Three essays on trade and transfers: country heterogeneity, preferential treatment and habit formation

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THREE ESSAYS ON TRADE AND TRANSFERS: COUNTRY HETEROGENEITY, PREFERENTIAL TREATMENT AND HABIT FORMATION

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Writing a thesis while working full-time is probably the toughest challenge I have faced so far. I believe that such capacity comes from above (2 Corinthians 3, 5).

À Aimée, mon épouse
À Joanie Grace

Résumé

Ma thèse est un ensemble d'essais à la fois théoriques et empiriques sur les transferts internationaux et le commerce entre pays hétérogènes. Dans le premier essai, j'utilise le modèle de guerre tarifaire développé par Kennan and Riezman (1988) et montre qu'avec des fonctions d'utilité Stone-Geary, la maximisation du bien-être global conduit à une solution en coin qui correspond au libre-échange. La résolution de ce problème suggère également une autre solution qui, lorsque les pays sont asymétriques, est tel que le Sud applique un tarif alors que le Nord subventionne ses importations. Cette solution est toutefois rejetée puisqu'elle correspond, non pas à un maximum, mais plutôt à un point de selle. Les résultats de cette recherche mettent en lumière l'inefficacité des accords de Lomé et de Cotonou conclus entre les pays ACP et l'Union européenne qui accordent un accès préférentiel aux exportations des pays ACP sur le marché européen et qui, par ailleurs, permettent aux ACPs de maintenir leurs tarifs. Cette étude permet ainsi de comprendre la transition qui s'opère dans les traités ACP-UE d'un système de tarifs préférentiels vers des accords de partenariat économique, lesquels sont compatibles avec les règles de l'OMC.

Dans le deuxième essai, je développe un modèle d'accord commercial entre deux pays hétérogènes (le Nord et le Sud) afin d'étudier l'effet d'un accord de libre-échange (ALE) sur le bien-être. Ces effets dépendent du type d'hétérogénéité considéré. Lorsque les fonctions d'offre sont suffisamment, le pays qui a des contraintes de capacité d'offre (CCO) – « le petit pays » – subit une perte de bien-être, contrairement à son partenaire dont le bien-être s'accroît. Dans ce cas précis, le petit pays ne ratifiera l'ALE que s'il reçoit un transfert compensatoire de son partenaire. Cependant, en présence d'une forte asymétrie de taille ou de suffisamment d'hétérogénéité dans les fonctions de demande, c'est le petit pays qui bénéfice de l'ALE, tandis que le grand pays subit une baisse de bien-être. Ainsi, le petit pays doit compenser le grand pays pour l'inciter à conclure l'ALE. Ce modèle permet de comprendre pourquoi les Accords de partenariat économique (APE) entre les pays ACP et l'UE prévoient une assistance technique et financière de l'UE aux ACP qui ont des CCOs. Par ailleurs, le test empirique avec les données ACP-UE montre que l'initiation des APEs intérimaires a un effet positif sur l'aide étrangère allouée par les pays de l'UE aux ACP lorsque l'hétérogénéité de l'offre est prise en compte dans le modèle.

Enfin, dans le troisième essai, j'utilise un modèle d'échange pur à deux périodes, afin d'étudier les effets de l'aide internationale sur le bien-être en présence de formation d'habitudes. En supposant que le Nord effectue le transfert en période 1, je montre que l'effet de ce dernier sur les termes de l'échange en période 2 opère à travers le paramètre mesurant les habitudes. Ainsi, en l'absence de formation d'habitudes, le transfert n'entraîne pas de distorsion des prix relatifs et donc, il n'y a pas de paradoxe des transferts. Je prouve que l'existence de ce dernier dépend essentiellement de la croissance des dotations totales des deux biens ; en effet, le paradoxe des transferts se produit lorsque la dotation totale du bien importé par le Nord (exporté par le Sud) augmente suffisamment plus que la dotation du bien qu'il exporte (importe). En outre, le modèle montre que l'impact du transfert sur les exportations est de courte durée, puisque l'effet d'habitudes diminue au fil du temps. Le test empirique réalisé à partir des données de l'aide internationale et des exportations françaises vers 32 pays ACP corrobore cette prédiction, puisque le transfert stimule les exportations françaises vers ces pays avec un retard d'une période. La contribution de cet article est de décrire le processus par lequel l'aide étrangère bénéficie aux pays donateurs à travers la formation des habitudes dans les pays récipiendaires de l'aide.

Abstract

My dissertation is a theoretical and empirical study of international transfers and trade between heterogeneous countries. In the first essay, I use the trade war model developed by Kennan and Riezman (1988) with Stone-Geary preferences and show that free trade is the corner solution to the maximization of the global welfare. This maximization problem yields a candidate solution that corresponds to a tariff-subsidy combination where the South (the small country) applies a tariff against its imports, while the North (the large country) subsidies its imports when countries are asymmetric. This candidate solution is of course rejected as it corresponds to a saddle point. These findings shed light on the inefficiency of the unilateral privileged access that ACP countries enjoyed on the European market under the Lomé and the Cotonou agreements, while keeping their tariffs high. In addition, this paper explains the transition from such treaties to WTO-compatible economic partnership agreements.

In the second essay, I develop a standard North-South trade agreement model between two heterogeneous countries. I find that the welfare effects of a free trade agreement (FTA) depends on the type of heterogeneity considered. In the presence of sufficient heterogeneity in the supply functions, the country experiencing supply-side constraints (SSCs) - " the small country" - is worse off, while the bigger is better off. In this case, the transfer flows from the large to the small country. However, when countries are sufficiently heterogeneous with respect to either size or demand functions, the small country is better off, while the large country is worse off. Thus, the small country must compensate the large country for the FTA to be incentive-compatible. This model provides an interesting explanation of the FTA between the ACP countries and the EU (Economic Partnership Agreements, EPAs). Indeed, the EPA provides for technical and financial assistance from the EU to the ACP to enable them to overcome the supply constraints. Testing this prediction with ACP-EU data, I find that the initiation of the interim EPA has a positive effect on foreign aid allocation decision when supply heterogeneity is taken into account.

Finally, using a two-period pure exchange model of free trade, in the third essay, I study the welfare effects of foreign aid in the presence of habit formation. Assuming that the North makes a transfer only in the first period, I show that the terms-of-trade effect of the transfer in the second period operates through the habit parameter; in other words, in the absence of habit formation, the transfer does not distort relative prices and thus, there is no transfer paradox. I prove that its existence crucially depends on the growth of total endowments; actually, the transfer paradox occurs when the world endowment of the North's import (the South's export) good increases sufficiently more that of its export (import) good. Moreover, the model shows that the export-enhancing effect of the transfer is short-lived, since the habit formation effect decreases over time. Testing this claim with aid and trade data between France and 32 ACP countries, I find that only one period lagged transfer affects french exports. The contribution of this essay is to describe the process by which foreign aid benefits the donor country through the formation of habits in the recipient country for the good it exports.

Contents

General Introduction

Recent years have witnessed a major change in the development policy of both bilateral and multilateral donors. The Economic Partnership Agreements (EPAs) between the EU and the ACP countries are good evidence of the ongoing transformation of North-South development and trade relationships. Under the EPAs, ACP countries have to liberalize more their trade, while the EU removes trade preferences. In fact, the disappointing result of this policy instrument (preferential access to the EU market) has led donors to consider alternative channels to assist developing countries more effectively. Strengthening developing nations' trade capabilities appears to be one of the chosen strategies to help poor nations reap the benefits of global free trade.

With the signing of interim economic partnership agreements (EPAs) in late 2007, the long-lasting economic treaties between the African, Caribbean and Pacific (ACP) and the European Union (EU) gradually move away from non-reciprocal preferential arrangements to free trade agreements (FTAs). In fact, under the different treaties that have governed the ACP-EU relations, ACP countries enjoyed not only preferential tariffs, but also preferences for foreign aid treatment.[1] As noted by van der Staak (2006: 50), "the European Union has a long history of offering trade agreements in combination with financial assistance to African countries."[2]

However, this privileged treatment discriminated the ACP group from other developing countries and was incompatible with WTO rules; a negotiated waiver allowed this practice until January 2008, after which it has been progressively replaced by reciprocal EPAs between the EU and each of the six regional trade blocs of ACP countries (Fontagné, Laborde and

[1] These treaties are known successively as the Yaoundé conventions (1963-1975), the Lomé conventions (1975-2000) and the Cotonou agreements (2000-2007).

[2] In fact, since the Yaounde agreements signed in 1960s - the period when most African colonies became independent from their European metropoles, the successive ACP-EU treaties have included not only trade but also development and political dimensions. Thus, the ACP-EU relationship was considered unique in the world (Nwobike, 2012).

Mitaritonna, 2011). As of July 2014, the CARIFORUM[3] and 12 individual ACP countries have signed an "interim EPA" with the EU covering trade in goods in compliance with WTO rules, although 7 others initiated the process in 2007 (see table 0.1 below). The EU and the ACP countries are still negotiating full EPAs that will cover not in trade in goods, but also services, investment and standards.

As shown in table 0.2, most ACP Least developed Countries (LDCs) have not signed yet, probably because they can take advantage of the Everything But Arms (EBA) Initiative. Under the EBA, all imports (except arms and ammunition) from ACP LDCs enter the EU market duty and quota free; Candau and Jean (2009) note the under-utilization of EBA among ACP LDCs, which they explain by the presence of the Cotonou Agreement, a competing and less-restrictive preference system that has existed for a long time. Apart from EBA beneficiaries, 3 African countries and 7 from the Pacific decided not to engage EPA negotiations with the EU. Actually, the volume of trade between the Pacific and the EU is very limited, except for the two major countries - Papua New Guinea and Fiji - that concluded an interim EPA. Gabon, Congo-Brazzaville and Nigeria abstained from entering into interim EPAs with the EU due to the fact that their economies are essentially based on oil exports which enjoy a duty free access into the EU. Although it did not benefit from the Cotonou trade regime, South Africa participates in to the SADC EPA negotiation, given its strategic importance to country members of the South African Customs Union (SACU), whose end could very damaging to them. In fact, Botswana, Lesotho, Namibia and Swaziland get most of their revenue from the customs controlled by South Africa (OPPD, 2012).[4]

It is widely recognized that the recent proliferation of trade agreements worldwide has eroded the general system of preferences that major economies such as the EU or the USA grant to poor nations, particularly for ACP countries, whose export products are a function of these preferences. One can then expect that the conclusion of EPAs entail considerable costs for these economies, given their "very low adjustment capacity because of a combination of deficient capital markets, obstacles to labor mobility, the absence of safety nets, and the lack of training capacities" (Bouët, Fontagné and Jean, 2006).

[3]CARIFORUM members are Antigua and Barbuda, Bahamas, Barbados, Belize, Dominica, Dominican Republic, Grenada, Guyana, Haiti, Jamaica, St Lucia, St Vincent and the Grenadines, St Kitts and Nevis, Suriname, Trinidad and Tobago.

[4]South Africa concluded a trade agreement with the EU in 1999, known as the Trade, Development and Co-operation Agreement (TDCA). Therefore, it did not initiated an interim EPA.

In view of these constraints, the EPAs are intended to be a gradual and asymmetrical process, including safeguard measures to protect infant industries and to protect any production sector threatened by imports. ACP countries are granted a long transition period (up to 25 years) to reduce their tariffs in order to develop their competitiveness over the medium and long term ; moreover, ACP countries maintain their tariffs on goods that are sensitive to EU imports,[5] while the EU fully liberalizes its trade without delay.[6]

In addition, EPAs provide for financial support from the EU to the ACP for specific purposes, namely to develop various capacities stated in the agreement. Article 8 of the EU-CARIFORUM EPA is very eloquent in this regard:

Article 8 Cooperation priorities

1. Development cooperation as provided for in Article 7 shall be primarily focused on the following areas as further articulated in the individual Chapters of this Agreement:

(i) The provision of technical assistance to build human, legal and institutional capacity in the CARIFORUM States so as to facilitate their ability to comply with the commitments set out in this Agreement; (ii) The provision of assistance for capacity and institution building for fiscal reform in order to strengthen tax administration and improve the collection of tax revenues with a view to shifting dependence from tariffs and other duties and charges to other forms of indirect taxation; (iii) The provision of support measures aimed at promoting private sector and enterprise development, in particular small economic operators, and enhancing the international competitiveness of CARIFORUM firms and diversification of the CARIFORUM economies; (iv) The diversification of CARIFORUM exports of goods and services through new investment and the development of new sectors; (v) Enhancing the technological and research capabilities of the CARIFORUM States so as to facilitate development of, and compliance with, internationally recognised sanitary and phytosanitary measures and technical standards and internationally recognised labour and environmental standards; (vi) The development of CARIFORUM innovation systems, including the development of technological capacity; (vii) Support for the development of infrastructure in CARIFORUM States necessary for the

[5] Sensitive products include those of vulnerable industries and goods where import duties represent an important share of government revenues.

[6] Exceptions apply to rice and sugar where free access starts in 2010 and 2015 respectively.

conduct of trade.

