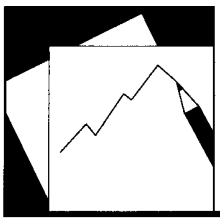
WP/08/249



IMF Working Paper

Trade Effects of Currency Unions: Do Economic Dissimilarities Matter?

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INTERNATIONAL MONETARY FUND

 WP/08/249

IMF Working Paper

IMF Institute

Trade Effects of Currency Unions: Do Economic Dissimilarities Matter?[1]

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Authorized for distribution by Marc Quintyn

October 2008

Abstract

This paper provides a general equilibrium analysis of the trade effects of the formation of a currency union, and of its subsequent enlargement to include an economically dissimilar country. Furthermore, it investigates how economic dissimilarities among countries affect the magnitude of the trade effects fostered by a common currency. We show that sharing a common currency enhances the volume of bilateral trade among countries. However, the more economically dissimilar is an accession country, compared to the original members of a currency union, the smaller are the gains in trade that would follow the enlargement of a currency union.

JEL Classification Numbers: F12; F15

Keywords: Currency Union; Enlargement; Economic Dissimilarities, Intra-industry Trade

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[1] I thank Tony Venables, Steve Redding, Gianmarco Ottaviano, and Frédéric Robert-Nicoud for their comments. The usual disclaimers apply.

Contents Page

I. INTRODUCTION

One of the most commonly identified benefits of currency unions is the potential increase in trade that they might foster among their members. In his seminal contribution, Mundell (1961) stressed that the main benefit of a currency union is to facilitate trade among its members while its main disadvantage is the loss of independent monetary policy. Rose (2000) was the first study to measure the direct impact of sharing a common currency on the international flows of trade.[2] Adding a common currency dummy to an augmented gravity model and estimating it on a sample of over 200 countries, he showed that sharing a common currency more than tripled bilateral trade between countries.

The magnitude of Rose's estimates of the "currency union effect" on trade generated a buoyant debate, and a number of studies followed proposing alternative methodologies to estimate how trade between countries is affected by the use of a common currency. These contributions refined the magnitude of the currency union effect but confirmed that sharing a common currency has a significant positive effect on trade. Glick and Rose (2001) using panel estimation techniques showed that sharing a common currency approximately doubles bilateral trade between pairs of countries. Rose and van Wincoop (2001) using sample prediction showed that the adoption of the euro by the members of the European Union could lead to an increase of 60 percent in the euro area trade. Frankel and Rose (2001) concluded that belonging to a currency union more than triples bilateral trade realized between pairs of member countries.[3]

In addition, Alesina, Barro and Tenreyro (2002), using an instrumental variable approach to the common currency dummy in the gravity model, showed a large positive currency union effect on trade. Alesina and Barro (2002) provided a model which incorporated the trade effects of currency unions showing that countries that trade more with each other would benefit more from the adoption of a common currency. Recently, Micco et al. (2003), showed that the formation of the European Monetary Union (EMU) had a significant positive effect on bilateral trade between members ranging between 4 and 10 percent, when compared to trade between all other pairs of countries, and between 8 and 16 percent when compared to trade between non-EMU countries.

The contribution of this paper to the literature on currency unions is twofold. First, it provides a general equilibrium analysis of the trade effects of the formation of a currency union, and of its subsequent enlargement to include an economically dissimilar country.

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[2] McCallum (1995) and Helliwell (1998) indicated that country borders matter for trade flows by showing that trade between Canadian provinces was 10 to 20 times greater than trade between a Canadian province and a US state.

[3] Thom and Walsh (2002) found no significant effect on the Anglo-Irish following Ireland's break with sterling due to its decision to enter the European Monetary System in 1979. In addition, Nitsch (2001), manipulating Rose (2000) data-set, showed that the estimated currency union effect on trade is halved. Persson (2001), applying non-parametric matching techniques to Rose (2000) data-set, showed that the currency union effect on trade only ranges between 45 percent and 13 percent.

Second, it investigates how economic dissimilarities among countries affect the magnitude of the trade effects fostered by the adoption of a common currency. Thus, our framework provides a useful analytical set-up to explain recent empirical findings on the trade effects of the formation of the EMU, and to assess the trade effects the envisaged eastward enlargement of the EMU might entail.

We develop a three-country intra-industry trade model in which economic dissimilarities across countries exist, and sharing a common currency affects the patterns of trade by reducing trade costs through the elimination of transaction costs due to the use of different currencies, and by a general equilibrium induced effect on the relative wages across countries.[4]

First, our analysis points out that the formation of a currency union affects the patterns of trade of both member and non-member countries by reducing trade costs between members, through the elimination of transaction costs, and by leading to a general equilibrium induced reduction of the relative wage in non-member countries. Taking into account these effects, we show that the formation of a currency union leads to an increase in the volume of bilateral trade between members and it reduces the volume of bilateral trade between member and non-member countries.

Second, we show that the enlargement of a currency union to include an economically dissimilar country affects the patterns of trade of the original members and of the accession country by reducing trade costs among them via the elimination of transaction costs, and by implying a general equilibrium induced increase in the relative wage in the accession country. In this regard, we prove that the enlargement leads to an increase in the volume of bilateral trade between the original members and the accession country while it reduces the volume of bilateral trade between the original members.

Finally, we assess the impact of greater economic dissimilarities among the original members and the accession country on the magnitude of the trade effects that would be fostered by the enlargement of the currency union. Simulating our model, we show that the more economically dissimilar is the accession country, compared to the original members of the currency union, the lower will be the gains in trade following the enlargement.

Thus, in line with recent empirical findings, our results highlight that the formation of the EMU should have lead to an increase in the volume of intra-industry bilateral trade between member countries. In addition, our results suggest that the eastward enlargement of the EMU

[4] Our analysis disregards other channels through which sharing a common currency may affect bilateral trade, i.e., eliminating the volatility in bilateral nominal exchange rates and increasing the transparency of markets. We also abstract from the loss of independent monetary policy of the member countries following the adoption of a common currency. See Emerson et al. (1992) for a formal presentation of the channels through which a monetary union may potentially affect trade among members. See Frankel and Wei (1992), and Eichengreen and Irwin (1995), and De Grauwe and Skudelny (2000) for an assessment of the effect of reduced exchange rate volatility on international trade. Furthermore, see De Grauwe (1994) for a detailed discussion of the effect sharing a common currency on the transparency of markets, and the implied loss of an independent monetary policy.

would enhance the volume of bilateral intra-industry trade between members and the eastern European accession countries.

However, our analysis also points out that the economic dissimilarities existing between EMU members and the eastern European accession countries would constrain the magnitude of the gain in bilateral trade between any EMU member and the accession countries. As a main policy implication, our work suggests that the gains in intra-industry trade that would follow the EMU eastward enlargement could be enhanced if the eastern European accession countries were to further reduce their economic dissimilarities with respect to the existing EMU members before adopting the euro.

II. THE BASIC MODEL

We consider that the world economy is constituted by three countries, labeled as X, Y and Z, all members of a regional trade agreement. In any country, consumers' preferences are:

$$U = C_M \quad \text{with} \quad C_M = \left[\sum_i c_i^{(\sigma-1)/\sigma} \right]^{\frac{\sigma}{(\sigma-1)}}, \tag{1}$$

c_i being the consumption of manufactured variety *i*, and $\sigma > 1$ the elasticity of substitution between any two varieties. Notably, consumers' income only derives from the labor provided to firms.

On the production side, we assume that in any country a manufacturing sector exists, with differentiated products, increasing returns to scale and monopolistic competition.[5] In any country the cost of introducing a new manufactured variety is zero, free entry and free exit exist in response to profits or losses, and firms can not internationally relocate. Furthermore, we assume that all countries are endowed with the same amount of labor and laborers cannot relocate across different countries.

