.71 | -0.49 | -0.65 | -0.46 | -0.69 | -0.48 |
| regional trade agreem | 0.96 | 5.62 | 0.99 | 5.82 | 0.96 | 5.64 |
| GSP preferences | 0.68 | 18.76 | 0.71 | 19.44 | 0.69 | 19.00 |
| **Exchange rate effects** | | | | | | |
| SAMECU | 1.04 | 6.72 | 1.05 | 6.78 | 1.04 | 6.70 |
| ANCHORCU | 0.56 | 3.42 | 0.53 | 3.30 | 0.56 | 3.43 |
| DIFFCU | 0.58 | 3.92 | 0.58 | 3.90 | 0.58 | 3.94 |
| SAMECUPEG | 0.34 | 2.33 | 0.40 | 2.75 | 0.35 | 2.43 |
| DIFFCUPEG | 0.19 | 2.10 | 0.21 | 2.29 | 0.20 | 2.18 |
| SAMEPEG | 0.05 | 0.47 | 0.09 | 0.83 | 0.06 | 0.59 |
| ANCHORPEG | 0.81 | 5.01 | 0.77 | 4.82 | 0.81 | 5.01 |
| DIFFPEG | 0.19 | 1.97 | 0.23 | 2.37 | 0.20 | 2.08 |
| SAMECUREF | 0.48 | 4.90 | 0.54 | 5.41 | 0.50 | 5.01 |
| ANCHORREF | 0.92 | 6.35 | 0.86 | 5.93 | 0.93 | 6.38 |
| DIFFCUREF | 0.34 | 4.43 | 0.36 | 4.55 | 0.35 | 4.53 |
| SAMEPEGREF | 0.13 | 1.72 | 0.17 | 2.23 | 0.15 | 1.87 |
| DIFFPEGREF | 0.21 | 2.98 | 0.26 | 3.64 | 0.23 | 3.19 |
| SAMEREF | 0.29 | 3.81 | 0.33 | 4.26 | 0.30 | 3.96 |
| DIFFREF | 0.29 | 4.08 | 0.34 | 4.81 | 0.31 | 4.33 |
| REFMAN | 0.19 | 3.03 | 0.21 | 3.50 | 0.19 | 3.17 |
| CUMAN | 0.09 | 1.15 | 0.10 | 1.31 | 0.10 | 1.22 |
| PEGMAN | -0.05 | -0.78 | -0.03 | -0.38 | -0.05 | -0.67 |
| MANMAN | 0.00 | | 0.00 | | 0.00 | |
| CUFLOAT | 0.59 | 6.47 | 0.55 | 6.00 | 0.60 | 6.51 |
| PEGFLOAT | 0.69 | 7.31 | 0.70 | 7.36 | 0.70 | 7.39 |
| REFFLOAT | 0.60 | 7.38 | 0.60 | 7.34 | 0.61 | 7.46 |
| MANFLOAT | 0.60 | 7.44 | 0.56 | 6.98 | 0.60 | 7.43 |
| CUFALL | 0.04 | 0.41 | 0.06 | 0.67 | 0.05 | 0.49 |
| PEGFALL | -0.16 | -1.83 | -0.13 | -1.53 | -0.15 | -1.75 |
| REFFALL | 0.23 | 3.31 | 0.26 | 3.76 | 0.24 | 3.42 |
| MANFALL | -0.17 | -2.21 | -0.15 | -1.96 | -0.17 | -2.16 |
| FALLFALL | -0.11 | -0.89 | -0.10 | -0.86 | -0.11 | -0.90 |
| FALLFLOAT | 0.61 | 5.28 | 0.58 | 5.15 | 0.60 | 5.27 |
| FLOATFLOAT | 0.96 | 6.53 | 0.89 | 5.99 | 0.96 | 6.50 |
| year dummies | Yes | | Yes | | Yes | |
| country dummies | No | | No | | No | |
| MTRs (weights) | No | | Yes (GDP) | | Yes (equal) | |
| Adjusted $R^2$ | 0.671 | | 0.669 | | 0.671 | |
| F[Year dummy effec | 80.32 | [0.000] | 72.09 | [0.000] | 71.48 | [0.000] |
| F[Exchange rate dur | 12.56 | [0.000] | 11.42 | [0.000] | 12.38 | [0.000] |
| No. observations | 183692 | | 183692 | | 183692 | |

**Notes:** [1] heteroscedastic and autocorrelation robust t-statistics in parentheses.
[2] F-test against joint significance of year dummies (probability in brackets).
[3] F-test against joint significance of exchange rate dummies (probability in brackets).