Negotiations for EPAs between the EU and the ACP countries that did not sign interim EPAs are still ongoing. In fact, the prospect of more aid related to the free trade agreement is one of 'the carrots' keeping them on the negotiation table, given their high dependence on aid for their annual budgets (Alavi, Gibbon and Niels Jon, 2007).

The above account sheds light on two important phases in the EU-ACP relationships: the first phase, from the Yaoundé convention to the Cotonou agreement, where the EU granted preferential tariffs in combination with foreign aid, and a second transitional phase, that of the interim EPAs, in which the ACP countries sign a partial free trade agreement and receive transfers to facilitate adjustments.

The objective of this thesis is to develop theoretical and empirical models that explain both types of trade agreements as well as transfer payments they include. In other words, the three essays of this thesis answer the following questions: what is the interest of a rich economy like the EU in letting a poor country apply high tariffs and, at the same time, grant preferential tariffs? What explains the following passage of a system of unilateral preferences to free trade? Why the EPA include temporary transfers, this time in the context of free trade? Does foreign aid benefit donors by promoting their exports?

Table 0.1. Interim EU-ACP EPAs

Region	**Country**	**Date of signature**
West Africa	Côte d'Ivoire	26 November 2008
	Ghana	2007*
Central Africa	Cameroon	15 January 2009
Eastern and Southern Africa (ESA)	Madagascar	August 2009
	Mauritius	August 2009
	Seychelles	August 2009
	Zimbabwe	August 2009
Eastern African Community (EAC)	Burundi	28 November 2007*
	Kenya	28 November 2007*
	Rwanda	28 November 2007*
	Tanzania	28 November 2007*
	Uganda	28 November 2007*
South African Development Community (SADC)	Botswana	4 June 2009
	Lesotho	4 June 2009
	Swaziland	4 June 2009
	Mozambique	15 June 2009
	Namibia	3 December 2007*
Caribbean	CARIFORUM	October 2008
Pacific	Papua New Guinea	30 July 2009
	Fiji	11 December 2009

Source: European Commision (EC), "An Overview Of The Interim Agreements", accessed on August 02, 2014 at http://trade.ec.europa.eu/doclib/docs/2009/january/tradoc_142188.pdf
Other sources: EC, several fact sheets on the interim EPAs on different ACP regions.

Note: * corresponds to the date of the initiation of EPA negotiation (not signed yet)

Table 0.2. Trade Regime after 01/01/08 by ACP country[1]

EPA configuration	**EPA (10 LDCs, 26 non-LDCs)**	**EBA (31 LDCs)**	**GSP (10 non-LDCs)**
Caribbean	*Antigua & Barb* *Dom. Republic* *St Kitts & Nevis* *Bahamas* *Grenada* *St Lucia* *Barbados* *Guyana* *St Vinc. & Gren.* *Belize* *Haiti* *Surinam* *Dominica* *Jamaica* *Trinidad &Tob.*		
Central Africa	*Cameroon*	Central African Rep. Equat. Guinea DR Congo Chad São Tome	*Gabon* *Rep. Congo*
ESA	EAC: Burundi Kenya, *Kenya* Rwanda, Tanzania Uganda ESA: Comoros *Zimbabwe*, Madagascar *Mauritius*, *Seychelles* Zambia	Djibouti Somalia Eritrea Sudan Ethiopia Malawi	
Pacific	*Papua New Guinea* Fiji	East Timor Solomon Islands Kiribati Tuvalu Samoa Vanuatu	*Cook Islands* *Micronesia* *Tonga* *Palau* *Marshall I.* *Nauru* *Niue*
West Africa	*Côte d'Ivoire* *Ghana*	Benin Guinea Bissau Niger Burkina Faso Liberia Senegal Cape-Verde[2] Mali Sierra Leone Gambia Mauritania Togo Guinea	*Nigeria*
SADC	*Botswana* *Namibia* *Swaziland* Lesotho Mozambique	Angola	

Source: European Commision (EC), "An Overview Of The Interim Agreements" at http://trade.ec.europa.eu/doclib/docs/2009/january/tradoc_142188.pdf

1. Non-LDCs are shown in italic and South Africa is not included as its trade regime is unaffected by the expiry of the Cotonou trade preferences

2. Cape Verde loses its LDC status in 2008 but will continue to benefit from GSP EBA for a transitional period

Country size and trade agreements

The first essay tackles the two first questions mentioned above. For many decades, not only did ACP countries enjoy unilateral trade preferences in the EU market, but they were also allowed to maintain high tariffs. Yet, the trade war literature (Johnson, 1953-44; Kennan and Riezman, 1988; Syropoulos, 2002) sheds light on the economic reasons for which a large country would want to apply an import tariff. We learn from that literature that when a country enjoys market power, it is better off under a tariff war - namely a situation where both countries apply their Nash tariffs - than free trade. My starting point is Kennan and Riezman (1988, hereafter KR (1988)); I develop a North-South pure exchange model of trade and use Stone-Geary utility functions instead of Cobb-Douglas. Contrary to KR (1988), free trade always dominates the trade war equilibrium, regardless of countries' endowments. This theoretical finding points to the commercial benefits a large country gains from signing a free trade agreement (FTA) with a small trading partner. It is recognized today that leading world economies like the EU use FTAs as instruments of its "raw material diplomacy" whose aim is to secure access to raw materials by eliminating export restrictions in face of competitors such as BRIC countries (Ramdoo, 2011).

In this study, I use the trade war model developed by Kennan and Riezman (1988, hereafter, KR) with Stone-Geary preferences to show that free trade is the corner solution to the maximization of the global welfare. The maximization problem yields a candidate solution that corresponds to a tariff-subsidy combination where the South (the small country) applies a tariff against its imports, while the North (the large country) subsidies its imports when countries are asymmetric. This candidate solution is of course rejected as it corresponds to a saddle point.

This finding provides a theoretical argument to the transition from the privileged market access to free trade agreements. In fact, the disappointing results of the long lasting preferential treatment that ACP countries enjoyed in the EU market, while being among the most protected markets, has called for alternative trade arrangements.

Country heterogeneity, financial compensation and international trade agreements : a study of ACP-EU agreements

In the second essay, I develop a standard North-South trade agreement model à la Bond and Park (2002) to analyze three different sources of heterogeneity. In fact, countries are not only heterogeneous in size, but also either in their demand for goods or in their supply capacities. I find that the welfare effects of a free trade agreement (FTA) depends on the type of heterogeneity considered. When size asymmetry or heterogeneity in the demand functions is considered, the small country is always better off, while the large country can be worse off. Thus, the small country must compensate the large country for the FTA to be incentive-compatible. However, in the presence of sufficient heterogeneity in the supply functions, the small country experiencing supply-side constraints (SSCs) is worse off, while the bigger country is better off. In this case, the transfer must flow from the large to the small country. This last result provides a theoretical account of temporary transfers that the EU provides to ACP signatories under the interim EPAs.

In the empirical part of the second essay, I confront the above theoretical predictions with foreign aid data from the EU donors to the ACP countries. Demand heterogeneity is captured by the ratio of the recipient's GDP on the expenditure side to the donor's GDP on the expenditure side. Finally, supply heterogeneity is computed in a like manner using the stock of capital. Following the theory, I run one regression for each dimension of heterogeneity. Since the theory predicts that the small country (or the one with the smaller demand) makes a compensation payment to the large country (or the one with a larger demand) in the presence of heterogeneity in size (or in aggregate demand), foreign aid is expected to decrease after the initiation of the interim EPA. On the contrary, in the presence of supply heterogeneity, foreign aid is expected to increase. This is exactly what the empirical results reveal. Indeed, the initiation of the interim EPA has a positive (resp. negative) effect on foreign aid allocation decision when supply (resp. demand or size) heterogeneity is taken into account. Since the degree of heterogeneity matters for the amount of the transfer, it turns out that aid allocation decreases with each measure of heterogeneity.

Foreign aid and habit formation in a trade model

The positive effect of foreign aid on donor exports is empirically well-established (Lloyd, McGillivray, Morrissey, and Osei, 2000; Martínez-Zarzoso, Nowak-Lehmann, Klasen and Larch, 2009; Nilsson, 1997). This is theoretically explained by habit formation: using a two-period model, Djajic, Lahiri, and Raimondos-Moller (2004, hereafter DLR (2004)) argue that the first-period transfer changes the second-period preferences of the recipient in favor of the donor's export product. As a consequence, the recipient imports more of the donor's product in the second period. Unfortunately, their paper just invokes without explicitly modeling the recipient's habit forming behavior. The third essay helps filling this gap in the literature, by modeling habit formation in a two-period pure exchange model of free trade.

As in DLR (2004), I assume that the North makes a transfer only in the first period and show that the terms-of-trade effect of the transfer operates through the habit parameter; in other words, in the absence of habit formation, the transfer does not distort relative prices and thus, there is no transfer paradox. I prove that its existence crucially depends on the growth of total endowments; actually, the transfer paradox occurs when the world endowment of the North's import (the South's export) good increases sufficiently more that of its export (import) good. Moreover, the model shows that the export-enhancing effect of the transfer is short-lived, since the habit formation effect decreases over time. Testing this claim with aid and trade data between France and 32 ACP countries from 1980 to 2011, I find that only one period lagged transfer affects french exports. The contribution of this essay is to describe the habit formation process by which foreign aid benefits the donor country.

Chapter 1

Country size and trade agreements

1.1 Introduction

In the aftermath of the independence of African countries, the European Community (EC) and its Member States signed a treaty of cooperation with their ex-colonies. Known as the Yaounde convention, this treaty and its successors include both trade agreements and development aid but also political cooperation in the international arena.[1] In fact, under these different treaties, African, Caribbean and Pacific (ACP) countries enjoyed tariff preferences in the European market (a form a subsidy to foreign exporters), despite being among the most protected markets.

The European Commission (1996) notes that the impact of the EC trade preferences to the ACP countries over a period of 30 years has been disappointing, given the sharp decline of ACP share in European imports.[2] Thus, the preferential system failed to meet some goals of the ACP-EU agreements, namely poverty reduction, sustainable development and the gradual integration of the ACP countries into the world economy (see article 1 of the Cotonou agreement). The disappointing outcome of the preferential access policy led the EC to consider alternative channels

[1] After the Yaounde convention (1963-1975), European and ACP states signed the four Lome conventions (1975-2000) and the Cotonou agreement (2000-2007). Since 2008, the EU has signed interim EPAs with some ACP countries and others are under negotiation. The present analysis focuses on treaties that were in force before 2008.

[2] The OPPD (2012) notes a decline in the ACP share in European imports from nearly 8% in 1975 to 2.8% in 2000, while non-ACP developing countries that did not benefit from the Lome trade preferences outpaced the ACP countries in their exports to the EU.

to assist ACP countries more effectively. Therefore, the EC initiated the Economic Partnership Agreements (EPAs) with the ACP countries, which are free trade agreements that include a development policy aimed at fighting poverty and underdevelopment (OPPD, 2012).

Using the trade war model developed by Kennan and Riezman (1988, hereafter, KR) with Stone-Geary preferences, I show that free trade is the corner solution to the maximization of the global welfare for all possible distributions of endowments. The underlying maximization problem yields a candidate solution that corresponds to a tariff-subsidy combination where the South (the small country) applies a tariff against its imports, while the North (the large country) subsidies its imports when countries are asymmetric. This candidate solution is of course rejected as it corresponds to a saddle point.

The main contribution of this paper is to show that free trade benefits both countries whether they are heterogeneous in endowment size or not. This result provides a theoretical support to the transition from a privileged access to free trade agreements (EPAs), which supposedly deliver better outcomes. Moreover, it sheds light on the inefficiency of the long-lasting ACP-EU commercial treaties, where ACP countries were allowed to keep high tariffs, while benefiting from a privileged access to the EU market.

Moving to the self-enforcement of trade agreements, I determine the critical discount factor of the North and the South using numerical simulations. For a free trade agreement (FTA), the South always has a smaller discount factor than the North.

The present work is related to two strands of the trade. First, this article is related to the trade war literature. In their seminal paper, Kennan and Riezman (1988) use a pure exchange model with Cobb-Douglas preferences and compare welfare levels under Nash tariff and free trade for all possible endowments. They find that "sufficiently" big countries win the trade war.[3] Actually, their simulations reveal that, both countries are better off under free trade in most cases. The fact that a big country is better off under trade war than free trade is not a rule of thumb; cases where this is true are fewer than those where both countries' utilities increase when free trade prevails. By using Stone-Geary instead of Cobb-Douglas preferences, the present study shows that free trade dominates the trade war equilibrium for all possible endowments.

For some researchers, a tariff negotiation between two countries of different size may result in a tariff-subsidy equilibrium (TSE);

[3]Syropoulos (2002) obtains a similar result using a neoclassical trade model where the relative size is defined as the ratio of the number of workers in both countries

Chongbunwatana (2004) find that a trade agreement involving heterogeneous countries is such that the large country imposes a tariff and the small country subsidies its imports. His simulation result is derived from a Nash bargaining in a pure exchange model of trade where the trade equilibrium with tariffs is compared to autarky. Using a graphical analysis, Mayer (1981) shows the existence of tariff-subsidy equilibria that dominate the tariff war; when countries are asymmetric, the outcome of the tariff negotiation is such that the small country will apply an import subsidy to induce the large country to lower its tariff.[4] This result rests on the assumption that the small country is better off when it adopts unilaterally free trade in a non-cooperative tariff game; thus in a cooperative, applying a subsidy may induce the large country to adopt a smaller tariff than the one that prevails under a tariff war. As a result, both countries are better off under the TSE. Moreover, Mayer (1981) finds that free trade may not be attainable if one country is better off at the tariff retaliation point than in free trade.