Crucially, while countries Y and X are symmetric, country Z is economically dissimilar since its manufacturing production technology is less efficient. Notably, the fixed labor cost required to produce a manufactured variety in country Z is greater than in any of the two symmetric countries, Y and X. Thus, the labor input requirement for any manufactured variety produced in any of the two symmetric countries is:

$$l_R = \alpha_1 + \beta x_R, \qquad \text{with } \alpha_1 > 0 \text{ and } \beta > 0, \tag{2}$$

where x_R is the amount produced, and α_1 is the fixed labor input requirement.

[5] The monopolistic competition framework was introduced by the seminal work of Dixit and Stiglitz (1976). See Helpman and Krugman (1989), and Fujta, Krugman and Venables (1999) for a detailed discussion.

On the other hand, the labor input requirement for any manufactured variety produced in country Z is:

$$l_A = \alpha_2 + \beta x_A, \qquad \text{with } \alpha_2 > 0 \text{ and } \beta > 0, \tag{3}$$

where x_A is the amount produced, and α_2 is the fixed labor input requirement, with $\alpha_2 > \alpha_1$.

Focusing on the international flows of goods, we assume that iceberg trade costs exist on international trade of manufactured goods while no trade costs apply on domestic sales. So, shipping any manufactured good between any two countries melts a fraction of the shipment. Furthermore, trade costs on international flows of goods are the sum of non-rent creating trade barriers and transaction costs owing to the use of different currencies in the exchanges.[6]

Thus, trade costs applying on manufactured goods traded between any two countries are:

$$\tau_1 = \delta_1 + \theta, \tag{4}$$

where δ_1 represents the non-rent creating barriers, and θ represents the transaction costs due to the use of different currencies in the trade exchanges, with $\delta_1 > 1$ and $\theta > 1$.

III. THE INITIAL EQUILIBRIUM

Taking wage in countries Y and X to be the numeraire, and normalizing the labor force in any country, the aggregate income of laborers in countries Y and X and in the asymmetric country Z, respectively, are:

$$E_R = 1, \tag{5}$$

$$E_A = w_A, \tag{6}$$

where w_A is the wage laborers perceive in the asymmetric country.

Since the cost introducing a new manufactured variety is zero and all varieties enter consumers' demand in a symmetric way, there will be only one firm producing a given variety. Furthermore, since all manufacturing firms in a country use the same technology, all varieties produced within that country are symmetric and have the same price. Consumers' utility maximization implies that the demand in country *j* for a manufactured variety *i* produced in country *s*, is:

[6] See Alesina and Barro (2002) for a similar approach.

$$c_{ij} = \frac{\left(p_s \cdot \tau_1\right)^{(-\sigma)}}{P_j^{(1-\sigma)}}, \tag{7}$$

where P_j^0 is the manufactured composite index price of consumers located in country j, p_s is the mill or f.o.b. price of any manufactured variety produced in country s.

Taking the manufacturing composite price index as given, the profit-maximizing producer price of any manufactured variety is a constant mark-up over its marginal cost. Assuming manufactured goods to be measured in units chosen so that the unit input coefficient β equals (σ-1)/σ, all manufacturing firms in the symmetric countries will charge a unitary price, while all firms in the asymmetric country will charge a price equal to w_A. Consumers located in any of the two symmetric countries will pay a unitary price for varieties produced locally, and a price τ_1 and $w_A \cdot \tau_1$, respectively, for any variety produced in the other symmetric country and in the asymmetric country. Similarly, consumers in the asymmetric country will pay a price w_A for any local variety, and a price $w_A \cdot \tau_1$ for any imported variety.

Owing to free entry and exit in the manufacturing sector, the zero-profit condition implies that the equilibrium output of a firm located in any of the symmetric countries and in the asymmetric country are, respectively, equal to $\alpha_1 \cdot \sigma$ and $\alpha_2 \cdot \sigma$. Thus in symmetric countries Y and X, $1/\left(\alpha_1 \cdot \sigma\right)$ manufactured varieties are produced, while in the asymmetric country Z, $1/\left(\alpha_2 \cdot \sigma\right)$ varieties are produced. However, for any manufacturing firm the equilibrium output has to be equal to its equilibrium sales. So, manufacturing firms located in any country will break even if the equilibrium wage in the asymmetric country is such that the following condition, referred to as the wage equation, is verified:

$$w_A^{\sigma} - \frac{\left(\frac{\alpha_1}{\alpha_2}\right)^2 \cdot w_A^{(1-\sigma)} + 2\frac{\alpha_1}{\alpha_2}\tau_1^{(1-\sigma)}}{1 + \tau_1^{(1-\sigma)} + \frac{\alpha_1}{\alpha_2}\left(\tau_1 \cdot w_A\right)^{(1-\sigma)}} = 0 \tag{8}$$

Focusing on the international flows of goods, the volume of exports and imports of any symmetric country to and from the other member country, respectively, are:

$$EXP_R^R = IMP_R^R = \frac{\tau_1^{(1-\sigma)}}{1 + \tau_1^{(1-\sigma)} + \frac{\alpha_1}{\alpha_2}\left(\tau_1 \cdot w_A\right)^{(1-\sigma)}} \tag{9}$$

On the other hand, the volume of exports and imports of any member country to and from the excluded country, respectively, are:

$$EXP_A^R = \frac{\tau_1^{(1-\sigma)} \cdot w_A}{\frac{\alpha_1}{\alpha_2}\left(w_A\right)^{(1-\sigma)} + 2\tau_1^{(1-\sigma)}} \tag{10}$$

$$IMP_A^R = \frac{\tau_1^{(1-\sigma)} \cdot w_A^{-\sigma}}{\frac{\alpha_2}{\alpha_1} \cdot \left(1 + \tau_1^{(1-\sigma)}\right) + \left(\tau_1 \cdot w_A\right)^{(1-\sigma)}} \tag{11}$$

In the rest of the analysis, we define the volume of bilateral trade between any two countries as the sum of the volume of one country's exports and imports to and from the other.

IV. The Formation of a Currency Union

We consider that Y and X, the two symmetric members of the regional trading bloc, deepen their integration by forming a currency union.[7] The formation of the currency union is modeled as the elimination of the transaction costs due to the use of different currencies applying on trade flows. So, the formation of the currency union reduces trade costs on the flows of manufactured varieties between countries Y and X from the initial level τ_1 to δ_1, with $\delta_1 < \tau_1$. On the other hand, trade costs applying on trade flows between countries Y and X, members of the currency union, and the excluded country Z are unchanged at τ_1.

A. The General Equilibrium Effect on the Relative Wage

The formation of the currency union between the two symmetric members of the regional trading bloc will affect the equilibrium relative wage (in terms of the numeraire) in the excluded country Z, compared to the initial equilibrium. In this regard, we can state the following proposition:

Proposition 1. The formation of the currency union between the members of the regional trading bloc reduces the equilibrium relative wage in the excluded country.

Proof. See Mathematical Appendix.

The formation of the currency union reduces the level of trade costs applying to the flows of manufactured varieties between the member countries. Thus, consumers located in any of the member countries will perceive varieties produced in the other member country as relatively cheaper since their c.i.f. price decreases with respect to the initial equilibrium. So, they will increase their demand for manufactured varieties produced in the other member country, and to reduce their demand for varieties produced locally and in the excluded country.

[7] Our analysis focuses on the formation of a currency union as a form of deeper integration among countries in a regional trading bloc. However, our results can be generalized to any form of deepening of regional integration leading to a reduction in intra-bloc trade costs.