**Table 8: The full model with MTRs and CFEs**

**Dependent Variable: Log bilateral trade (constant US dollars)**

**Pooled OLS Estimation. Sample: 1973-2004 [unbalanced panel]**

| | [13=4] estimate | [13=4] t-statistic | [14] estimate | [14] t-statistic | [15] estimate | [15] t-statistic | [14] Partial r-squared |
|---|---|---|---|---|---|---|---|
| **Constant** | -25.46 | -50.37 | -26.96 | -52.77 | -26.19 | -51.62 | |
| **Basic variables** | | | | | | | |
| log product real GDP | 1.23 | 70.52 | 1.24 | 68.80 | 1.24 | 69.94 | 0.446 |
| log product population | -0.34 | -15.58 | -0.30 | -13.80 | -0.33 | -15.19 | -0.103 |
| log distance | -1.27 | -48.78 | -1.27 | -48.53 | -1.28 | -48.80 | -0.361 |
| **Standard controls** | | | | | | | |
| log product area | -0.10 | -7.92 | -0.12 | -8.83 | -0.11 | -8.20 | -0.074 |
| landlocked | -0.56 | -13.43 | -0.60 | -14.15 | -0.57 | -13.60 | -0.106 |
| island | -0.07 | -1.36 | -0.06 | -1.20 | -0.07 | -1.36 | -0.009 |
| common language | 0.38 | 8.07 | 0.38 | 8.08 | 0.38 | 8.04 | 0.064 |
| common border | 0.49 | 4.00 | 0.49 | 3.97 | 0.49 | 3.98 | 0.035 |
| common colony | 0.54 | 7.66 | 0.54 | 7.58 | 0.54 | 7.66 | 0.063 |
| current colony | 1.56 | 5.68 | 1.53 | 5.70 | 1.55 | 5.68 | 0.040 |
| ever colony | 1.00 | 8.45 | 1.00 | 8.38 | 1.00 | 8.45 | 0.057 |
| common country | -0.63 | -0.47 | -0.56 | -0.43 | -0.62 | -0.46 | -0.004 |
| regional trade agreem | 0.92 | 4.55 | 0.95 | 4.67 | 0.92 | 4.52 | 0.048 |
| GSP preferences | 0.43 | 9.58 | 0.45 | 10.06 | 0.43 | 9.69 | 0.067 |
| **Exchange rate effects** | | | | | | | |
| SAMECU | 0.92 | 6.29 | 0.96 | 6.54 | 0.92 | 6.28 | 0.043 |
| ANCHORCU | 0.33 | 2.17 | 0.37 | 2.42 | 0.34 | 2.23 | 0.015 |
| DIFFCU | 0.31 | 2.25 | 0.35 | 2.47 | 0.32 | 2.30 | 0.016 |
| SAMECUPEG | 0.48 | 3.49 | 0.56 | 4.04 | 0.50 | 3.61 | 0.024 |
| DIFFCUPEG | 0.11 | 1.34 | 0.15 | 1.88 | 0.12 | 1.47 | 0.010 |
| SAMEPEG | 0.28 | 3.00 | 0.33 | 3.50 | 0.30 | 3.16 | 0.019 |
| ANCHORPEG | 0.22 | 1.38 | 0.31 | 1.96 | 0.24 | 1.50 | 0.009 |
| DIFFPEG | 0.16 | 1.79 | 0.21 | 2.41 | 0.17 | 1.96 | 0.011 |