The present analysis helps to understand the recent evolution of the ACP-EU trade relationships. During the Lomé conventions up to the end of the Cotonou agreement in 2007, ACP countries were granted a unilateral privileged market access to the European market, but were free to set their trade policies.[5] The poor performance of ACP countries in terms of trade, development and growth over a period more than 50 years evidences the inefficiency of these agreements. With the signing of EPAs, the ACPs give more trade concessions to their European partners. By so doing, ACP-EU arrangements become more in line with WTO regulations. The model predicts that both signatories to an FTA derive direct benefits from such treaty. At first glance, this finding can appear counterfactual, given the tiny commercial interests of the EU in ACP countries and the marginal share of the latter in the global trade. However, given the presence of competitors like BRIC countries for energy and non-energy resources, the ACP-EU EPAs can be perceived as an instrument of the EU "raw material diplomacy" whose aim is to secure access to affordable raw materials by eliminating export restrictions (Ramdoo, 2011).[6,7] On one hand, free trade

[4] A tariff (or trade) war refers to a non-cooperative Nash equilibrium of a static tariff game between two welfare maximizing countries (Syropoulos, 2002).

[5] This treaty signed in 1975 is actually an expansion of the 1963's first Yaounde convention between the Europe and the French-speaking African countries to include the United Kingdom and English-speaking countries of the Pacific ocean and the Caribbean islands.

[6] This is known as "the raw materials initiative" developed by the European Commission.

[7] In a study of the EU reactions to violations of democratic principles in Africa,

will be economically beneficial to European countries, as it provides them with better access to raw materials, which *"are essential for the sustainable functioning of modern societies"* (European commission, 2008). In fact, the EU relies heavily on imports of "high-tech" metals for which some African countries are among the leading suppliers. On the other hand, ACP countries, provided that they overcome supply capacity constraints that have prevented them to take advantage of preferences in the EU market, will benefit from free trade.

The remainder of this article is as follows. Section 2.2 presents the model and the theoretical results. Section 2.3 presents the empirical test of the model using ACP-EU foreign aid data. Finally, section 2.4 concludes.

Del Biondo (2012) notes a tolerance towards resource-rich countries. This finding sheds additional light on the EU raw material diplomacy.

1.2 The Model

The economic environment

Consider a static pure exchange model in the spirit of Kennan and Riezman (1988, hereafter KR). Two countries, the North (without *) and the South (with *), trade two goods, x and y. In both countries, the representative consumer has Stone-Geary (SG) preferences given by[8]:

$$u(x,y) = \left(1 + x^{(*)}\right)\left(1 + y^{(*)}\right) \tag{1.1}$$

where $x^{(*)}$ and $y^{(*)}$ are consumption of x and y in each country.

This simple SG utility allows to express countries' trade policy in terms of endowments of both goods, which they are initially endowed with. The world endowment for each good is normalized to 1. The endowment structure is as follows: the North has $1-\gamma$ of units x and μ of y, while the South has γ units of x and $1-\mu$ of y. Assume that the North (resp. the South) has a comparative advantage in y (resp. x) and that the South is smaller than or is of equal size as the North ($0.5 < \gamma \leq \mu \leq 1$).[9] Following this assumption, the trade pattern is as follows: the North (resp. the South) imports good x (resp. y) and exports good y (resp. x).

Each country has a unique trade policy instrument denoted by τ_x and τ_y^* respectively. This instrument corresponds to an ad valorem tariff if $\tau_i > 0$, with $i \in \{x, y\}$ and to an import subsidy otherwise. For notational ease, let $t = 1 + \tau_x$ and $s = 1 + \tau_y^*$. In each of the countries, the domestic prices are given by $p_x = tp_x^w$, $p_y^* = sp_y^w$, $p_x^* = p_x^w$; $p_y = p_y^w$. In the presence of a tariff (subsidy), the domestic price of the imported good is higher (smaller) than the corresponding international price.

Consumers spend their income on both goods; in this model, income consists of the value of endowments at home prices, plus (minus) tariff (subsidy) revenue as it is assumed that the tariff (subsidy) proceeds are distributed to (collected from) consumers in a lump-sum fashion. The

[8]KR (1988) use a Cobb-Douglas (CB) function of the form $u(x,y) = x \cdot y$. Under both CD and SG functions, each country's utility is concave in its tariff and convex in its trading partner's tariff. As shown below, the main difference between both functions resides in the welfare effects of a free trade: with SG preferences, both countries' Nash welfare is smaller than their welfare under free trade. On the contrary, with CD preferences, the country with the sufficiently large (resp. small) endowments is better off (resp. worse off) under its Nash welfare than its welfare under free trade.

[9]The assumption captures the fact that aid dependent countries are always poorer than the donors; I allow for both countries to be of the same size for comparison purposes.

countries' budget constraints can be written as:

The North

$$tp_x^w(1-\gamma) + p_y^w\mu + (t-1)\,p_x^w Z_x = I \tag{1.2}$$

$$tp_x^w x + p_y^w y = I \tag{1.3}$$

The South

$$p_x^w\gamma + sp_y^w(1-\mu) + (s-1)\,p_y^w Z_y = I^* \tag{1.4}$$

$$p_x^w x^* + sp_y^w y^* = I^* \tag{1.5}$$

where I and I^* are the incomes, Z_i are imports of good $i \in \{x, y\}$ and $x^{(*)}$, $y^{(*)}$ are equilibrium consumptions.

Equations (1.2) and (1.4) above respectively give the North's and the South's incomes as functions of their endowments ($\mathcal{IF}$), while (1.3) and (1.5) are countries' expenditure functions ($\mathcal{EF}$). From the above definitions, one can see that trade is balanced: for each country, the value of imports equals the value of exports.

This completes the presentation of the pure exchange model. In what follows, I first derive the equilibrium consumption of both goods x, y and the utility in terms of γ, μ, s, t. Turning to the trade analysis, I determine the global optimal tariffs at the intersection of trade policy reaction functions. The Nash tariffs are found in a similar way. Finally, I compare utility levels under both regimes to free trade.

Equilibrium consumption and trade

The problem of the Northern representative consumer is to choose the consumption bundle (x, y) to maximize its utility given by (1.1) subject to the budget constraint (1.3). The Lagrangian is formulated as follows:

$$L\,(x, y, \lambda) = u\,(x, y) + \lambda\mathcal{IF}\,(x, y) \tag{1.6}$$

Since x and y are the objects of choice, the first-order conditions (FOCs) of the Lagrangian are

$$\frac{\partial L\left(x,y,\lambda\right)}{\partial x}=1+y-\lambda t p_x^w=0 \tag{1.7}$$

$$\frac{\partial L\left(x,y,\lambda\right)}{\partial y}=1+x-\lambda p_y^w=0 \tag{1.8}$$

Rearranging both expressions and dividing (1.7) by (1.8) gives:

$$\frac{1+y}{1+x}=\frac{tp_x^w}{p_y^w} \tag{1.9}$$

Likewise, the consumer optimization in the South implies:

$$\frac{1+y^*}{1+x^*}=\frac{p_x^w}{sp_y^w} \tag{1.10}$$

To determine the quantities traded in equilibrium, I following KR (1988). Re-write $x=1-\gamma+Z_x$, $y=\mu-Z_y$, $x^*=\gamma-Z_x^*$ and $y^*=1-\mu+Z_y^*$. Inserting these expressions into (1.9) and (1.10) brings the following system of equations

$$\begin{cases} tp_x^w\left(2-\gamma+Z_x\right)-p_y^w\left(1+\mu-Z_y\right)=0 \\ p_x^w\left(1+\gamma-Z_x^*\right)-sp_y^w\left(2-\mu+Z_y^*\right)=0 \end{cases} \tag{1.11}$$

To solve the system (1.11), one needs to find the trade balance equation by subtracting (1.3) from (1.2) (or (1.5) from (1.4)):

$$\begin{gathered} p_x^w(\underbrace{1-\gamma-x}_{Z_x<0})+p_y^w(\underbrace{\mu-y}_{Z_y>0})=0 \\ p_x^w(\underbrace{\gamma-x^*}_{Z_x^*>0})+p_y^w(\underbrace{1-\mu-y^*}_{Z_y^*<0})=0 \end{gathered} \tag{1.12}$$

$Z_i<0$ (resp. $Z_j>0$) if a country exports (resp. imports) good i (resp. j). Let x be the *numéraire* good such that $p_x^w=1$; isolating p_y from each equation in (1.12) brings

$$p_y^w = \frac{Z_x}{Z_y} = \frac{Z_x^*}{Z_y^*} \tag{1.13}$$

From (1.13), one can easily see that trade is balanced ($Z_x = Z_x^*$ and $Z_y = Z_y^*$). (1.12) can be transformed into

$$\begin{cases} tZ_y\left(2-\gamma+Z_x\right) - Z_x\left(1+\mu-Z_y\right) = 0 \\ Z_y\left(1+\gamma-Z_x\right) - sZ_x\left(2-\mu+Z_y\right) = 0 \end{cases} \tag{1.14}$$

The solution to the system of equations (1.14) is given by

$$Z_x^E = \frac{1-4st-\gamma\left[st(\mu-2)-\mu-1\right]+\mu+2st\mu}{1+3s+\mu+st\left(2-\mu\right)} \tag{1.15}$$

$$Z_y^E = \frac{1+\mu+2st\left(\mu-2\right)+\gamma\left[(1-st(\mu-2)+\mu)\right]}{1+\gamma+3t+st\left(2-\gamma\right)} \tag{1.16}$$

Inserting (1.15) and (1.16) into (1.13) brings the North's ToT as $p_y = \frac{1+\gamma+3t+2st-st\gamma}{1+\mu+3s++2st-st\mu}$; the South's ToT are simply the reverse of the North's. As shown below, each country improves (deteriorates) its (partner's) terms-of-trade by raising its tariff:

$$\frac{\partial ToT}{\partial t} = \frac{3(1+s)\left[1+\mu+s\left(2-\gamma\right)\right]}{\left[1+3s+\mu+st\left(2-\mu\right)\right]^2} > 0 \quad \frac{\partial ToT}{\partial s} = -\frac{3(1+t)\left[1+\gamma+t\left(2-\mu\right)\right]}{\left[1+3s+\mu+st\left(2-\mu\right)\right]^2} < 0$$

$$\frac{\partial ToT^*}{\partial s} = \frac{3(1+t)\left[1+\gamma+t\left(2-\mu\right)\right]}{\left[1+\gamma+3t+st\left(2-\gamma\right)\right]^2} > 0 \quad \frac{\partial ToT^*}{\partial t} = -\frac{3(1+s)\left[1+\mu+t\left(2-\gamma\right)\right]}{\left[1+\gamma+3t+st\left(2-\gamma\right)\right]^2} < 0$$

In each country, equilibrium consumptions of x, y are respectively

- for the North

$$\begin{pmatrix} x^E \\ \\ y^E \end{pmatrix} = \begin{pmatrix} \frac{2(1+\mu)+3s(1-\gamma)+st(\mu-2)}{1+3s+\mu+st(2-\mu)} \\ \\ \frac{3t\mu-1-\gamma+2st(2-\gamma)}{1+\gamma+3t+st(2-\gamma)} \end{pmatrix}$$

- for the South

$$\begin{pmatrix} x^{*E} \\ \\ y^{*E} \end{pmatrix} = \begin{pmatrix} \frac{3s\gamma-1-\mu+2st(2-\mu)}{1+3s+\mu-st(2-\mu)} \\ \\ \frac{2(1+\gamma)+3t(1-\mu)+st(\gamma-2)}{1+\gamma+3t+st(2-\gamma)} \end{pmatrix}$$

To express countries' utilities as functions of endowments and tariffs, simply insert x^E and y^E (resp. x^{*E} and y^{*E}) into (1.1).

Figure 1.1 shows that a country's welfare is concave in its own trade policy instrument (TPI) and convex in its partner's. The vertical axis measures utility, while the horizontal axis (x-axis) measures the TPI. Point 1 on the x-axis corresponds to zero-tariff; all the points located at the left (right) of the zero-tariff point correspond to a situation where a country applies an import subsidy (tariff). It can easily be seen that a country's utility decreases with both countries' tariffs, but increases with its partner's subsidy. In addition, subsidizing imports reduces one country's utility. In the upper panel of figure 1, the maximum point is reached when a country applies its Nash tariff.