On the other hand, the reduction in trade costs will not affect the amount of production for which any manufacturing firm located in any of the member countries and in the excluded country, respectively, breaks even. Thus, the equilibrium relative wage in the excluded country will adjust such that the amount of sales of any manufacturing firm located in any of the member countries and in the excluded country equals the level of output for which the firm breaks even. Notably, the general equilibrium induced reduction in the excluded country will be such as to offset the effects of the reduction in intra-bloc trade costs on the sales of manufacturing firms located in any member country and in the excluded country.

In fact, the reduction in the equilibrium relative wage in the excluded country implies an equal reduction in the f.o.b. price of manufactured varieties produced in the excluded country, and in the income of consumers in the excluded country. Consumers in the member country, perceiving varieties produced in the excluded country as relatively cheaper, will increase their demand for these varieties while decreasing their demand for varieties in any of the member countries. In addition, the reduction in the income of consumers in the excluded country will reinforce the reduction in their demand for varieties produced in any of the member countries while limiting the increase in their demand for varieties produced locally.

B. The Effect on the Bilateral Patterns of Trade

The formation of the currency union affects the patterns of trade of countries Y and X, and of the excluded country Z, by reducing trade costs between its members through the elimination of transaction costs due to the use of different currencies, and by a general equilibrium induced reduction of the relative wage in the excluded country. First, we analyze the implications of the formation of the currency union on the volume of bilateral trade between members. In this regard, we can state the following proposition:

Proposition 2. The formation of the currency union unambiguously enhances the volume of bilateral trade realized between the member countries.

Proof. See Mathematical Appendix.

The formation of the currency union enhances the volume of bilateral trade between its members by increasing the volume of exports and imports realized by any member country from, and to the other member. On the one hand, the reduction in trade costs increases the volume of exports and imports of any member country from, and to the other member country. In fact, the reduction in trade costs implies that the equilibrium c.i.f. price paid by consumers located in any of the member countries for any manufactured variety produced in the other member country will decrease. So, they will increase their consumption of manufactured varieties produced in the other member country, perceiving them as relatively cheaper, compared to the initial equilibrium.

On the other hand, the general equilibrium induced reduction in the relative wage in the excluded country will reduce the volume of exports and imports realized by any member country from and to the other member country. The reduction in the relative wage in the excluded country will equally reduce the equilibrium f.o.b. price of varieties produced in

country Z. So, consumers in any of the member countries, perceiving varieties produced in the excluded country as relatively cheaper, will increase their consumption of those varieties while reducing their consumption of varieties produced in the other member country.

We emphasize that the reduction in the level of intra-bloc trade costs and the general equilibrium induced reduction in the relative wage in the excluded country implied by the formation of the currency union have opposite implications on the volume of bilateral trade realized between the member countries. However, as shown in the Mathematical Appendix, the positive effect of the reduction in trade costs on the volume of bilateral trade between members is greater than the negative effect of the reduction in the relative wage in the excluded country.

Notably, the volume of exports and imports of any member country to and from the other member country in the equilibrium characterized by the existence of a currency union between the symmetric members of the regional trading bloc is:

$$EXP_{1,R}^{R} = IMP_{1,R}^{R} = \frac{\delta_1^{(1-\sigma)}}{1+\delta_1^{(1-\sigma)}+\frac{\alpha_1}{\alpha_2}\left(\delta_1 \cdot w_A\right)^{(1-\sigma)}} \tag{12}$$

Focusing on the volume of bilateral trade between any member country and the excluded country Z, we highlight that trade costs applying to the flows of manufactured goods between any member country and excluded country are unaffected. In fact, since different currencies are still used in the trade exchanges between any of the member countries and the excluded country, transaction costs applying to these flows of manufactured goods will exist. Nonetheless, the formation of the currency union will affect the volume of bilateral trade between any of the member countries and the excluded country through the reduction trade costs among members and the general equilibrium induced reduction in the relative wage in the excluded country. At this regard, we can state the following proposition:

Proposition 3. The formation of the currency union unambiguously reduces the volume of bilateral trade realized between any of the members and the excluded country.

Proof. See Mathematical Appendix.

First, the formation of the currency union will reduce the volume of export of any member country to the excluded country Z, compared to the initial equilibrium. In fact, consumers in the excluded country will perceive local varieties as relatively cheaper since the reduction in the relative wage in the excluded country leads to an equal reduction in the equilibrium f.o.b. price of varieties produced in the excluded country. Thus, they will reduce their consumption of varieties produced in any of the members while increasing their consumption of local varieties. In addition, the reduction in their income will reinforce the reduction in their consumption of varieties produced in any of the member countries, while limiting the increase in their consumption of local varieties.

Furthermore, the formation of the currency union will reduce the volume of imports of any member country from the excluded country. Due to the reduction trade costs, consumers in any of the member countries, perceiving manufactured varieties produced in the other member as relatively cheaper, will increase their consumption of those varieties and reduce their consumption of those produced in the excluded country. However, the general equilibrium induced reduction in the relative wage in the excluded country, will increase the volume of imports of any member country from the excluded country. In fact, due to the reduction in the equilibrium f.o.b. price of varieties produced in the excluded country, consumers in any of the member countries will increase their consumption of those varieties, perceiving them as relatively cheaper.

We highlight that the reduction in trade costs between members and the general equilibrium induced reduction in the relative wage in the excluded country implied by the formation of the currency union have opposite implications on the volume of import of any member country from the excluded country. However, as shown in the Mathematical Appendix, the negative effect on the volume of imports of any member country from the excluded country of the reduction in trade costs is greater than the positive effect on the volume of imports of the reduction in the equilibrium relative wage in the excluded country.

So, the formation of the currency union unambiguously decreases the volume of bilateral trade between any of the member countries and the excluded country by reducing both the volume of exports and imports of any member to and from the excluded country compared to the initial equilibrium. Notably, the volume of exports and imports of any member country to and from the other member country in the equilibrium characterized by the existence of a currency union between the symmetric members of the regional trading bloc, are:

$$EXP_{1,A}^{R} = \frac{\tau_1^{(1-\sigma)} \cdot w_A}{\frac{\alpha_1}{\alpha_2}\left(w_A\right)^{(1-\sigma)} + 2\tau_1^{(1-\sigma)}} \tag{13}$$

$$IMP_{1,A}^{R} = \frac{\tau_1^{(1-\sigma)} \cdot w_A^{-\sigma}}{\frac{\alpha_2}{\alpha_1} \cdot \left(1 + \delta_1^{(1-\sigma)}\right) + \left(\tau_1 \cdot w_A\right)^{(1-\sigma)}} \tag{14}$$

V. THE ENLARGEMENT OF THE CURRENCY UNION

We consider that the currency union formed by the two symmetric members of the regional trading bloc enlarges to include the initially excluded country Z, labeled in the remaining of the analysis as the accession country.[8] Notably, we model the enlargement of the currency union as the elimination of the transaction costs due to the use of different currencies applying on trade exchanges. So, the enlargement of the currency union reduces trade costs

[8] In this paper, the choice for the currency union to enlarge and for the accession country to join is assumed to be exogenous. See Albertin (2007) for a formal analysis of the endogenous choice of a regional trading bloc to enlarge and for third countries to join.

on the flows of manufactured goods between any of the original member countries and the accession country from the initial level τ_1 to δ_1, with $\delta_1 < \tau_1$.

A. The General Equilibrium Effect on the Relative Wage

The enlargement of the currency union towards the accession country will affect the relative wage in the accession country compared to the equilibrium in which the accession country is excluded from the currency union. At this regard, we can state the following proposition:

Proposition 4. The enlargement of the currency union increases the equilibrium relative wage in the accession country compared to the equilibrium in which the accession country is excluded from the currency union.