| SAMECUREF | 0.47 | 5.42 | 0.53 | 6.03 | 0.48 | 5.54 | 0.034 |
| ANCHORREF | 0.33 | 2.44 | 0.39 | 2.81 | 0.35 | 2.54 | 0.014 |
| DIFFCUREF | 0.15 | 2.04 | 0.18 | 2.48 | 0.16 | 2.18 | 0.014 |
| SAMEPEGREF | 0.29 | 4.23 | 0.34 | 4.85 | 0.31 | 4.41 | 0.026 |
| DIFFPEGREF | 0.11 | 1.83 | 0.16 | 2.61 | 0.13 | 2.06 | 0.013 |
| SAMEREF | 0.35 | 5.12 | 0.38 | 5.60 | 0.36 | 5.28 | 0.028 |
| DIFFREF | 0.17 | 2.72 | 0.21 | 3.39 | 0.19 | 2.95 | 0.016 |
| REFMAN | 0.14 | 2.52 | 0.16 | 2.99 | 0.14 | 2.66 | 0.015 |
| CUMAN | 0.01 | 0.18 | 0.04 | 0.56 | 0.02 | 0.26 | 0.003 |
| PEGMAN | -0.01 | -0.18 | 0.02 | 0.38 | 0.00 | -0.04 | 0.002 |
| MANMAN | 0.00 | | 0.00 | | 0.00 | | |
| CUFLOAT | 0.20 | 2.32 | 0.22 | 2.61 | 0.21 | 2.44 | 0.012 |
| PEGFLOAT | 0.44 | 5.06 | 0.50 | 5.73 | 0.46 | 5.23 | 0.026 |
| REFFLOAT | 0.32 | 4.45 | 0.36 | 4.99 | 0.33 | 4.61 | 0.023 |
| MANFLOAT | 0.27 | 3.68 | 0.30 | 3.98 | 0.28 | 3.76 | 0.018 |
| CUFALL | 0.01 | 0.07 | 0.05 | 0.52 | 0.02 | 0.19 | 0.003 |
| PEGFALL | -0.12 | -1.57 | -0.09 | -1.14 | -0.11 | -1.45 | -0.006 |
| REFFALL | 0.21 | 3.50 | 0.24 | 3.90 | 0.22 | 3.62 | 0.019 |
| MANFALL | -0.10 | -1.37 | -0.08 | -1.16 | -0.09 | -1.32 | -0.006 |
| FALLFALL | -0.14 | -1.27 | -0.13 | -1.21 | -0.14 | -1.26 | -0.006 |
| FALLFLOAT | 0.28 | 2.73 | 0.33 | 3.19 | 0.29 | 2.80 | 0.015 |
| FLOATFLOAT | 0.43 | 3.32 | 0.44 | 3.32 | 0.44 | 3.37 | 0.013 |
| year dummies | Yes | | Yes | | Yes | | |
| country dummies | No | | No | | No | | |
| MTRs (weights) | No | | Yes (GDP) | | Yes (equal) | | |
| Adjusted $R^2$ | 0.705 | | 0.703 | | 0.705 | | |
| F[Year dummy effec | 76.14 | [0.000] | 69.46 | [0.000] | 69.00 | [0.000] | |
| F[country dummy eff | 18.08 | [0.000] | 18.06 | [0.000] | 18.14 | [0.000] | |
| F[Exchange rate dur | 6.66 | [0.000] | 7.1 | [0.000] | 6.73 | [0.000] | |
| No. observations | 183692 | | 183692 | | 183692 | | |

**Notes:** [1] heteroscedastic and autocorrelation robust t-statistics in parentheses.
[2] F-test against joint significance of year dummies (probability in brackets).
[3] F-test against joint significance of exchange rate dummies (probability in brackets).