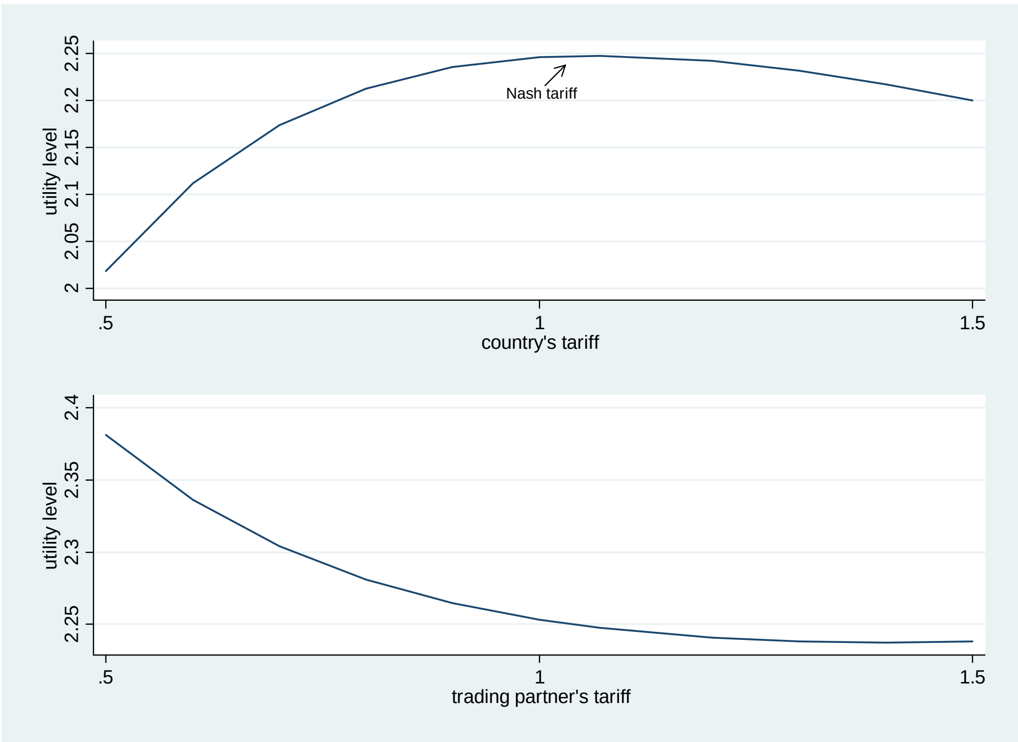

Figure 1.1: Concavity and convexity of the utility function for $\gamma = \mu = 0.6$

By totally differentiating utility functions w.r.t to s and t, I show that countries are worse off when they apply positive tariffs if $\gamma = \mu$. Since the analytical proof is similar for both countries, I focus on the North's utility $u(x(s,t), y(s,t))$. Set $p_x = 1$ and divide the FOC (1.7) by (1.8):

$$\frac{\partial u/\partial x}{\partial u/\partial y} = \frac{t}{p_y(s,t)} \Rightarrow \frac{\partial u}{\partial y} = \frac{\partial u}{\partial x} \cdot \frac{p_y(s,t)}{t} \tag{1.17}$$

The first-derivative of $u(x(s,t), y(s,t))$ w.r.t to s is implicitly given by

$$\frac{\partial u}{\partial s} = \frac{\partial u}{\partial x} \cdot \frac{\partial x}{\partial s} + \frac{\partial u}{\partial y} \cdot \frac{\partial y}{\partial s} \tag{1.18}$$

Inserting (1.17) into (1.18):

$$\frac{\partial u}{\partial s} = \frac{\partial u}{\partial x}\left(\frac{\partial x}{\partial s} + \frac{\partial y}{\partial s} \cdot \frac{p_y(s,t)}{t}\right) \tag{1.19}$$

The North's trade balance (1.12) can be used to isolate p_y:

$$(1-\gamma-x) + p_y(\mu - y) = 0 \Rightarrow p_y = \frac{x-(1-\gamma)}{\mu - y} \tag{1.20}$$

Using (1.20) into (1.19):

$$\frac{\partial u}{\partial s} = \frac{\partial u}{\partial x}\left(\frac{\partial x}{\partial s} + \frac{\partial y}{\partial s} \cdot \frac{x-(1-\gamma)}{t(\mu - y)}\right) \tag{1.21}$$

Totally differentiating $u(x(s,t), y(s,t))$ w.r.t to s and t and using (1.21) with its equivalent expression for $\partial u/\partial t$ gives

$$\partial u = \frac{\partial u}{\partial s}ds + \frac{\partial u}{\partial t}dt = \frac{\partial u}{\partial x}\left(\frac{\partial x}{\partial s} + \frac{\partial x}{\partial t} + \left(\frac{\partial y}{\partial s} + \frac{\partial y}{\partial t}\right) \cdot \frac{x-(1-\gamma)}{t(\mu - y)}\right) \tag{1.22}$$

To sign (1.22), I first sign the partial derivatives of x and y w.r.t to s and t. It turns out that:

$$\frac{\partial x}{\partial s} = -\frac{3(1+\mu)(1+\gamma+t(2-\mu))}{[1+\mu+3s+st(2-\mu)]^2} < 0; \qquad \frac{\partial x}{\partial t} = -\frac{3s(2-\mu)(1+\mu+s(2-\gamma))}{[1+\mu+3s+st(2-\mu)]^2} < 0$$

$$\frac{\partial y}{\partial s} = \frac{3t(2-\mu)(1+\gamma+t(2-\mu))}{[1+\gamma+3t+st(2-\gamma)]^2} > 0 \qquad \frac{\partial y}{\partial t} = \frac{3(1+\gamma)(1+\mu+s(2-\gamma))}{[1+\gamma+3t+st(2-\gamma)]^2} > 0$$

Under symmetry ($\gamma = \mu$), it turns out that $\partial x/\partial s = -\partial y/\partial t$, $\partial y/\partial s = -\partial x/\partial t$ and $p_y = 1$; the export (import) volume of goods x and y are equal. Thus,

$$\partial u \mid_{\gamma=\mu} = \frac{\partial u}{\partial s} ds + \frac{\partial u}{\partial t} dt = \frac{\partial u}{\partial x} \left(\frac{\partial x}{\partial s} + \frac{\partial x}{\partial t} + \left(\frac{\partial y}{\partial s} + \frac{\partial y}{\partial t} \right) \cdot \frac{1}{t} \right) < 0$$

It can be shown numerically that (1.22) is always negative even for $\gamma < \mu$.

Table 1.1: Tariffs and welfare as functions of endowments

Endowments		Welfare under the candidate solution				Nash utility				Utility under free trade	
γ	μ	s^c	t^c	$u(s^c, t^c)$	$u^*(s^c, t^c)$	s^N	t^N	u^N	u^{*N}	u^{FT}	u^{*FT}
0.6	0.6	1.0	1.0	2.250	2.250	1.07	1.07	2.247	2.247	2.250	2.250
0.6	0.7	2.0	0.50	2.250	2.250	1.10	1.11	2.398	2.096	2.403	2.103
0.6	0.8	3.0	0.33	2.250	2.250	1.13	1.15	2.553	1.947	2.560	1.960
0.6	0.9	4.0	0.25	2.250	2.250	1.16	1.21	2.714	1.801	2.723	1.823
0.6	1.0	5.0	0.20	2.250	2.250	1.20	1.26	2.881	1.656	2.890	1.690
0.7	0.7	1.0	1.00	2.250	2.250	1.14	1.14	2.240	2.240	2.250	2.250
0.7	0.8	1.5	0.67	2.250	2.250	1.18	1.19	2.389	2.085	2.403	2.103
0.7	0.9	2.0	0.50	2.250	2.250	1.21	1.24	2.544	1.931	2.560	1.960
0.7	1.0	2.5	0.40	2.250	2.250	1.24	1.30	2.705	1.779	2.723	1.823
0.8	0.8	1.0	1.00	2.250	2.250	1.22	1.22	2.227	2.227	2.250	2.250
0.8	0.9	1.33	0.75	2.250	2.250	1.26	1.28	2.375	2.067	2.403	2.103
0.8	1.0	1.67	0.60	2.250	2.250	1.29	1.34	2.531	1.908	2.560	1.960
0.9	0.9	1.0	1.00	2.250	2.250	1.31	1.31	2.209	2.209	2.250	2.250
0.9	1.0	1.25	0.80	2.250	2.250	1.35	1.38	2.357	2.042	2.403	2.103
1.0	1.0	1	1.00	2.250	2.250	1.41	1.41	2.184	2.184	2.250	2.250

Tariffs and welfare

In this section, I compare the utility levels under the Nash equilibrium to the GOTs. The Nash equilibrium prevails when countries set their tariffs non-cooperatively. Optimal tariffs are derived through the optimization of countries' utility functions. Starting with the North, inserting $\left(x^E, y^E\right)$ into (1.1) brings

$$max\, \underset{t}{u}(x,y) = (1+\underbrace{\frac{2\left(1+\mu\right)+3s\left(1-\gamma\right)+st\left(\mu-2\right)}{1+3s+\mu+st\left(2-\mu\right)}}_{\bar{x}^E})(1+\underbrace{\frac{3t\mu-1-\gamma+2st\left(2-\gamma\right)}{1+\gamma+3t+st\left(2-\gamma\right)}}_{\bar{y}^E}) \tag{1.23}$$

The FOC of (1.23) w.r.t t gives the North's reaction function (u_t):

$$\frac{9\left[1+s\left(2-\gamma\right)+\mu\right]^2}{\left[1+3s\left(1-\left(2-\mu\right)t^2\right)+\gamma\left(1+3s+s^2t^2\left(2-\mu\right)+\mu\right)-2s^2t^2\left(2-\mu\right)+\mu\right]}=0 \tag{1.24}$$

Proceeding similarly with the South,

$$max\, \underset{s}{u}^*(x,y) = \left(1+\frac{3s\gamma-1-\mu+2st\left(2-\mu\right)}{1+3s+\mu-st\left(2-\mu\right)}\right)\left(1+\frac{2\left(1+\gamma\right)+3t\left(1-\mu\right)+st\left(\gamma-2\right)}{1+\gamma+3t+st\left(2-\gamma\right)}\right) \tag{1.25}$$

The South's tariff reaction function (u_s^*) is

$$\frac{9\left[1+t\left(2-\mu\right)+\gamma\right]^2}{\left[1+3t\left(1-2s^2+\mu\right)+\gamma\left(1+s^2t\left(3+t\left(2-\mu\right)\right)+\mu\right)-2s^2t^2\left(2-\mu\right)+\mu\right]}=0 \tag{1.26}$$

The intersection of the two tariff reaction functions determines the Nash tariffs (denoted by t^N and s^N). Solving the system of equations (1.24) and (1.26) gives:

$$\left(s^N,\, t^N\right) = \left(\left(\frac{1+\mu}{2-\gamma}\right)^{\frac{1}{2}};\left(\frac{1+\gamma}{2-\mu}\right)^{\frac{1}{2}}\right) \tag{1.27}$$

These tariffs look very much like KR (1988), who obtain the following Nash tariffs $(S,\, T) = \left(\left(\mu/\left(1-\gamma\right)\right)^{\frac{1}{2}};\left(\gamma/\left(1-\mu\right)\right)^{\frac{1}{2}}\right)$ with a Cobb-Douglas utility.[10] Nash welfare levels are obtained after inserting $\left(s^N, t^N\right)$ back into countries' utility functions. Table 1.1 presents numerical values of Nash tariffs and utilities for different values of γ, μ : when countries are symmetric $(\gamma = \mu)$, their Nash tariffs and utility levels are identical. In the presence of size asymmetry $(\gamma < \mu)$, the North apples a higher Nash tariff and reaches a higher utility level than the South.[11] The welfare gap between countries increases with their difference in size.

The global optimal tariffs (GOTs) are the solutions to the maximization problem of the world welfare, $W = u\left(x, y\right) + u^*\left(x, y\right)$ (Bagwell and Staiger 1999, 2002); as for Nash tariffs, GOTs are found at the intersection of countries' reaction functions ($\partial W/\partial s$ and $\partial W/\partial t$). The underlying maximization problem yields the following candidate solution

$$\left(s^c,\, t^c\right) = \left(\frac{2\mu - 1}{2\gamma - 1};\, \frac{2\gamma - 1}{2\mu - 1}\right) \tag{1.28}$$

Note that the same results obtain with a Cobb-Douglas utility function as in KR (1988). I perform a second derivative test for the critical point $(s^c,\, t^c)$. The corresponding Hessian is given by :

$$\begin{bmatrix} W_{ss}\left(\cdot\right) = -\frac{1}{4}\frac{(1+\mu)(2-\gamma)(2\gamma-1)^3}{(2\mu-1)(\gamma-1+\mu)^2} & W_{st}\left(\cdot\right) = -\frac{1}{8}\frac{(2\gamma-1)(2\mu-1)(2\gamma\mu-\gamma-\mu+5)}{(\gamma-1+\mu)^2} \\ W_{ts}\left(\cdot\right) = -\frac{1}{8}\frac{(2\gamma-1)(2\mu-1)(2\gamma\mu-\gamma-\mu+5)}{(\gamma-1+\mu)^2} & W_{tt}\left(\cdot\right) = -\frac{1}{4}\frac{(1+\gamma)(2-\mu)(2\mu-1)^3}{(2\gamma-1)(\gamma-1+\mu)^2} \end{bmatrix}$$

The principal minors are respectively $\Delta_1\left(s^c,\, t^c\right) \equiv W_{ss} < 0$ and $\Delta_2\left(s^c,\, t^c\right) = W_{ss} \cdot W_{tt} - \left(W_{st}\right)^2 = -\frac{9}{64}\frac{(2\gamma-1)^2(2\mu-1)^2}{(\gamma+\mu-1)} < 0$. Thus, $(s^c,\, t^c)$ is a saddle point. This candidate solution corresponds to a tariff-subsidy combination when countries are asymmetric; actually, the South (the small country) applies a tariff against its imports, while the North (the large country) subsidies its imports. Since the second-order conditions are not satisfied at an interior solution, the maximization problem leads to a corner solution where free trade is optimal.