Proof. See Mathematical Appendix.

The enlargement of the currency union leads to a reduction in the trade costs applying to the flows of manufactured varieties between any of the original members and the accession country. Consumers in any of the original member countries will perceive varieties produced in the accession country as relatively cheaper since their c.i.f. price decreases. Thus, consumers in any of the original member countries will increase their demand for varieties produced in the accession country while decreasing their demand for varieties produced locally and in the other original members. Similarly, consumers in the accession country, perceiving varieties in any of the original members as relatively cheaper, will increase their demand for those varieties while decreasing their demand of varieties produced locally.

However, the reduction in trade costs will not affect the amount of production for which any manufacturing firms breaks even. Thus, the equilibrium relative wage in the accession country will adjust such that the amount of sales of any manufacturing firm located in any of the original member countries and in the accession country equals the level of output for which firms break even. Notably, the general equilibrium induced increase in the relative wage in the accession country will be such to offset the effects of the reduction in trade costs on the sales of manufacturing firms located in any of the original member country and in the accession country.

The increase in the relative wage in the accession country will imply an equal increase in the equilibrium f.o.b. price of varieties produced in the accession country, and in the income of consumers in the accession country. Consumers in any of the original members, perceiving varieties produced in the accession country as relatively more expensive, will increase their demand for varieties produced locally and in other original member, and decrease their demand for those produced in the accession country. Consumers in the accession country, perceiving local varieties as relatively more expensive, will decrease their demand for those varieties and increase their demand for varieties produced in any of the original members. Notably, the increase in their income will reinforce the increase in their demand for varieties produced in any original member and limit the reduction in the demand for local varieties.

B. The Effect on the Bilateral Patterns of Trade

The enlargement of the currency union affects the patterns of trade of the original member countries and the accession country by reducing trade costs through the elimination of transaction costs due to the use of different currencies, and by leading to a general equilibrium induced increase in the relative wage in the accession country. Focusing on the implications of the enlargement on the volume of bilateral trade between any of the original members and the accession country, we can state the following proposition:

Proposition 5. The enlargement of the currency union unambiguously increases the volume of bilateral trade between any of the member countries and the accession country.

Proof. See Mathematical Appendix.

The enlargement of the currency union increases the volume of bilateral trade between any of the original member countries and the accession country by increasing the volume of exports and imports of any original member country to, and from the accession country.

First, the reduction in trade costs and the general equilibrium induced increase in the relative wage in the accession country will increase the volume of exports of any of the original member countries to the accession country, compared to the equilibrium in which the accession country is excluded from the currency union. Following the reduction in trade costs, consumers located in the accession country, perceiving manufactured varieties produced in any of the member country as relatively cheaper, will increase their consumption of those varieties. In addition, consumers located in the accession country, experiencing a positive income effect due to the increase in the equilibrium relative wage in the accession country, will increase their consumption of varieties produced locally and in any of the original member countries.

Furthermore, the increase in the relative wage in the accession country implies an equal increase in the equilibrium f.o.b. price of varieties produced in the accession country. Thus, consumers located in the accession country, perceiving varieties produced locally as relatively more expensive, will reduce their consumption of those varieties and increase their consumption of varieties produced in any of the original members.

On the other hand, the reduction in trade costs and the general equilibrium induced increase in the accession country's relative wage have opposite implications on the volume of import of any of the original member countries from the accession country. Due to the reduction in trade costs, consumers in any of the original member countries, perceiving manufactured varieties produced in the accession country as relatively cheaper, will increase their consumption of those varieties and decrease their consumption of varieties produced locally and in the other original member country.

However, since the increase in the equilibrium relative wage in the accession country implies an equal increase in the equilibrium f.o.b. price of varieties produced in the accession country, consumers located in any of the member countries will decrease their consumption

of these varieties, perceiving them as relatively more expensive. As shown in the Mathematical Appendix, the positive effect on the volume of imports of any original member country from the accession country implied by the reduction in extra-bloc trade costs is greater than the negative effect implied by the increase in equilibrium relative wage in the accession country.

The volume of exports and imports of any member country to and from the other member in the equilibrium characterized by the enlarged currency union, respectively, are:

$$EXP_{2,A}^{R} = \frac{\delta_1^{(1-\sigma)} \cdot w_A}{\frac{\alpha_1}{\alpha_2}\left(w_A\right)^{(1-\sigma)} + 2\delta_1^{(1-\sigma)}} \tag{15}$$

$$IMP_{2A}^{R} = \frac{\delta_1^{(1-\sigma)} \cdot w_A^{-\sigma}}{\frac{\alpha_2}{\alpha_1} \cdot \left(1 + \delta_1^{(1-\sigma)}\right) + \left(\delta_1 \cdot w_A\right)^{(1-\sigma)}} \tag{16}$$

Focusing on how the enlargement affects the volume of bilateral trade between the two original member countries, we can state the following proposition:

Proposition 6. The enlargement of the currency union unambiguously reduces the volume of bilateral trade between the original member countries.

Proof. See Mathematical Appendix.

The enlargement of the currency union reduces the volume of bilateral trade between the two original member countries by reducing the volume of exports and imports of any original member country to and from the accession country. First, the reduction in trade costs implies that the equilibrium c.i.f. price paid by consumers in any original member country for varieties produced in the accession country will decrease. Thus, consumers located in any of the original member countries, perceiving varieties produced in the other member country as relatively more expensive, will reduce their demand of those varieties.

On the other hand, the increase in the equilibrium relative wage leads to an equal increase in the equilibrium f.o.b. price of manufacturing varieties produced in the accession country. As a result, consumers located in any of the original members, perceiving varieties produced in the accession country as relatively more expensive, will decrease their consumption of these varieties while increasing their consumption of varieties produced locally and in the other original member country.

So, the reduction in trade costs and the general equilibrium induced increase in the relative wage in the accession country implied by the enlargement have opposite implications on the volume of bilateral trade between the original member countries. However, as shown in the Mathematical Appendix, the negative effect of the reduction of extra-bloc trade costs on the

volume of bilateral trade between the member countries is greater than the positive effect of the increase in the equilibrium relative wage in the accession country.

Notably, the volume of exports and imports of any member country to and from the other member in the equilibrium characterized by the enlarged the currency union, is:

$$EXP_{2,R}^{R} = IMP_{2,R}^{R} = \frac{\delta_1^{(1-\sigma)}}{1+\delta_1^{(1-\sigma)}+\frac{\alpha_1}{\alpha_2}\left(\delta_1 \cdot w_A\right)^{(1-\sigma)}} \tag{17}$$

VI. DO ECONOMIC DISSIMILARITIES MATTER?

We simulate our model under different values of the parameters to assess how greater technological inefficiency in the accession country affects the magnitude of the gain in bilateral trade between any original member and the accession country that would follow the enlargement of the currency union. Focusing on a marginal reduction in trade costs between the original members and the accession country, we summarize our results in Table 1.

In Case 1, the accession country is assumed to be almost as technologically efficient as the original members of the currency union, with a fixed labor input requirement in the accession country, relative to the one in the original members of 1.5. On the other hand, in Case 2, the accession country is assumed to be highly technologically inefficient compared to the original member countries, with a fixed labor input requirement in the accession country, relative to the one in the original members of 4.