**Table 9: The effects of changes in countries' exchange rate regimes on their trade**

**Case I: Kenya and Tanzania form a new currency union [from managed floats]**

**Baseline Trade and Distribution**

| | Total Trade |
|---|---|
| **Kenya** | 18.03 |
| **Tanzania** | 18.35 |

**Initial distribution of trade**

| | US $ bloc | Europe | Latin America | Asia | Rest of Africa | EAC | Other |
|---|---|---|---|---|---|---|---|
| Kenya | 9.1% | 30.1% | 0.5% | 19.0% | 17.8% | 2.6% | 20.8% |
| Tanzania | 2.0% | 13.3% | 0.1% | 15.3% | 8.6% | 2.5% | 58.1% |

**Percentage point change in trade**

| | | Kenya | Tanzania |
|---|---|---|---|
| **Total** | **Overall** | 12.98% | 15.37% |
| due to | **Direct** | 13.16% | 15.59% |
| | **MTR** | -0.46% | -0.57% |
| | **WTR** | 0.29% | 0.36% |

**Revised distribution**

| | US $ bloc | Europe | Latin America | Asia | Rest of Africa | EAC | Other |
|---|---|---|---|---|---|---|---|
| **Kenya** | 8.2% | 32.9% | 0.5% | 17.3% | 15.0% | 5.9% | 20.3% |
| **Tanzania** | 1.8% | 14.6% | 0.1% | 13.6% | 7.1% | 5.7% | 57.2% |

**Case II: Kenya Tanzania and Uganda form a new currency union**
**[Kenya and Tanzania from managed floats, Uganda from a free float]**

**Baseline Trade and Distribution**

| | Total Trade |
|---|---|
| **Kenya** | 18.03 |
| **Tanzania** | 18.35 |
| **Uganda** | 4.689 |

**Initial distribution of trade**

| | US $ bloc | Europe | Latin America | Asia | Rest of Africa | EAC | Other |
|---|---|---|---|---|---|---|---|
| Kenya | 9.1% | 30.1% | 0.5% | 19.0% | 11.1% | 9.3% | 20.8% |
| Tanzania | 2.0% | 13.3% | 0.1% | 15.3% | 8.4% | 2.8% | 58.1% |
| Uganda | 6.2% | 28.2% | 0.3% | 16.4% | 10.8% | 26.7% | 11.5% |

**Percentage point change in trade**

| | | Kenya | Tanzania | Uganda |
|---|---|---|---|---|
| **Total** | **Overall** | 19.75% | 15.62% | 16.04% |
| due to | **Direct** | 20.01% | 15.84% | 16.36% |
| | **MTR** | -0.70% | -0.58% | -0.72% |
| | **WTR** | 0.44% | 0.36% | 0.40% |

**Revised distribution**

| | US $ bloc | Europe | Latin America | Asia | Rest of Africa | EAC | Other |
|---|---|---|---|---|---|---|---|
| **Kenya** | 7.7% | 31.0% | 0.4% | 16.3% | 8.9% | 16.5% | 19.2% |
| **Tanzania** | 1.8% | 14.6% | 0.1% | 13.5% | 6.8% | 6.1% | 57.0% |
| **Uganda** | 4.6% | 24.7% | 0.2% | 11.2% | 7.4% | 44.7% | 7.2% |

**Case III: Italy leaves the Euro [from membership of EMU to a managed float]**

**Baseline Trade and Distribution**

| | Total Trade |
|---|---|
| **Italy** | 1621.6 |

**Initial distribution of trade**

| | US $ bloc | Europe | Latin America | Asia | Africa | Other |
|---|---|---|---|---|---|---|
| **Italy** | 7.5% | 64.6% | 2.2% | 7.4% | 2.3% | 15.9% |

**Percentage point change in trade**

| | | Italy |
|---|---|---|
| **Total** | **Overall** | -33.35% |
| due to | **Direct** | -36.07% |
| | **MTR** | 4.43% |
| | **WTR** | -1.71% |