[10] To obtain $\left(s^N,\, t^N\right)$ from $(s,\, t)$ obtained by KR (1988), just add the value '1' to the numerator and denominator of each Nash tariff. Remember that the SG function used in this study $\left[\left(1+x\right)\left(1+y\right)\right]$ is also obtained in a similar manner from the KR (1988) CD function $(x \cdot y)$.

[11] This result is reminiscent of Limão and Saggi (2013) who find that uncoordinated small countries individually set a lower Nash tariff than their large trading partner.

In fact, simulation results presented in table 1.1 show, for all possible distributions of endowments, that the sum of countries' welfare under free trade is higher than under the candidate solution for an interior maximum. In addition, each country has a higher utility under free trade than under Nash tariffs. All the above findings are summarized in the following proposition:

Proposition 1.1: *the maximization problem of the global welfare in a pure exchange model with Stone-Geary preferences leads to a corner solution where free trade is optimal.*

This result is at odds with KR (1988) who find that sufficiently big countries win the tariff war. However, this is not a rule of thumb: in fact, their simulations reveal that, in most cases, both countries are better off under free trade.[12] By using Stone-Geary instead of Cobb-Douglas preferences, the present study shows that free trade dominates the trade war equilibrium for all possible endowments. In particular, numerical simulations show that the small country experiences gains more than the big one.

The findings of this study provide a rationale to the transition of ACP-EU relations from a privileged market access to economic partnership agreements (EPA). These results shed light on the inefficiency of the unilateral privileged access that ACP countries enjoyed on the European market under the Lomé and the Cotonou agreements, while keeping their tariffs high. In addition, this paper explains the transition from such treaties to WTO-compatible economic partnership agreements.

Self-enforcing trade agreement

In the absence of a supranational authority, a trade agreement needs to be self-enforcing (Farrell and Maskin, 1989; Van Damme, 1989). Consider an infinitely repeated game between the North and the South. Let $\left(u^N \equiv u\left(s^N, t^N\right), u^{*N} \equiv u^*\left(s^N, t^N\right)\right)$ be countries' Nash utilities and $\left(u^{FT} \equiv u(1,1), u^{*FT} \equiv u^*(1,1)\right)$ their utilities under an FTA. A one-period deviation is denoted by $u^D = u\left(1, t^N\right)$ for the North and by $u^{*D} = u^*\left(s^N, 1\right)$ for the South.

[12] In the working paper version of their study (1984), Kennan and Riezman (1988) mention that a country gains a trade war if the difference in endowment size of both goods is higher than 0.2 ($\mid \gamma - \mu \mid > 0.2$ for $\{\gamma, \mu\} \in [0.6; 0.1]$; with $\gamma\,(\mu)$ being the initial endowment of good $x\,(y)$ that a country (its trading partner) has).

For simplicity, I consider that cheating induces an infinite Nash reversion. Given this punishment scheme, each country weighs the (discounted) utility from abiding by the agreement with the (discounted) payoff from cheating: $u^{FT} + \delta u^{FT} + \delta^2 u^{FT} + ... \lesseqqgtr u^D + \delta u^N + \delta^2 u^N + ...$, where $\delta \in [0,1]$ is the country's discount factor. This is equivalent to $u^{FT} / (1+\delta) \lesseqqgtr u^D + \delta u^N / (1+\delta)$. Re-arranging this expression brings a critical value of discount parameter, $\delta^C = \left(u^D - u^{FT}\right) / \left(u^D - u^N\right)$, so that for any $\delta > \delta^C$, there will be no cheating, since the country values the future gains from free trade highly enough. The critical discount factor, δ^C, is actually the ratio of the one-shot gain from violating the FTA to the permanent loss from infinite Nash reversion.

In what follows, I compute discount factors for different values of the endowments (γ, μ). Simulation results are presented in table 1.2. For $\gamma < \mu$, the North's (resp. the South's) critical discount factor is higher (resp. smaller) than the South's (resp. the North's). This observation suggests that it is more likely for a large country to cheat than a small one. In fact, trade disputes often involve large (advanced) economies; the great majority of developing countries are usually not involved, given their minor contribution to the world trade.

Observation 1.1: *For $\gamma < \mu$, this inequality $\delta^{*C} < \delta^C$ always holds; thus, the FTA is self-enforcing if $\delta^{*C} < \delta^* < \delta^C < \delta$. Moreover, the North's (resp. the South's) critical discount factor δ^C (resp. δ^{*C}) increases (resp. decreases) with countries' asymmetry in endowment size $\mid \gamma - \mu \mid$.* If $\gamma = \mu$, then $\delta^C = \delta^{*C}$.

Table 1.2: Utility under defection and countries' critical discount factors under the free trade agreement

Endowments		The North cheats			The South cheats		
γ	μ	u^D	u^{*D}	δ^C	u^D	u^{*D}	δ^{*C}
0.6	0.6	2.253	2.246	0.56	2.246	2.253	0.56
0.6	0.7	2.410	2.092	0.61	2.393	2.109	0.50
0.6	0.8	2.575	1.941	0.68	2.543	1.970	0.45
0.6	0.9	2.749	1.793	0.75	2.697	1.837	0.41
0.6	1.0	2.932	1.645	0.83	2.855	1.709	0.36
0.7	0.7	2.263	2.232	0.56	2.232	2.263	0.56
0.7	0.8	2.424	2.074	0.61	2.376	2.121	0.50
0.7	0.9	2.595	1.918	0.68	2.522	1.984	0.45
0.7	1.0	2.774	1.763	0.75	2.673	1.852	0.41
0.8	0.8	2.279	2.210	0.56	2.210	2.279	0.56
0.8	0.9	2.446	2.046	0.61	2.349	1.138	0.50
0.8	1.0	2.622	1.884	0.68	2.743	2.003	0.45
0.9	0.9	2.302	2.(28	0.55	2.178	2.302	0.55
0.9	1.0	2.475	2.008	0.61	2.314	2.163	0.50
1.0	1.0	2.332	2.136	0.55	2.136	2.332	0.55

1.3 Conclusion

The goal of this paper has been to develop a theoretical framework that explains the change in ACP-EU trade agreements from a preferential market access over 50 years enjoyed by ACP exporters on the European markets to free trade. In fact, the disappointing results of the long lasting preferential treatment that ACP countries enjoyed in the EU market, while being among the most protected markets, has called for alternative trade arrangements.

Contrary to conventional wisdom, free trade dominates the Nash equilibrium for all possible distributions of endowments. This last result challenges the view that a free trade agreement between asymmetric countries is more likely to bring economic benefits to the small country compared to its large partner. It is worth noting that large countries such as the EU or the US are often the initiators of trade agreements with their smaller partners, some of which are important suppliers of primary products vital to their industries. Given the increasing competition from emerging economies like China or India, the proliferation of commercial treaties between the EU or the US and developing countries is, among other things, a testimony of their "raw material diplomacy". In fact, the EU and the US seek to secure access to raw materials by eliminating export restrictions.

The analysis presented in this paper is based on a North-South pure exchange model which abstracts from the supply-side of the economy by assuming some given endowments of goods. Moreover, both countries are assumed to have similar demand functions. Yet, countries differ in their supply capacities and their demands, which inevitably affect trade. A promising avenue for future research would be to study how heterogeneity in demand and in supply affects countries' welfare and thus compensation transfers. It would also be interesting to extend this study to a traditional model of trade like the Heckscher-Ohlin trade model.

Chapter 2

Country heterogeneity, financial compensation and international trade agreements: a study of ACP-EU agreements

2.1 Introduction

According to the GATT/WTO, 377 trade agreements were in force as of January 2014, most of which involve heterogeneous countries with respect to size, supply and demand in world markets. Economic Partnership Agreements (EPAs) are an interesting case of so-called "new regionalism", as they involve the European Union (EU) with six African, Caribbean and Pacific (ACP) negotiation groups, whose member countries are among the world's poorest economies.[1,2] Unlike standard trade agreements, EPAs combine trade policy with both development aid and other development initiatives aimed "at enhancing the production, supply and trading capacity of the ACP countries as well as their capacity to attract investment" (article

[1]As explained by Fontagné, Mitaritonna and Laborde (2011), ACP countries are free to negotiate EPAs individually or as groups in accordance within their own regional integration schemes. Therefore, ACP countries' outside options are the "Everything But Arms" (EBA) initiative for least developed ACPs and the "Generalized System of Preferences" (GSP) for the other ACPs (see the appendix for more details).

[2]Since 2008, the EU has signed several interim EPAs with ACP countries covering trade in goods in compliance with WTO rules; other EPAs were initiated in 2007, but not signed yet. The EU and the ACP countries are still negotiating full EPAs that will cover not only trade in goods, but also services, investment and standards. As of july 2014, full EPAs have been signed with the CARIFORUM (2008), Papua New Guinea (2009) and Fiji (2009).

34 of the Cotonou Agreement). Moreover, EPAs usually include provisions related to non-trade issues such as the foreign direct investment (FDI), the protection of intellectual property rights (IPRs) or democracy and governance.

Two strands of the trade agreements literature explain the inclusion of non-trade issues in trade agreements. First, political-economy theories of trade policy invoke the external commitment argument; that is, a small country signs a trade agreement with a large partner to strengthen the credibility of its domestic economic and political reforms that are welfare improving but time inconsistent (Conconi and Perroni, 2011, 2013; Ethier, 1998; Sapir, 1998; Whalley, 1998). This commitment is credible if it constrains the small country to more discipline under the monitoring of its large country, so that future governments can not renege on their international obligations without costs. Moreover, tying its hands through this mechanism makes a reforming country more attractive for FDI, compared to others without such a strong signal.[3] FDI may raise employment and improves the small country's labor market; by so doing, a trade agreement relaxes the pressures of illegal immigration in a large country (Fernandez, 1997).

Second, standard trade theories of trade agreements consider the adoption of reforms in non-trade areas such as the investment code, the protection of intellectual property rights as transfer payments made by small countries to large counterparts. Actually, the removal of tariff and non-tariff barriers to trade provides a small country with a better access to its large country's market and thus improves its terms-of-trade gains. However, these benefits are often quite small in the case of a large country; the welfare gains that a large country derives from such arrangements stem from the small country's concessions on non-trade issues (Bond and Park, 2002; Chauffour and Maur, 2011; Limão, 2007; Park, 2000).[4]

The above mentioned literature provides key insights on the impact of countries' size on the nature of benefits that they derive from trade agreements. In particular, it turns out that non-monetary compensation transfers flow from the small country to the large country. However, this literature does not take account of different sorts of country heterogeneity and thus fall short to explain monetary and non-monetary transfers paid

[3]According to Ethier (1998), FDI renders trade agreements attractive for small countries even though they do not receive important trade concessions from their large partners.

[4]This is not the case when countries are symmetric: actually, a trade agreement induces an equal increase of countries' trade volume without deteriorating their terms-of-trade (Bagwell and Staiger, 1999, 2001).

by EU donors to their ACP partners. For instance, article 8 of the EU-CARIFORUM EPA provides for the EU aid towards the CARIFORUM for capacity and institution building, the promotion of the private sector, the diversification of ACP exports, the development of both innovation systems (research and technological capacity) and infrastructure.

In this paper, I argue that in the presence of supply heterogeneity, the "net compensation transfer" is paid by the large country to its small counterpart that experiences a welfare loss after signing a trade agreement.[5] This argument is supported by the EU recognition that ACP countries face supply-side constraints that prevent them from taking full advantage of the EPAs (European Research Office, 2007).

This paper brings new insights on the welfare effects of a trade agreement by studying successively three sources of heterogeneity in standard models. To do so, I determine both countries' welfare under Nash tariffs ("Nash welfare") and under globally optimal tariffs (GOTs).[6] In particular, it shows that, depending on the kind of heterogeneity considered a small country may be either better or worse off than its large partner country. This of course has important implications about the direction of the net compensating transfer, a point that has been ignored in previous studies. To the best of my knowledge, this is the first theoretical attempt to examine the different welfare effects of heterogeneity in a North-South trade agreement model. This is actually the first contribution of this paper.