In both cases we choose an elasticity of substitution of 5, to be in the middle of the range of estimates provided in Broda and Weinstein (2004) and Anderson and van Wincoop (2004), but we also experiment with values of 4 and 10 to cover the range of their empirical estimates.[9] Trade costs between any original member and the accession country of 1.6 are used to be in the middle of the estimates in Anderson and van Wincoop (2004), but we also provide simulations for the lower value of 1.4 and higher value of 1.8 to cover the range of their empirical estimates.[10] Finally, trade costs between the original members of 1.2 are chosen to replicate the estimates in Anderson and van Wincoop (2004), but we also experiment with values of 1.1 and 1.5 to reflect the possibility that trade costs might be higher than simple transportation costs.[11]

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[9] Broda and Weinstein (2004) estimated that the average elasticity of substitution in the U.S. for the period 1990-2001 was around eight for 10-digit goods, around five within 5-digit goods, and about four within 3-digit goods. Anderson and van Wincoop (2004) provided a survey of the empirical estimates of the elasticity of substitution in the trade literature, and showed that is in the range of four to ten.

[10] Anderson and van Wincoop (2004) estimated the tax equivalent of trade costs, including transport costs and border barriers to be in the range of 40-80 percent for industrialized countries.

[11] Anderson and van Wincoop (2004) estimated the tax equivalent of the transportation costs component of trade costs to be about 21 percent for industrialized countries.

Table 1. Simulations of the Gain in Bilateral Trade

	σ	δ_1	τ_1	α_2/α_1	**Gain in bilateral trade**
Case 1	5	1.2	1.6	1.5	0.43879
Case 2	5	1.2	1.6	4	0.43514
Lower σ	4	1.2	1.6	1.5	0.53417
Lower σ	4	1.2	1.6	4	0.44657
Higher σ	10	1.2	1.6	1.5	0.20153
Higher σ	10	1.2	1.6	4	0.14395
Lower δ_1	5	1.1	1.6	1.5	0.41994
Lower δ_1	5	1.1	1.6	4	0.39185
Higher δ_1	5	1.5	1.6	1.5	0.47096
Higher δ_1	5	1.5	1.6	4	0.43674
Lower τ_1	5	1.2	1.4	1.5	0.68202
Lower τ_1	5	1.2	1.4	4	0.66486
Higher τ_1	5	1.2	1.8	1.5	0.27701
Higher τ_1	5	1.2	1.8	4	0.27699

Our simulation analysis points out that the more technologically inefficient the accession country is, compared to the original members of the currency union, the lower is the gain in the volume of bilateral trade between any of the original member countries and the accession country that would follow the enlargement of the currency union. Greater technological inefficiency in the accession country will affects trade effects of the enlargement by reducing the f.o.b. price of varieties produced in the accession country before the enlargement, by enhancing the general equilibrium induced increase in the relative wage in the accession country, and by contracting the number of manufactured varieties produced in the accession countries.

Taking into account the above-mentioned effects, our simulations show that greater technological inefficiency in the accession country reduces the gain in the volume of exports of any original member to the accession country while increasing the gain in imports of any original member from the accession country. Notably, the reduction in the volume of exports of any member country to the accession country will dominate the increase in the gain in the volume of imports of any original member from the accession country.

VII. CONCLUSIONS

Recent empirical findings have suggested that sharing a common currency significantly enhances bilateral trade realized between pairs of countries. Our work provided a general equilibrium analysis of the trade effects of the formation of a currency union between the members of a regional trading bloc, and of the subsequent enlargement of this currency union to include an economically dissimilar country. In addition, we investigated the role played by economic dissimilarities across countries on the magnitude of the trade effects following the adoption of a common currency.

First, we showed that the formation of a currency union affects the patterns of trade by reducing trade costs between its members, through the elimination of transaction costs due to the use of different currencies, and by a general equilibrium induced reduction of the relative wage in the non-member countries. As a result, the formation of the currency union increases the volume of bilateral trade between the members increases while it reduces the volume of bilateral trade between any of the members and the excluded country.

Furthermore, we proved that the enlargement of the currency union to include an economically dissimilar country affects the patterns of trade by reducing trade costs between original members and the accession country, through the elimination of transaction costs due to the use of different currencies, and by a general equilibrium induced increase in the relative wage in the accession country. Considering these effects, we showed that the enlargement increases the volume of bilateral trade between any original member and the accession country, and it reduces the volume of bilateral trade between the original members.

Finally, we analyzed how economic dissimilarities between the original members of the currency union and the accession country affect the magnitude of the gain in the volume of bilateral trade that would follow the enlargement. Simulating our general equilibrium model, we showed that the more technologically inefficient the accession country is, compared to the original members of the currency union, the lower is the gain in the volume of bilateral trade between any original member and the accession country following the enlargement.

Our results are particularly relevant in light of the envisaged EMU eastward enlargement. In fact, our model suggests that the enlargement would increase the volume of bilateral intra-industry trade between EMU members and the accession countries. However, the existence of economic dissimilarities between EMU members and the eastern European accession countries would constrain the magnitude of those gains. As a main policy implication, our analysis suggests that the gains in trade that would follow the EMU enlargement could be enhanced if the accession countries were to further "catch up" before joining the EMU.

MATHEMATICAL APPENDIX

A. Proof of Proposition 1

The wage equation expressed in equation (8) can be rewritten as:

$$1-\frac{\left(\frac{\alpha_1}{\alpha_2}\right)^2\cdot w_A^{(1-2\sigma)}+2\frac{\alpha_1}{\alpha_2}w_A^{-\sigma}\tau_1^{(1-\sigma)}}{1+\tau_1^{(1-\sigma)}+\frac{\alpha_1}{\alpha_2}\left(\tau_1\cdot w_A\right)^{(1-\sigma)}}=0 \tag{18}$$

Being G the left-hand side of equation (18) and applying the implicit function theorem, we have:

$$\frac{\partial w_A}{\partial \tau_1}=-\frac{\frac{\partial G}{\partial \tau_1}}{\frac{\delta G}{\delta w_A}} \tag{19}$$

After some simplifications, we obtain:

$$\frac{\partial G}{\partial \tau_1}=\frac{-\left(\frac{\alpha_1}{\alpha_2}\right)\cdot(\sigma-1)\tau_1^{-\sigma}\cdot\left[\frac{\alpha_1}{\alpha_2}\cdot w_A^{(1-2\sigma)}+2w_A^{-\sigma}\tau_1^{(1-\sigma)}\right]}{\left[1+\tau_1^{(1-\sigma)}+\frac{\alpha_1}{\alpha_2}\left(\tau_1\cdot w_A\right)^{(1-\sigma)}\right]^2} \tag{20}$$

$$\frac{\partial G}{\partial w_A}=\frac{\left\{\begin{array}{l}\left[\left(2\sigma-1\right)\left(\frac{\alpha_1}{\alpha_2}\right)^2\cdot w_A^{-2\sigma}+2\frac{\alpha_1}{\alpha_2}\sigma w_A^{(-\sigma-1)}\cdot\tau_1^{(1-\sigma)}\right]\cdot\left(1+\tau_1^{(1-\sigma)}\right)+\\ +\sigma\left(\frac{\alpha_1}{\alpha_2}\right)^3\cdot w_A^{(1-3\sigma)}\cdot\tau_1^{(1-\sigma)}+2\left(\frac{\alpha_1}{\alpha_2}\right)^2\cdot w_A^{-2\sigma}\tau_1^{2(1-\sigma)}\end{array}\right\}}{\left[1+\tau_1^{(1-\sigma)}+\frac{\alpha_1}{\alpha_2}\left(\tau_1\cdot w_A\right)^{(1-\sigma)}\right]^2} \tag{21}$$

Since $\alpha_1>0$, $\alpha_2>0$, $\tau_1>1$ and $\sigma>1$, we have that $\frac{\partial G}{\partial \tau_1}<0$ and $\frac{\delta G}{\delta w_A}>0$. Thus, given equation (19), it follows that $\frac{\partial w_A}{\partial \tau_1}>0$.