**Revised distribution**

| | US $ bloc | Europe | Latin America | Asia | Africa | Other |
|---|---|---|---|---|---|---|
| **Italy** | 11.7% | 48.6% | 3.2% | 11.0% | 3.4% | 22.1% |

| **Memorandum items** | **Kenya** | **Tanzania** | **Uganda** | **Italy** |
|---|---|---|---|---|
| share in world GDP | 0.09% | 0.08% | 0.07% | 2.70% |
| Top 10 trading partners | UK | Qatar | Kenya | Germany |
| | UAE | South Africa | UK | France |
| | US | India | South Africa | US |
| | Uganda | China | India | Spain |
| | Netherlands | Japan | UAE | UK |
| | Saudi Arabia | Zambia | US | Austria |
| | South Africa | Kenya | Netherlands | Switzerland |
| | China | UK | Japan | China |
| | Germany | UAE | China | Russia |
| | India | Netherlands | Germany | Japan |

**Figure 1: Exchange rate coefficients from Table 8**

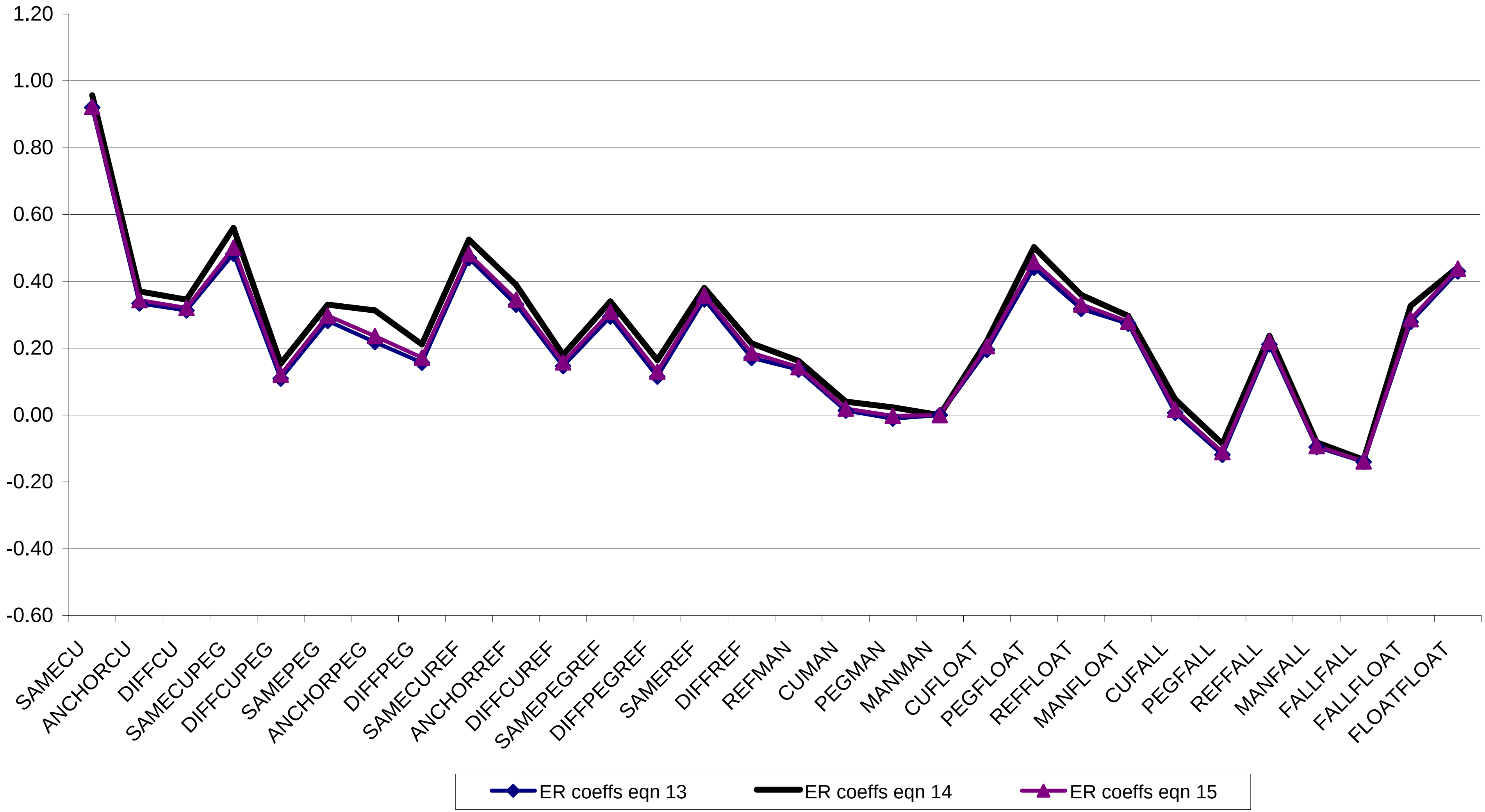
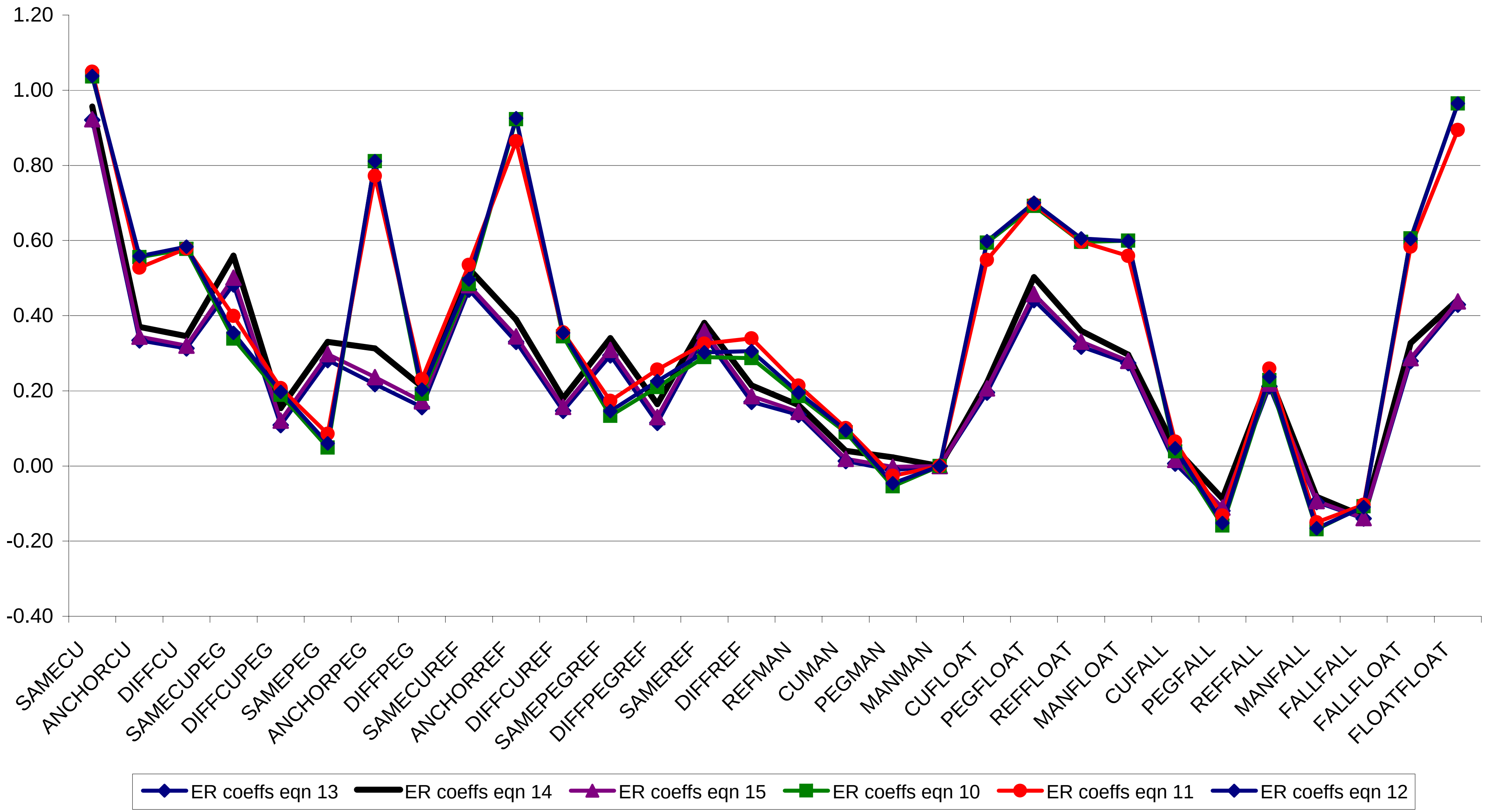