First, I analyze supply heterogeneity by adding a parameter on the South's supply of both goods. I compare welfare functions under both tariff regimes and find that a country, say the South, loses (gains) if the parameter is smaller (greater) than a critical value.[7] Thus, the South is worse off under the trade agreement if it is sufficiently smaller than the North. The intuition behind this is that, in the presence of supply-side constraints, the small country cannot take fully advantage of its bigger partner's market access after signing the TA. Actually, given the limited capacity of the producers of the small country, the TA expands markets more for the large rather than the small country. As a result, the large country is better off, while the small one is worse off. Thus, the small country has to be compensated

[5]The gross transfer paid by the large country must be higher than the costs incurred by the small country when the latter agrees on non-trade issues which are a side-payment to the large country.

[6]GOTs are the "efficient" tariffs that maximize the sum of both countries' welfare. It is implicitly assumed that each country applies its GOT instead of its Nash tariff under the trade agreement.

[7]In the appendix, I show that this result holds even if the parameter is only introduced in the supply of one good.

by the big country. This finding better describes the situation of most least developed countries that have an underdeveloped industrial sector.[8]

Second, I consider heterogeneity in demand and introduce a parameter on the South's demand of both goods. The welfare analysis shows that the country which has a sufficiently small domestic demand gains from the TA, while the other loses.[9] This last case better reflects the situation of developing countries that produce goods for rich countries, lacking a domestic demand for their own products. Therefore, they have to make compensation payments to "buy their market access" to large economies.

Third, I study size heterogeneity by introducing a size parameter in both the supply and the demand functions of the South as in Bond and Park (2002, hereafter, BP). Depending on the magnitude of that parameter, the South is either a small or a big replica of the North. It turns out that free trade benefits the sufficiently small country, but harms its large trading partner. Therefore, the small partner has to compensate its larger commercial partner with a side payment. This well-established result probably describes the reality of very few developing countries, such as BRIC countries (Brazil, Russia, India, China) and other NIC (Newly Industrialized Countries) that possess a large industrial sector and a solvable domestic demand to be considered a replica of large economies such as the European Union, Japan or the United States.

Armed with these predictions, I then move to the second contribution of this paper: I confront the theoretical predictions with foreign aid data, which is probably the most easily measurable type of transfer paid by the EU donors to the ACP countries. By so doing, the present work sheds light on an important motive for giving, namely supply heterogeneity which has been overlooked in the aid literature.[10]

[8]Our results are reminiscent of Furusawa and Konishi (2007, hereafter FK) who find that a pair of countries sign an free trade agreement (FTA) only if their industrialization levels are similar ; they conclude that developed countries and developing countries form mutually exclusive trading blocs. Thus, an FTA between a developed economy and a less developed one is possible only in the presence of transfers (FK, 2005).

[9]In the appendix, I show that this result holds even if the parameter is only introduced in the demand of one good.

[10]Reasons for giving are well-documented in the literature; Lahiri and Raimondos-Moller (1999) and Hamada (2008), for example, show the existence of a positive optimal value of aid in the presence of altruism. Alesina and Dollar (2000) shed light on political dimensions of giving such as securing support in international arena. Finally, several empirical works show that aid is export-promoting for donors (Nowak-Lehmann, Martinez-Zarzoso, Cardozo, Herzer and Klasen, 2010; Osei, Morrissey and Lloyd, 2004). In addition, Bhagwati, Brecher and Hatta (1983, 1985) prove the existence of a "transfer paradox" ("immiserizing transfer"), namely the possibility that a transfer improves the donor welfare and, at the same time, worsens that of the recipient.

Following the theory, I run one regression for each dimension of heterogeneity. Since the theory predicts that the small country (or the one with the small demand) makes a compensation payment to the large country (or the one with a large demand) in the presence of demand heterogeneity (DH), the interaction term between the EPA and the DH variable should have a negative effect on donors' aid allocation. On the contrary, the interaction term between the EPA and the supply heterogeneity variable should have a positive effect on foreign aid. This is exactly what the empirical results reveal.

Since the degree of heterogeneity matters for the amount of the transfer, one may expect recipient countries to receive more aid the more heterogeneous they are to donors. It goes without saying that the EU donor pictures for the large country and the ACP recipient, the small one. Demand heterogeneity is captured by the ratio of the recipient's GDP on the expenditure side to the donor's GDP on the expenditure side. Supply heterogeneity is computed in a like manner using the stock of capital.

These findings are robust to several sensitivity checks. First, I include additional control variables expected to influence the donors' decision to give aid (colonial ties, common language). Second, I use alternative measures of heterogeneity, namely, the ratio of recipient population to donor population for demand heterogeneity, on the one hand, and the ratio of recipient-donor GDP per worker for supply heterogeneity, on the other hand.

This paper is related to several strands of literature. In a theoretical perspective, this research is related to Bond and Park (2002) who study size heterogeneity in a two-country two-good perfectly competitive model of trade agreement. Contrary to them, this article studies these two sources of heterogeneity. In an empirical perspective, this work is related to studies on the determinants of foreign aid. Recipient's population size and national product (GDP) are widely used as aid determinants in the literature (Alesina and Dollar, 2000; Berthélemy and Tichit, 2004; Boone, 1996; Feeney and McGillivray, 2008; Younas, 2008). In the present study, I use the recipient-donor ratio of these variables instead. To the best of my knowledge, this paper is the first to use productivity heterogeneity as a determinant of the aid allocation behavior of donors. This article is also closely related to Baccini and Uperlainen (2012) who find that foreign aid is a strategic transfer made by major powers to developing countries to adhere to preferential trade agreements.

This study has policy implications for the inclusion of non-trade concerns (NTCs) in trade agreements, notably the trade-related aspects of IPRs (TRIPS). For many scholars, the enforcement of more stringent IPRs in the South is profitable to the inventing countries of the North where innovating activities are concentrated, but harmful to developing countries of the South where consumers face higher prices (Chin and Grossman, 1990; Deardoff, 1990, 1992; Ives, 2007). Combined with TAs, stringent TRIPS can effectively serve as compensation from the South to the North for the North's market access. My theory suggests that TRIPS should not be extended to all developing countries, but should be selectively imposed only to developing countries (DCs) that gain from TAs and most likely possess an imitative capacity. DCs that lose from TAs - notably least developed countries (LDC), should be exempted to adhere to IPRs, since doing so implies a double loss stemming not only from the TA but also from the TRIPS' adoption (which is equivalent to an income transfer from poor consumers of the South to monopoly inventors of the North). Instead, these DCs should receive compensation payments for the loss from TAs. Thus, TAs involving LDC should be unlinked to IPRs, which further reduce their welfare.

Moreover, several scholars believe that stringent IPRs and trade liberalization reduce DCs' policy space, which they need for their economic development strategies, in order to move up the value chain, to consolidate their infant industries and to strengthen their technological capacities (Ramrod, 2011; Wade, 2003). Actually, under FTAs like EPAs, many industrial and trade policies become illegal and several resource-rich DCs are locked into a role of raw materials suppliers to resource-hungry economies.[11] However, some dispositions of EPAs provide for possibilities to authorize a Signatory State to depart from the agreement "to promote the establishment of domestic production and protect infant industry." (see for example Article 18 § 6 of the interim EPA with ESA states). In addition to these safeguard measures, the legal texts of EPAs include binding commitments on the provision of development assistance from the EU to address supply-side rigidities and thereby support the consolidation of their production as well as their export capacity. ACP countries also have negotiated the sequencing of aid and trade liberalization, so that development aid is made available before the implementation of trade reforms (Alavi, Gibbon and Niels Jon, 2007). Moreover, ACP countries are granted a long transition period (up to 25 years) to liberalize their tariffs in order to develop their competitiveness over the medium and long term. They are also allowed to maintain their tariffs on goods that are sensitive

[11] In February 2014, Nigeria's trade minister raises this point and says that under the EPA, some ACP countries "would be stuck in a quasi-colonial cycle of exporting raw materials and importing finished goods" (Donnan, 2014).

to EU imports,[12] while having a full and immediate access to the European market.[13]

The rest of the paper is organized as follows. Section 3.2 presents the model. Section 3.3 describes the empirical results of country heterogeneity on the aid allocation behavior of donors. Section 3.4 concludes.

[12]Sensitive products include goods produced by vulnerable industries and those where import duties represent an important share of government revenues.

[13]Exceptions apply to rice and sugar where free access starts in 2010 and 2015 respectively.

2.2 The model

In this section, I study heterogeneity in a two-country two-sector trade agreement model in the spirit of Bond and Park (2002, hereafter BP). The North (the South) has a comparative advantage over the production of good y (x) which it exports and imports good x (y) from the South (the North). Countries choose between two trade regimes: the trade agreement regime denoted by $\underline{r} \equiv \left(\underline{\tau}^N, \underline{\tau}^S\right)$ or the Nash tariff regime $\overline{r} \equiv \left(\overline{\tau}^N, \overline{\tau}^S\right)$ and τ is a tariff. Countries' welfare is a function of the trade regime and depends on an heterogeneity parameter $\zeta^h \in (0, \infty\}$, with $h = s$, d introduced either in the South's supply functions ($h = s$) or its demand functions ($h = d$) or both ($h = s = d$). To study the welfare effects of the trade agreement in the presence of heterogeneity, I compute, for each country, Δw, which is the difference between a country's welfare under both tariff regimes. I show that parameter ζ^h affects Δw^i. In particular, I obtain the well-established result that both countries gain from signing a trade agreement when they are symmetric ($\Delta w^N = \Delta w^S$ for $\zeta = 1$). In what follows, I consider three cases of heterogeneity. First, I study supply heterogeneity, which yields new results. Second, I examine demand heterogeneity. Lastly, I consider size heterogeneity and thus replicate BP (2002), where one country is a small replica of the other.[14]

Trade agreement in the presence of supply heterogeneity

When countries are heterogeneous in terms of production of both goods, x, y, the demand functions in each country are specified as $D_j^i\left(p_j^i\right) = \alpha - \beta p_j^i$, where $i \in \{N, S\}$, $j = x, y$ and p_j^i is the local price of good j in country i. The North's supply functions are given by $Q_x^N(p_x^N) = \beta p_x^N$ and $Q_y^N(p_y^N) = \alpha + \beta p_y^N$; for the South, the supply functions are given by $Q_x^S(p_x^S) = \zeta^s\left(\alpha + \beta p_x^S\right)$ and $Q_y^S(p_y^S) = \zeta^s\left(\beta p_y^S\right)$, where the parameter ζ^s captures supply heterogeneity. If $\zeta^s < 1$, then the South faces supply-side constraints (SSCs), while $\zeta^s = 1$ means both countries are symmetric. Finally, $\zeta^s > 1$ means that the South has higher supply capacity than the North.

Let τ^N , τ^S be import tariff, which are the only trade policy instruments that countries can use to protect their import-competing sectors. Ruling out

[14]Introducing the heterogeneity parameter in the supply (demand) of only one good yields similar results to those of section 2.2.1 (2.2.2) (see the appendix).

prohibitive tariffs[15], the domestic prices of imported goods are $p_x^N = p_x^S + \tau^N$ and $p_y^S = p_y^N + \tau^S$ so that $D_x^N(p_x^N) = \alpha - \beta(p_x^w + \tau^N)$ and $D_y^S(p_y^S) = \alpha - \beta(p_y^w + \tau^S)$, where p_x^w and p_y^w denote the local prices in the exporting country ($p_x^w = p_x^S$ and $p_y^w = p_y^N$). The market clearing condition is given by:

$$\sum_j D_j^i \left(p_j^i\right) = \sum_j Q_j^i(p_j^i) \tag{2.1}$$

Solving for p_x^w and p_y^w yields equilibrium world market prices as functions of the associated import tariffs and the supply heterogeneity parameter:

$$p_x^w\left(\zeta^s\right) = \frac{\left(2-\zeta^s\right)\alpha - \beta\tau^N}{\beta\left(3+\zeta^s\right)};\ p_y^w\left(\zeta^s\right) = \frac{\alpha - \beta\tau^S}{\beta\left(3+\zeta^s\right)} \tag{2.2}$$

From the above, one can see the effect of supply heterogeneity on prices. Comparative statics show that, for $\tau^N = \tau^S = 0$, $\partial p_x^w/\partial\zeta^s = -5\alpha/\beta\left(3+\zeta^s\right)^2$ and $\partial p_y^w/\partial\zeta^s = -\alpha/\beta\left(3+\zeta^s\right)^2$.[16] These results are very intuitive : the supply capacity constraints in the South ($\zeta^s < 1$) reduce the world supply of both goods, which pushes their prices upward compared to the situation where countries are symmetric ($\zeta^s = 1$). On the contrary, if the South is a large producer of both goods ($\zeta^s > 1$), the world supply of both goods will be larger than under symmetry ($\zeta^s = 1$); thus, international prices will be lower. As one can see, ζ^s affects more the price of good x than that of y. This is easy to understand since the South is a larger supplier of good x that the North, which the South exports. Equation (2.2) can be used to determine the domestic price of the good x (y) in the North (the South)

$$p_x^N\left(\zeta^s\right) = \frac{\left(2-\zeta^s\right)\alpha + \left(2+\zeta^s\right)\beta\tau^N}{\beta\left(3+\zeta^s\right)};\ p_y^S\left(\zeta^s\right) = \frac{\alpha + \left(2+\zeta^s\right)\beta\tau^S}{\beta\left(3+\zeta^s\right)} \tag{2.3}$$

As is obvious from equation (2.3), the domestic price of the import good j in country i increases in its tariff, but decreases with ζ^S as explained above. It is easily verified that $\partial p_x^w/\partial\zeta^s = \partial p_x^N/\partial\zeta^s$ and $\partial p_y^w/\partial\zeta^s = \partial p_y^s/\partial\zeta^s$. In addition, (2.3) shows that the tariff is partially passed through to domestic consumers; that supposes that a portion of the tariff is bore by foreign exporters. This result depends on the capacity countries have to influence terms-of-trade to their advantage. In this model, the South's international

[15] There is trade only if tariffs are below prohibitive levels, which are $\tau^N_{M_x=0} = \frac{\alpha(3\zeta^s-1)}{2\beta(2+\zeta^s)}$ and $\tau^S_{M_y=0} = \frac{2\alpha}{\beta(2+3\zeta^s+\zeta^{s2})}$.