B. Proof of Proposition 2

Given equation (9), the total derivative of the volume of bilateral trade between the member countries, $BIL_{1,R}^{\ R}$, with respect to τ_1, is:

$$\frac{\partial BIL_{1,R}^{\ R}}{\partial \tau_1} = \frac{2(1-\sigma)\tau_1^{-\sigma} \cdot \left[1 + \frac{\alpha_1}{\alpha_2} \cdot w_A^{(1-\sigma)} \tau_1^{(1-\sigma)}\right] + 2\frac{\alpha_1}{\alpha_2} \cdot (\sigma - 1) \cdot \tau_1^{2(1-\sigma)} \cdot w_A^{-\sigma} \cdot \frac{\partial w_A}{\partial \tau_1}}{\left[1 + \tau_1^{(1-\sigma)} + \frac{\alpha_1}{\alpha_2}(\tau_1 \cdot w_A)^{(1-\sigma)}\right]^2} \tag{22}$$

Since $\alpha_1 > 0$, $\alpha_2 > 0$, $\tau_1 > 1$ and $\sigma > 1$, the denominator of equation (22) is positive. After some manipulations, we have that its numerator is negative if:

$$\frac{\tau_1}{w_A} \cdot \frac{\partial w_A}{\partial \tau_1} < 1 + \frac{\alpha_2}{\alpha_2} \tau_1^{(\sigma-1)} w_A^{(\sigma-1)} \tag{23}$$

Given equations (19), (20) and (21), the above inequality is satisfied so that the total derivative in (22) is negative. We note that the partial derivative of BIL_R^R with respect to τ_1, assuming w_A to be unchanged, is:

$$\frac{\partial BIL_{1,R}^{\ R}}{\partial \tau_1, \overline{w}_A} = \frac{2(1-\sigma)\tau_1^{-\sigma} \cdot \left[1 + \frac{\alpha_1}{\alpha_2} \cdot w_A^{(1-\sigma)} \tau_1^{(1-\sigma)}\right]}{\left[1 + \tau_1^{(1-\sigma)} + \frac{\alpha_1}{\alpha_2}(\tau_1 \cdot w_A)^{(1-\sigma)}\right]^2} \tag{24}$$

Since $\sigma > 1$ the derivative is negative. In addition, the derivative of $BIL_{1,R}^{\ R}$ with respect to w_A, times the derivative of w_A with respect to τ_1 is:

$$\frac{\partial BIL_{1,R}^{\ R}}{\partial \tau_1} \cdot \frac{\partial w_A}{\partial \tau_1} = \frac{2\frac{\alpha_1}{\alpha_2} \cdot (\sigma - 1) \cdot \tau_1^{2(1-\sigma)} \cdot w_A^{-\sigma}}{\left[1 + \tau_1^{(1-\sigma)} + \frac{\alpha_1}{\alpha_2}(\tau_1 \cdot w_A)^{(1-\sigma)}\right]^2} \cdot \frac{\partial w_A}{\partial \tau_1} \tag{25}$$

Since $\frac{\partial w_A}{\partial \tau_1} > 0$, $\alpha_1 > 0$, $\alpha_2 > 0$, $\tau_1 > 1$ and $\sigma > 1$, the expression in (25) is positive.

C. Proof of Proposition 3

The total derivative of equation (10), with respect to τ_1 is:

$$\frac{\partial EXP_A^R}{\partial \tau_1} = \frac{\tau_1^{(1-\sigma)} \cdot \left[\frac{\alpha_1}{\alpha_2} \cdot w_A^{(1-\sigma)} + 2\tau_1^{(1-\sigma)} + (\sigma - 1)\frac{\alpha_1}{\alpha_2} w_A^{(1-\sigma)} \right] \cdot \frac{\partial w_A}{\partial \tau_1}}{\left[\frac{\alpha_1}{\alpha_2} (w_A)^{(1-\sigma)} + 2\tau_1^{(1-\sigma)} \right]^2} \tag{26}$$

Since $\frac{\partial w_A}{\partial \tau_1} > 0$, $\alpha_1 > 0$, $\alpha_2 > 0$, $\tau_1 > 1$ and $\sigma > 1$, the above derivative is positive for any value of the parameters. We note that the partial derivative of equation (10) with respect to τ_1, assuming w_A to be unchanged, is:

$$\frac{\partial EXP_A^R}{\partial \tau_1, \overline{w}_A} = 0$$

On the other hand, the derivative of equation (10) with respect to w_A, times the derivative of w_A with respect to τ_1, coincides with the total derivative in equation (26), and it is positive. The total derivative of equation (11), with respect to τ_1 is:

$$\frac{\partial IMP_A^R}{\partial \tau_1} = \frac{\frac{\alpha_2}{\alpha_1} \cdot (\sigma - 1) \cdot \tau_1^{(1-\sigma)} \cdot w_A^{-\sigma} \cdot \left[\tau_1^{(-\sigma)} \cdot w_A - \left(1 + \tau_1^{(1-\sigma)}\right) \cdot \frac{\partial w_A}{\partial \tau_1} \right]}{\left[\frac{\alpha_2}{\alpha_1} \left(1 + \tau_1^{(1-\sigma)}\right) + (\tau_1 \cdot w_A)^{(1-\sigma)} \right]^2} \tag{27}$$

Having assumed $\alpha_1 > 0$, $\alpha_2 > 0$, $\tau_1 > 1$ and $\sigma > 1$, the denominator of equation (27) is positive. Given equations (19), (20) and (21), its numerator is positive only if:

$$\frac{\partial w_A}{\partial \tau_1} = -\frac{\frac{\partial G}{\partial \tau_1} \cdot \left(1 + \tau_1^{(1-\sigma)}\right) - \tau_1^{(-\sigma)} \cdot w_A \cdot \frac{\partial G}{\delta w_A}}{\frac{\partial G}{\delta w_A} \cdot \left(1 + \tau_1^{(1-\sigma)}\right)} < 0 \tag{28}$$

Since $\frac{\delta G}{\delta w_A} > 0$ and $\frac{\partial G}{\partial \tau_1} < 0$, the above condition is verified so it follows that $\frac{\partial IMP_A^R}{\partial \tau_1}$ is positive. We note that the partial derivative of equation (11) with respect to τ_1, assuming w_A unchanged, is:

$$\frac{\partial IMP_A^R}{\partial \tau_1, \overline{w}_A} = \frac{\frac{\alpha_2}{\alpha_1} \cdot (\sigma - 1) \cdot \tau_1^{(-\sigma)} \left[\tau_1 \cdot w_A\right]^{(1-\sigma)}}{\left[\frac{\alpha_2}{\alpha_1}\left(1 + \tau_1^{(1-\sigma)}\right) + \left(\tau_1 \cdot w_A\right)^{(1-\sigma)}\right]^2} \tag{29}$$

Since $\alpha_1 > 0$, $\alpha_2 > 0$, $\tau_1 > 1$ and $\sigma > 1$, we have that $\frac{\partial IMP_A^R}{\partial \tau_1, \overline{w}_A}$ is positive. In addition, the partial derivative of equation (11) with respect to w_A times the derivative of w_A with respect to τ_1, is:

$$\frac{\partial IMP_A^R}{\partial w_A} \cdot \frac{\partial w_A}{\partial \tau_1} = \frac{\frac{\alpha_2}{\alpha_1} \cdot (1 - \sigma) \cdot \tau_1^{(1-\sigma)} \cdot w_A^{-\sigma} \cdot \left(1 + \tau_1^{(1-\sigma)}\right)}{\left[\frac{\alpha_2}{\alpha_1}\left(1 + \tau_1^{(1-\sigma)}\right) + \left(\tau_1 \cdot w_A\right)^{(1-\sigma)}\right]^2} \cdot \frac{\partial w_A}{\partial \tau_1} \tag{30}$$

Since $\frac{\partial w_A}{\partial \tau_1} > 0$, the expression in (30) is negative.