**Figure 2: Exchange rate coefficients from Tables 7 and 8**



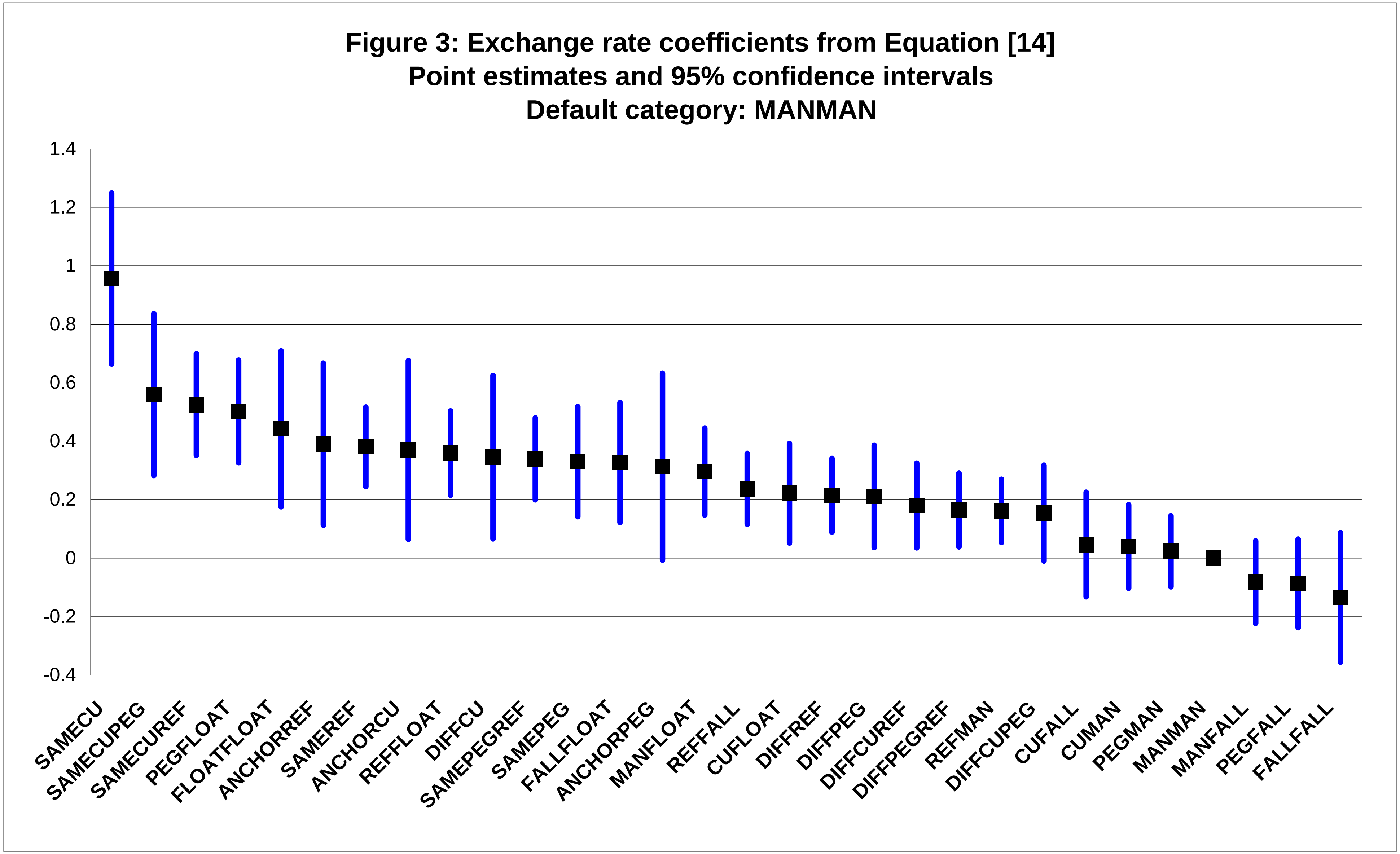


Figure 3: Exchange rate coefficients from Equation [14]
Point estimates and 95% confidence intervals
Default category: MANMAN
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
SAMECU
SAMECUPEG
SAMECUREF
PEGFLOAT
FLOATFLOAT
ANCHORREF
SAMEREF
ANCHORCU
REFFLOAT
DIFFCU
SAMEPEGREF
SAMEPEG
FALLFLOAT
ANCHORPEG
MANFLOAT
REFFALL
CUFLOAT
DIFFREF
DIFFPEG
DIFFCUREF
DIFFPEGREF
REFMAN
DIFFCUPEG
CUFALL
CUMAN
PEGMAN
MANMAN
MANFALL
PEGFALL
FALLFALL

## ABOUT THE CDMA

The **Centre for Dynamic Macroeconomic Analysis** was established by a direct grant from the University of St Andrews in 2003. The Centre funds PhD students and facilitates a programme of research centred on macroeconomic theory and policy. The Centre has research interests in areas such as: characterising the key stylised facts of the business cycle; constructing theoretical models that can match these business cycles; using theoretical models to understand the normative and positive aspects of the macroeconomic policymakers' stabilisation problem, in both open and closed economies; understanding the conduct of monetary/macroeconomic policy in the UK and other countries; analyzing the impact of globalization and policy reform on the macroeconomy; and analyzing the impact of financial factors on the long-run growth of the UK economy, from both an historical and a theoretical perspective. The Centre also has interests in developing numerical techniques for analyzing dynamic stochastic general equilibrium models. Its affiliated members are Faculty members at St Andrews and elsewhere with interests in the broad area of dynamic macroeconomics. Its international Advisory Board comprises a group of leading macroeconomists and, ex officio, the University's Principal.