[16] These comparative statics results hold generally for non-prohibitive tariffs; this assumption is to simplify notation.

terms-of-trade is given by $p^S \equiv p_x^w/p_y^w = \left((2-\zeta^s)-\beta\tau^N\right)/\left(\alpha-\tau^S\right)$; it is easily seen that p^S ($p^N = 1/p^S$) increases (decreases) with τ^S but decreases (increases) with τ^N ($\partial p^i/\partial\tau^k < 0 < \partial p^i/\partial\tau^i$, with $i \neq k \in \{N, S\}$).

As argued by Bagwell and Staiger (1999), countries' ability to manipulate their terms of trade also implies that a reduction in the domestic import tariff is not fully passed through to domestic consumers as a lowered price, since foreign exporters experience gains in export profit. This argument explain why symmetric countries seek a reciprocal trade liberalization through a trade agreement: each country experiences a positive net welfare change as the combined gain in consumer surplus and export profit of the export sector dominate the loss in both the home profit of the import-competing sector and the tariff revenue. In the present section, I show that countries' welfare change depends on the size of the supply heterogeneity parameter ζ^s and that there might be a winner (the country that is the large supplier of both goods) and a loser (the country with supply capacity constraints, hereafter SSCs) if countries are sufficiently heterogeneous. Therefore, the large supplier has to compensate the one experiencing SSCs with a side payment to induce him to sign the trade agreement.[17]

Countries' import demand functions, $M_x^N(\zeta^s)$ and $M_y^S(\zeta^s)$, and their export supply functions, $E_y^N(\zeta^s)$ and $E_x^S(\zeta^s)$ can be written in terms of domestic prices as

$$M_x^N(\zeta^s) = \alpha - 2\beta p_x^N \quad and \quad M_y^S(\zeta^s) = \alpha - (1+\zeta^s)\,\beta p_y^S$$

$$E_y^N(\zeta^s) = 2\beta p_y^N \quad and \quad E_x^S(\zeta^s) = (\zeta^s - 1)\,\alpha + (1+\zeta^s)\,\beta p_x^S$$

From the above expressions, it appears that an increase in the supply heterogeneity parameter ζ^s reduces the South's imports of good y, but raises its exports of good x. In equilibrium, $M_j^i = E_j^k$, $\partial M_x^N(\zeta^s)/\partial\zeta^s > 0$ and $\partial E_y^N(\zeta^s)/\partial\zeta^s < 0$. This happens because an increase in the South's supply of both goods x, y lowers the need to buy from abroad and, at the same time, enhances its capacity to sell abroad.

Each country's welfare is simply the sum of consumer surplus, producer surplus, and tariff revenue over both goods x, y: $w^i = \sum_j CS + \sum_j PS + TR$. The above equations are useful to

[17]This is also true in the case of either the demand or the size heterogeneity in the following sections.

calculate the welfare of country i as a function of parameters α, β, tariffs and the heterogeneity parameter ζ^s. Define now the world welfare as the sum of both country's welfare: $ww = \sum_i w^i$. Countries have to choose between a non-cooperative and a cooperative trade regimes.

Under the non-cooperative regime $\bar{r}$, each country sets its tariff to maximize its own welfare ($\overline{\tau}^i \equiv Arg\ max\ w^i$); therefore, $\overline{\tau}^N(\zeta^s) = \frac{\alpha(3\zeta^s-1)}{\beta(8+6\zeta^s+\zeta^{s2})}$ and $\overline{\tau}^S(\zeta^s) = \frac{2\alpha}{\beta(\zeta^s+1)(\zeta^s+2)(\zeta^s+4)}$. Note that for $\zeta^s < 1$, the South's optimal tariff level is strictly higher than the North's tariff; this means that the country with the small supplies of both goods applies a higher tariff at its optimum.[18] This observation supports the fact that most (least) developing countries heavily rely on import tariff revenues for a large share of government finance, contrary to their developed counterparts (Gallagher, 2008). Fiscal capacity is lowered in countries where the informal economy amounts up to three quarters of the GDP (Gordon and Li, 2005).

The cooperative regime $\underline{r}$ is such that each country sets its tariff to maximize the world welfare; in particular, $\underline{\tau}^i \equiv Arg\ max\ ww = 0$. In the absence of political economy considerations, the cooperative regime is equivalent to free trade. Now that tariffs prevailing under both trade regimes are known, let define $\Delta w^i(\underline{r} - \overline{r})$ as the difference between country i's welfare under trade regimes $\underline{r}$ and $\overline{r}$: $\Delta w^i(\underline{r} - \overline{r}) = w^i(\underline{r}) - w^i(\overline{r})$. Since Nash tariffs applied under the non-cooperative regime are themselves functions of the parameters of the model ($\overline{\tau}^i \equiv \overline{\tau}^i(\alpha, \beta, \zeta^s)$), we have that $\Delta w^i \equiv \Delta w^i(\alpha, \beta, \zeta^s)$. Using this last expression, one can study the welfare implication of moving from a non-cooperative to a cooperative regime when countries are heterogeneous in their supply functions.

Figure 2.1 illustrates the welfare effects of a free trade agreement (FTA) in the presence of heterogeneity in the countries' supply of both goods x, y. It reveals that the changes in traded quantities of x, y (panel 1), in the international price ratio (terms-of-trade) p_x/p_y (panel 2) and in the countries' welfare $\Delta w^N(\zeta^s)$ and $\Delta w^S(\zeta^s)$ (panel 3) are all functions of the parameter ζ^s, which captures the supply-side constraints (SSCs) faced by the South. When the North and the South are symmetric ($\zeta^s = 1$), the reciprocal trade liberalization induces an equal increase of imports from one country to another ($\alpha/10$), at an unchanged $p_x/p_y = 1$. As a result, each country experiences a welfare gain of $7\alpha^2/1800\beta$. In what follows, I consider two cases : $\zeta^s < 1$ and $\zeta^s > 1$ respectively.

In the presence of SSCs ($\zeta^s < 1$), the South's imports of good y from the North increase more than its exports of x to the North ($\Delta M_y^S > \Delta M_x^N$) and hence, the reciprocal liberalization is more beneficial to the North (see panel

[18] For the North, the sign of $\frac{\partial \overline{\tau}^N}{\partial \zeta^s}$ depends on ζ^s; in particular, $\frac{\partial \overline{\tau}^N}{\partial \zeta^s} > 0$ if $\zeta^s \geq 3.6$.

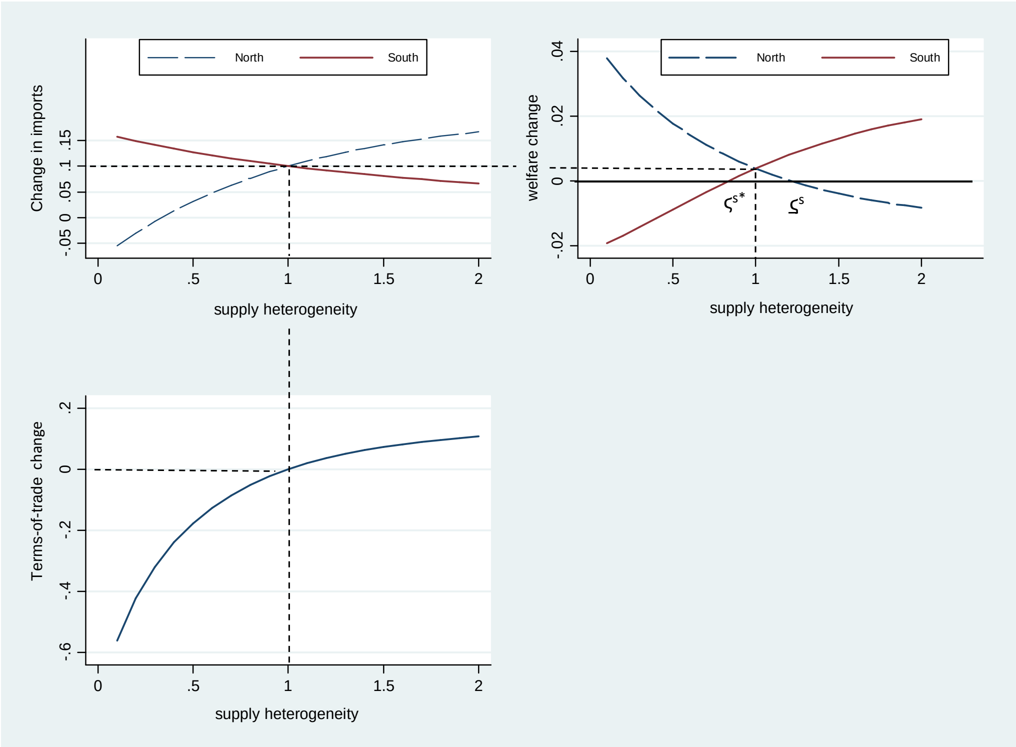

Figure 2.1: welfare change in the presence of supply heterogeneity(ζ^s) (with $\alpha^2/\beta = 1$)

3). Actually, this higher import demand of good y induces a lower price ratio than the symmetric case ($\Delta p^S < 0$ in panel 2). Panel 3 shows that, for $\zeta^s < 1$, the North is always better off, while the South's welfare change depends on the value of ζ^s. If the South's supply of both goods is sufficiently small compared to the North ($\zeta^s < \zeta^{s*}$), then the South is worse off under an FTA. In such a case, the FTA is not incentive-compatible, unless it includes a convention in which compensation payments (i.e., monetary transfers or "foreign aid" in the case of ACP-EU conventions) are available as a device to transfer welfare between signatories in a lump-sum fashion. Note that the South's welfare loss and consequently the compensation payment decrease with the parameter ζ^s, up to the point $\zeta^s = \zeta^{s*}$, where the South is indifferent regarding signing the tariff cut deal, as its welfare is the same under both tariff regimes. Finally, if $\zeta^{s*} < \zeta^s < 1$, both countries gain from the FTA, although the North benefits more than the South because of the terms-of-trade change.

Now, consider that the South's supply functions are higher than the North's ($\zeta^s > 1$). Under the FTA, the South's exports of good x to the North increase more than its imports of good y from the North

($\Delta M_y^S < \Delta M_x^N$). This higher import demand of x pushes the relative price of good x upward ($\Delta p^S > 0$). As depicted in panel 3, the South is always better off under an FTA, while the North's welfare change depends on the value of ζ^s. For $\zeta^s < \underline{\zeta}^s$, both countries gain form an FTA, even though the South's gain is greater than the North's. At some point $\zeta^s = \underline{\zeta}^s$, the South is indifferent between signing or not the FTA. Beyond that point, the North is worse off under the FTA and its loss increases with ζ^s; this implies that the greater $\underline{\zeta}^s$, the larger the compensation payment. Thus, it will sign the tariff cut deal if and only if it receives a lump-sum transfer from the South. When $1 < \zeta^s < \underline{\zeta}^s$, both countries gain from the FTA, although the North benefits more than the South. All the above can be summarized the following proposition

Proposition 2.1: *Let $w^i(\overline{r})$ and $w^i(\underline{r})$ be a country's welfare under the Nash equilibrium and the free trade regimes; given the supply heterogeneity parameter ζ^s, the per-period compensation transfer T^i that the country i gaining from the FTA is willing to pay to its trading partner for its welfare loss due to the FTA is given by*

1. *if $\zeta^s < \underline{\zeta}^{s*}$, the North (the large supplier of good y) is ready to compensate the South (the small supplier of good y) with a per-period transfer $T^N(\zeta^s) = \Delta w^S(\underline{r} - \overline{r})$,*

2. *if $\zeta^{s*} \leq \zeta^s \leq \underline{\zeta}^s$, no transfer is made since both countries are better off under an FTA,*

3. *if $\zeta^s > \underline{\zeta}^s$, the South (the large supplier of good y) is ready to compensate the North (the small supplier of good y) with a per-period transfer $T^S(\zeta^s) = \Delta w^N(\underline{r} - \overline{r})$.*

Trade agreement in the presence of demand heterogeneity

In the presence of demand heterogeneity for both products, x, y, the demand functions are given by $D_j^N(p_j^N) = \alpha - \beta p_j^N$ for the North and by $D_j^S(p_j^S) = \zeta^d \left(\alpha - \beta p_j^S\right)$ for the South, where $j = x, y$ and ζ^d is the demand heterogeneity parameter. If $\zeta^d < 1$ (resp. $\zeta^d > 1$), then the South has limited (resp. bigger) market demand for both goods than the North; otherwise, they are symmetric. The North's supply functions are as follows: $Q_x^N(p_x^N) = \beta p_x^N$ and $Q_y^N(p_y^N) = \alpha + \beta p_y^N$. The South's supply functions are symmetrically defined as $Q_x^S(p_x^S) = \alpha + \beta p_x^S$ and $Q_y^S(p_y^S) = \beta p_y^S$.