D. Proof of Proposition 4

The wage equation in the equilibrium characterized by the existence of a currency union between the two symmetric member countries is:

$$1 - \frac{\left(\frac{\alpha_1}{\alpha_2}\right)^2 \cdot \hat{w}_A^{(1-2\sigma)} + 2\frac{\alpha_1}{\alpha_2} \hat{w}_A^{-\sigma} \tau_1^{(1-\sigma)}}{1 + \delta_1^{(1-\sigma)} + \frac{\alpha_1}{\alpha_2}\left(\tau_1 \cdot \hat{w}_A\right)^{(1-\sigma)}} = 0 \tag{31}$$

Defining as G_1 the left-hand side of the above expression, the implicit function theorem implies that :

$$\frac{\partial \hat{w}_A}{\partial \tau_1} = -\frac{\frac{\partial G_1}{\partial \tau_1}}{\frac{\delta G_1}{\delta \hat{w}_A}} \tag{32}$$

After some simplifications, we have:

$$\frac{\partial G_1}{\partial \tau_1} = \frac{2\frac{\alpha_1}{\alpha_2}\cdot(\sigma-1)\tau_1^{-\sigma}\cdot\hat{w}_A^{-\sigma}\cdot\left[1+\delta_1^{(1-\sigma)}\right]-(\sigma-1)\cdot\left(\frac{\alpha_1}{\alpha_2}\right)^3\cdot\tau_1^{-\sigma}\cdot\hat{w}_A^{(2-3\sigma)}}{\left[1+\delta_1^{(1-\sigma)}+\frac{\alpha_1}{\alpha_2}\left(\tau_1\cdot w_A\right)^{(1-\sigma)}\right]^2} \tag{33}$$

$$\frac{\partial G_1}{\partial \hat{w}_A} = \frac{\left\{\begin{array}{l}\left[\left[(2\sigma-1)\left(\frac{\alpha_1}{\alpha_2}\right)^2\cdot\hat{w}_A^{-2\sigma}+2\frac{\alpha_1}{\alpha_2}\sigma\cdot\hat{w}_A^{(-\sigma-1)}\cdot\tau_1^{(1-\sigma)}\right]\cdot\left(1+\delta_1^{(1-\sigma)}\right)+\right.\\ \left.+\sigma\left(\frac{\alpha_1}{\alpha_2}\right)^3\cdot\hat{w}_A^{(1-3\sigma)}\cdot\tau_1^{(1-\sigma)}+2\left(\frac{\alpha_1}{\alpha_2}\right)^2\cdot\hat{w}_A^{-2\sigma}\tau_1^{2(1-\sigma)}\right\}}{\left[1+\delta_1^{(1-\sigma)}+\frac{\alpha_1}{\alpha_2}\left(\tau_1\cdot w_A\right)^{(1-\sigma)}\right]^2} \tag{34}$$

Since $\alpha_1 > 0$, $\alpha_2 > 0$, $\tau_1 > 0$ and $\sigma > 1$, $\frac{\partial G_1}{\partial \hat{w}_A}$ is positive. The denominator of expression (31) is positive and its numerator is positive if the following condition is verified:

$$\hat{w}_A > \frac{\left(\frac{\alpha_1}{\alpha_2}\right)^{\frac{1}{\sigma-1}}}{\left[2\cdot\left(1+\delta_1^{(1-\sigma)}\right)\right]^{\frac{1}{2(\sigma-1)}}} = 0 \tag{35}$$

If we substitute the right-hand side of (35) for $\hat{w}_A$ in equation (31), if the wage equation is not satisfied, $\hat{w}_A$ will not assume the specified value. Furthermore, since $\frac{\partial G_1}{\partial \hat{w}_A} > 0$, if G_1 is negative, $\hat{w}_A$ is greater than the specified value. Substituting the right-hand side of (35) for the equilibrium wage into G_1, it is possible to show that G_1 assumes a negative value. It follows that $\hat{w}_A$ satisfies the wage condition in (31) so that $\frac{\partial G_1}{\partial \tau_1} > 0$. Given equation (19), and being $\frac{\partial G_1}{\partial \tau_1} > 0$ and $\frac{\partial G_1}{\partial \hat{w}_A} > 0$, we have that $\frac{\partial \hat{w}_A}{\partial \tau_1} < 0$.

E. Proof of Proposition 5

The total derivative of (13) with respect to τ_1 is:

$$\frac{\partial EXP_{1,A}^{\ R}}{\partial \tau_1} = \frac{(1-\sigma)\tau_1^{(-\sigma)} \cdot \frac{\alpha_1}{\alpha_2} \cdot \hat{w}_A^{(2-\sigma)} + \frac{\partial \hat{w}_A}{\partial \tau_1} \cdot 2\tau_1^{2(1-\sigma)} + \sigma \frac{\alpha_1}{\alpha_2} \hat{w}_A^{(1-\sigma)} \cdot \tau_1^{(1-\sigma)} \cdot \frac{\partial \hat{w}_A}{\partial \tau_1}}{\left[\frac{\alpha_1}{\alpha_2}(\hat{w}_A)^{(1-\sigma)} + 2\tau_1^{(1-\sigma)}\right]^2} \tag{36}$$

Since $\alpha_1 > 0$, $\alpha_2 > 0$, $\tau_1 > 1$, $\sigma > 1$, and $\delta_1 > 1$, and, $\frac{\partial \hat{w}_A}{\partial \tau_1} < 0$ the above derivative is negative. We note that the partial derivative of equation (13) with respect to τ_1, assuming $\hat{w}_A$ to be unchanged, is:

$$\frac{\partial EXP_{1,A}^{\ R}}{\partial \tau_1} = \frac{(1-\sigma)\tau_1^{(-\sigma)} \cdot \frac{\alpha_1}{\alpha_2} \cdot \hat{w}_A^{(2-\sigma)}}{\left[\frac{\alpha_1}{\alpha_2}(\hat{w}_A)^{(1-\sigma)} + 2\tau_1^{(1-\sigma)}\right]^2} \tag{37}$$

Having assumed $\alpha_1 > 0$, $\alpha_2 > 0$, $\tau_1 > 1$, $\sigma > 1$, and $\delta_1 > 1$, the derivative in (37) is negative. In addition, the partial derivative of equation (13) with respect to $\hat{w}_A$, times the derivative of $\hat{w}_A$ with respect to τ_1, is:

$$\frac{\partial EXP_{1,A}^{\ R}}{\partial \tau_1} \cdot \frac{\partial \hat{w}_A}{\partial \tau_1} = \frac{2\tau_1^{2(1-\sigma)} + \sigma \frac{\alpha_1}{\alpha_2} \hat{w}_A^{(1-\sigma)} \cdot \tau_1^{(1-\sigma)} \cdot}{\left[\frac{\alpha_1}{\alpha_2}(\hat{w}_A)^{(1-\sigma)} + 2\tau_1^{(1-\sigma)}\right]^2} \cdot \frac{\partial \hat{w}_A}{\partial \tau_1} \tag{38}$$