**The CDMA Conference 2007**, held in St. Andrews, 5th to the 7th of September 2007.

**Papers presented at the conference, in order of presentation:**

| Title | Author(s) (presenter(s) in bold) |
| --- | --- |
| Real and Nominal Rigidity in a Model of Equal-Treatment Contracting | **Jonathan Thomas (Edinburgh)** |
| Inflation Persistence | **Patrick Minford (Cardiff)** |
| Winners and Losers in Housing Markets | Nobuhiro Kiyotaki (Princeton), Kalin Nikolov (Bank of England) and **Alex Michaelides (LSE)** |
| Taylor Rules Cause Fiscal Policy Ineffectiveness | **Neil Rankin (Warwick)** |
| Modelling Multilateral Resistance in a Gravity Model with Exchange Rate Regimes | **David Cobham (Heriot-Watt)** |
| Inflation, Financial Development and Human Capital-Based Endogenous Growth: An Explanation of Eight Empirical Findings | **Max Gillman (Cardiff)** |
| Herding in Financial Markets | **Hamid Sabourian (Cambridge)** |
| Country Portfolio Dynamics | Michael B. Devereux (British Columbia) and **Alan Sutherland (St Andrews)** |
| Endogenous Exchange Costs in General Equilibrium | Charles Nolan (St Andrews) and **Alex Trew (St Andrews)** |
| Information, Heterogeneity and Market Incompleteness in the Stochastic Growth Model | **Liam Graham (UCL)** and Stephen Wright (Birkbeck) |
| Saddle Path Learning | Martin Ellison (Warwick) and **Joe Pearlman (London Metropolitan)** |
| Uninsurable Risk and Financial Market Puzzles | **Parantap Basu (Durham)** |
| Exchange Rates, Interest Rates and Net Claims<br>Capital Flows and Asset Prices | **Peter Sinclair (Birmingham)**<br>**Nobuhiro Kiyotaki (Princeton),** Kosuke Aoki (LSE) and Gianluca Benigno (LSE) |

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