Since $\alpha_1 > 0$, $\alpha_2 > 0$, $\tau_1 > 1$, $\sigma > 1$, and $\delta_1 > 1$, and $\frac{\partial \hat{w}_A}{\partial \tau_1} < 0$, the derivative in equation (38) is negative. The total derivative of equation (14) with respect to τ_1, is:

$$\frac{\partial IMP_{1,A}^{\ R}}{\partial \tau_1} = \frac{\left[(1-\sigma) \cdot \tau_1^{(-\sigma)} - \sigma\tau_1^{(1-\sigma)} \hat{w}_A^{-1} \cdot \frac{\partial \hat{w}_A}{\partial \tau_1}\right] \cdot \hat{w}_A^{-\sigma} \cdot \frac{\alpha_2}{\alpha_1} \cdot \left(1 + \delta_1^{(1-\sigma)}\right) - \tau_1^{2(1-\sigma)} \cdot \hat{w}_A^{-2\sigma} \cdot \frac{\partial \hat{w}_A}{\partial \tau_1}}{\left[\frac{\alpha_2}{\alpha_1}\left(1 + \delta_1^{(1-\sigma)}\right) + (\tau_1 \cdot \hat{w}_A)^{(1-\sigma)}\right]^2} \tag{39}$$

Since $\alpha_1 > 0$, $\alpha_2 > 0$, $\tau_1 > 1$, $\sigma > 1$, and $\delta_1 > 1$, the denominator of (39) is positive. Given equations (19), (20) and (21), it is possible to show that the numerator of the above derivative is negative only if the following condition is satisfied:

$$\frac{-\frac{\partial G_1}{\partial \tau_1} + \frac{\hat{w}_A}{\tau_1} \cdot \frac{\partial G_1}{\partial \hat{w}_A}}{\frac{\partial G}{\partial \hat{w}_A}} > 0 \tag{40}$$

Since $\frac{\partial G_1}{\partial \hat{w}_A} > 0$ and $\frac{\partial G_1}{\partial \tau_1} > 0$, and it is possible to show that $\frac{\hat{w}_A}{\tau_1} \cdot \frac{\partial G_1}{\partial \hat{w}_A} > \frac{\partial G_1}{\partial \tau_1}$, the above condition is verified so that the numerator of the derivative in (40) is negative. In addition, the partial derivative of equation (14) with respect to $\tau_1 > 1$, assuming $\hat{w}_A$ to be unchanged, is:

$$\frac{\partial IMP_{1,A}^{R}}{\partial \tau_1, \overline{w}_A} = \frac{\hat{w}_A^{-\sigma} \cdot (1-\sigma) \cdot \tau_1^{(-\sigma)} \cdot \frac{\alpha_2}{\alpha_1} \cdot \left(1 + \delta_1^{(1-\sigma)}\right)}{\left[\frac{\alpha_2}{\alpha_1}\left(1 + \delta_1^{(1-\sigma)}\right) + \left(\tau_1 \cdot \hat{w}_A\right)^{(1-\sigma)}\right]^2} \tag{41}$$

Since $\alpha_1 > 0$, $\alpha_2 > 0$, $\tau_1 > 1$, $\sigma > 1$, and $\delta_1 > 1$, the above derivative is positive. Finally, the derivative of equation (14) with respect to $\hat{w}_A$, times the derivative of $\hat{w}_A$ with respect to τ_1, is:

$$\frac{\partial IMP_{1,A}^{R}}{\partial \tau_1} \cdot \frac{\partial \hat{w}_A}{\partial \tau_1} = \frac{-\sigma \tau_1^{(1-\sigma)} \frac{\alpha_2}{\alpha_1} \cdot \left(1 + \delta_1^{(1-\sigma)}\right) \cdot \hat{w}_A^{(-\sigma-1)} - \tau_1^{2(1-\sigma)} \cdot \hat{w}_A^{(-2\sigma)}}{\left[\frac{\alpha_2}{\alpha_1} \cdot \left(1 + \delta_1^{(1-\sigma)}\right) + \left(\tau_1 \cdot \hat{w}_A\right)^{(1-\sigma)}\right]^2} \cdot \frac{\partial \hat{w}_A}{\partial \tau_1} \tag{42}$$

Since $\frac{\partial \hat{w}_A}{\partial \tau_1} < 0$, $\alpha_1 > 0$, $\alpha_2 > 0$, $\tau_1 > 1$, $\sigma > 1$, and $\delta_1 > 1$, the above expression is positive.

F. Proof of Proposition 6

Given equation (17), the total derivative of the volume of bilateral trade between the original members of the currency union, $BIL_{1,R}^{R}$, with respect to τ_1, is:

$$\frac{\partial BIL_{1,R}^{R}}{\partial \tau_1} = \frac{2 \cdot \delta_1^{(1-\sigma)} \cdot \frac{\alpha_1}{\alpha_2} \cdot (\sigma - 1) \left[\tau_1^{(-\sigma)} \cdot \hat{w}_A^{(1-\sigma)} + \tau_1^{(1-\sigma)} \cdot \hat{w}_A^{-\sigma} \cdot \frac{\partial \hat{w}_A}{\partial \tau_1} \right]}{\left[1 + \delta_1^{(1-\sigma)} + \frac{\alpha_1}{\alpha_2} (\tau_1 \cdot \hat{w}_A)^{(1-\sigma)} \right]^2} \tag{43}$$

The denominator of the above derivative is positive since $\alpha_1 > 0$, $\alpha_2 > 0$, $\tau_1 > 1$, $\sigma > 1$, and $\delta_1 > 1$. It is possible to show that its numerator is positive if $\frac{\partial \hat{w}_A}{\partial \tau_1} > -\frac{\hat{w}_A}{\tau_1}$, which we previously proved to be verified. So the total derivative in equation (43) is positive.

Notably, the partial derivative of the derivative of $BIL_{1,R}^{R}$ with respect to τ_1 assuming $\hat{w}_A$, unchanged, is:

$$\frac{\partial BIL_{1,R}^{R}}{\partial \tau_1} = \frac{2 \cdot \delta_1^{(1-\sigma)} \cdot \frac{\alpha_1}{\alpha_2} \cdot \tau_1^{(-\sigma)} \cdot \hat{w}_A^{(1-\sigma)}}{\left[1 + \delta_1^{(1-\sigma)} + \frac{\alpha_1}{\alpha_2} (\tau_1 \cdot \hat{w}_A)^{(1-\sigma)} \right]^2} \tag{44}$$

Since $\alpha_1 > 0$, $\alpha_2 > 0$, $\tau_1 > 1$, $\sigma > 1$, and $\delta_1 > 1$, the derivative in equation (44) is positive. In addition, the derivative of $BIL_{1,R}^{R}$ with respect to $\hat{w}_A$, times the derivative of $\hat{w}_A$ with respect to τ_1, is:

$$\frac{\partial BIL_{1,R}^{R}}{\partial \tau_1} \cdot \frac{\partial \hat{w}_A}{\partial \tau_1} = \frac{2 \cdot \delta_1^{(1-\sigma)} \cdot \frac{\alpha_1}{\alpha_2} \cdot (\sigma - 1) \cdot \tau_1^{(1-\sigma)} \cdot \hat{w}_A^{-\sigma} \cdot \frac{\partial \hat{w}_A}{\partial \tau_1}}{\left[1 + \delta_1^{(1-\sigma)} + \frac{\alpha_1}{\alpha_2} (\tau_1 \cdot \hat{w}_A)^{(1-\sigma)} \right]^2} \tag{45}$$

Since $\frac{\partial \hat{w}_A}{\partial \tau_1} < 0$, $\alpha_1 > 0$, $\alpha_2 > 0$, $\tau_1 > 1$, $\sigma > 1$, and $\delta_1 > 1$, the above derivative is negative.

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