Assuming that import tariffs τ^N , τ^S are below their prohibitive levels[19], the demand for the imported good in each country can be written as $D_x^N(p_x^N) = \alpha - \beta(p_x^w + \tau^N)$ and $D_y^S(p_y^S) = \zeta^d \left[\alpha - \beta(p_y^w + \tau^S)\right]$, where p_x^w and p_y^w are international prices. Under market clearing conditions given by (2.1), equilibrium world market prices are respectively

$$p_x^w\left(\zeta^d\right) = \frac{\alpha\zeta^d - \beta\tau^N}{\beta\left(3+\zeta^d\right)};\ p_y^w\left(\zeta^d\right) = \frac{\zeta^d\left(\alpha - \beta\tau^S\right)}{\beta\left(3+\zeta^d\right)} \tag{2.4}$$

An increase in the demand heterogeneity parameter raises the international price of both goods; in fact, comparative statics show that, for $\tau^N = \tau^S = 0$, $\partial p_x^w/\partial\zeta^d = \partial p_y^w/\partial\zeta^d = 3\alpha/\beta\left(3+\zeta^d\right)^2$.[20] The intuition behind this results is as follows : the limited demand in the South $\left(\zeta^d < 1\right)$ reduces the world demand of both goods, which pushes their prices downward compared to the situation where countries are symmetric $\left(\zeta^d = 1\right)$. On the contrary, if the South is a large market for both goods $\left(\zeta^d > 1\right)$, the world demand of both goods will be larger than under symmetry $(\zeta^s = 1)$; thus, international prices will be higher. Equation (2.4) can be used to determine the domestic price of the good x (y) in the North (the South)

$$p_x^N\left(\zeta^d\right) = \frac{\alpha\zeta^d + \left(2+\zeta^d\right)\beta\tau^N}{\beta\left(3+\zeta^d\right)};\ p_y^S\left(\zeta^d\right) = \frac{\alpha\zeta^d + 3\beta\tau^S}{\beta\left(3+\zeta^d\right)} \tag{2.5}$$

Equation (2.5) shows that the domestic price of the import good increases with with the tariff and the demand parameter heterogeneity, as

[19]Prohibitive tariffs levels are given by $\tau_{M=0}^N = \frac{\alpha\left(3-\zeta^d\right)}{2(2+\zeta^d)\beta}$ and $\tau_{M=0}^S = \frac{2\zeta^d\alpha}{3(1+\zeta^d)\beta}$.

[20]This simplifying assumption help focus on the demand heterogeneity parameter ζ^d. Moreover, focusing on this case is interesting as free trade corresponds to the result of the trade agreement studied below.

explained above. In particular, one can see that a country's terms-of-trade increase with its tariff, but decrease with its partner's tariff: $\partial p^i/\partial\tau^k < 0 < \partial p^i/\partial\tau^i$ with $i \neq k \in \{N, S\}$, $p^S \equiv p_x^w/p_y^w = \left(\alpha\zeta^d - \beta\tau^N\right)/\zeta^d\left(\alpha - \beta\tau^S\right)$ and $p^N = 1/p^S$. Section 2.2.1 has already discussed the terms-of-trade motive of trade agreement between symmetric countries. In this section, I show that countries' welfare change depends on the size of the demand heterogeneity parameter ζ^d and that there might be a winner (the country with smaller demand functions of both goods) and a loser (the one with a large demand of both goods) if countries are sufficiently heterogeneous. Therefore, the country with small demand functions has to compensate the one with large demand functions with a compensating transfer to induce him to sign the trade agreement.

Countries' import demand functions, $M_x^N\left(\zeta^d\right)$ and $M_y^S\left(\zeta^d\right)$, and their export supply functions, $E_y^N\left(\zeta^d\right)$ and $E_x^S\left(\zeta^d\right)$, are respectively given by

$$M_x^N\left(\zeta^d\right) = \alpha - 2\beta p_x^N \quad and \quad M_y^S(\zeta^d) = \alpha\zeta^d - \left(1+\zeta^d\right)\beta p_y^S$$

$$E_y^N\left(\zeta^d\right) = 2\beta p_y^N \quad and \quad E_x^S\left(\zeta^d\right) = \left(1-\zeta^d\right)\alpha + \left(1+\zeta^d\right)\beta p_x^S$$

From the above expressions, it appears that the demand heterogeneity parameter ζ^d has a positive effect on the South's imports of good y, but a negative one on its exports of good x. In equilibrium, $M_j^i = E_j^k$, $\partial M_x^N(\zeta^d)/\partial\zeta^d < 0$ and $\partial E_y^N(\zeta^d)/\partial\zeta^d > 0$. This happens because an increase in the South's demand of both goods x, y enhances the need to buy from abroad and, at the same time, reduces its sales abroad.

Each country's welfare (w^i) and the world welfare (ww) are defined as in the previous section. Once again, countries have to choose between a non-cooperative and a cooperative trade regime. Under the non-cooperative regime $\bar{r}$, each country applies its optimal tariff ($\overline{\tau}^i \equiv Arg\ max\ w^i$); thus, $\overline{\tau}^N\left(\zeta^d\right) = \frac{\alpha\left(3-\zeta^d\right)}{2\beta\left(8+6\zeta^d+\zeta^{d2}\right)}$ and $\overline{\tau}^S\left(\zeta^d\right) = \frac{2\zeta^{d2}\alpha}{3\beta\left(5\zeta^d+3+2\zeta^{d2}\right)}$. Note that for $\zeta^d < 1$, the South's optimal tariff level is strictly lower than North's; this means that the country with the smaller demand for both goods applies a lower tariff at its optimum. This finding, which is different from that of section 2.2.1, certainly reflects countries' market power.

Under the cooperative regime $\underline{r}$, each country sets its tariff at the globally optimal level ($\underline{\tau}^i \equiv Arg\ max\ ww = 0$); free trade prevails in the absence of political economy considerations. Tariffs $\overline{\tau}^i$, $\underline{\tau}^i$ are useful to compute w^i and $\Delta w^i(\underline{r}-\overline{r})$ as functions of α, β, ζ^d. Fixing the values of α, β allows one to study the welfare implications of signing a trade agreement based on the demand heterogeneity parameter ζ^d.

Figure 2.2 depicts the welfare effects of an North-South FTA in the presence of heterogeneity in the demand of both goods x, y. It illustrates how the heterogeneity parameter ζ^d affects the changes in the traded quantities of x, y (panel 1), the international price ratio p_x/p_y (panel 2) and the countries' welfare $\Delta w^N(\zeta^d)$ and $\Delta w^S(\zeta^d)$ (panel 3). In section 2.1, it has been shown that an FTA is equally beneficial to both trading partners when they are symmetric ($\zeta^d = 1$); in fact, it boosts their bilateral exports ($\alpha/10$), at an unchanged terms-of-trade $p_x/p_y = 1$. As a consequence, the North and the South experience a welfare gain of $7\alpha^2/1800\beta$ each. Hereafter, I study two cases : $\zeta^d < 1$ and $\zeta^d > 1$ respectively.

If the South has smaller demand functions than the North ($\zeta^d < 1$), its imports of y from the North increase to a lesser extent than its exports of x ($\triangle M_y^S < \triangle M_x^N$). This higher import demand of x commands a higher international price ratio ($\Delta p^S > 0$ in panel 2); thus, $\zeta^d < 1$, the South is always better off under free trade, while the North's welfare change depends on the value of ζ^d as shown in panel 3. If the South's demand of good y is sufficiently small compared to the North $\left(\zeta^d < \underline{\zeta}^d\right)$, then the North is worse off under an FTA. Note that its welfare loss decreases with the parameter ζ^d. In such a case, the South needs to compensate the North for the FTA to be incentive-compatible; the amount of the compensation decreases with the parameter up to the point $\zeta^d = \underline{\zeta}^d$, where the North is indifferent between signing the tariff cut or not. At that point, its Nash welfare equals is free trade welfare. In the region where $\underline{\zeta} < \zeta^d < 1$, both countries benefit from the FTA, although the North gains less than the South due to the terms-of-trade effect.

When the South's demand of both goods x, y is higher than the North's ($\zeta^d > 1$), its imports of y from the North are higher than its exports of x ($\triangle M_y^S > \triangle M_x^N$). This higher import demand of y pushes the relative price of good x downward ($\Delta p^S < 0$). As a consequence, the North's welfare always increases under an FTA, whilst that of the South depends on the value of ζ^d. For values $\zeta^d < \zeta^{d*}$, both countries gain form an FTA, even though the North benefits more than the South due to the terms-of-trade effect. At the point where $\zeta^d = \zeta^{d*}$, the South is indifferent regarding signing the FTA, since its Nash welfare equals its free trade welfare. However, if $\zeta^d > \zeta^{d*}$, the South is worse off under the FTA, and is willing to sign the FTA if and only if it receives a lump-sum transfer from the North. Note that the loss increases with ζ^d; thus, the greater ζ^d, the higher the transfer to the North. Panel 3 shows that both countries gain

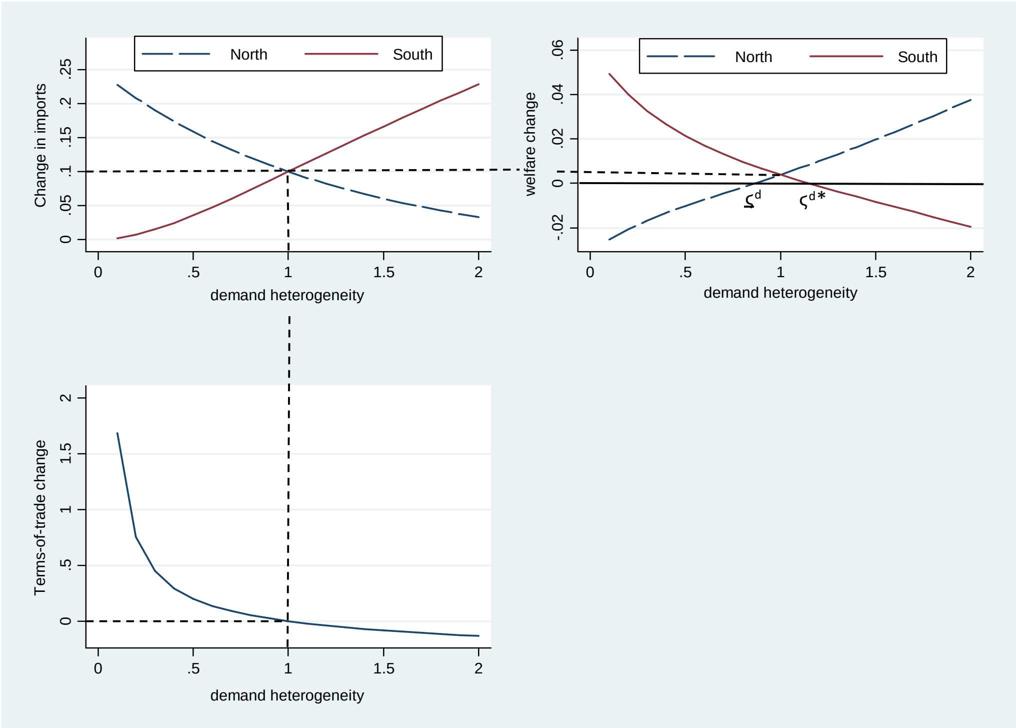

Figure 2.2: welfare change in the presence of demand heterogeneity (ζ^d) (with $\alpha^2/\beta = 1$)

from the FTA when $\underline{\zeta} < \zeta^d < 1$.

From the above, I make the following proposition:

Proposition 2.2: *Let $w^i(\overline{r})$ and $w^i(\underline{r})$ be a country's welfare under the Nash and the free trade regimes; given the demand heterogeneity parameter ζ^d, the per-period compensation transfer $T^i(\zeta^d)$ that the country i gaining from the FTA is willing to pay to its trading partner for its welfare loss due to the FTA is given by*

1. *for $\zeta^d < \underline{\zeta}^d$, the South (the small consumer of good y) is ready to compensate the North (the large consumer of good y) with a per-period transfer $T^S(\zeta^d) = \Delta w^N(\underline{r} - \overline{r})$,*

2. *for $\underline{\zeta} \leq \zeta^d < \zeta^{d*}$, no transfer is made since both countries are better off under FTA,*

3. *for $\zeta^d > \zeta^{d*}$, the North (the small consumer of good y) is ready to compensate the South (the small consumer of good y) with a per-period of transfer $T^N\left(\zeta^d\right) = \Delta w^N(\underline{r} - \overline{r})$.*

Trade agreement between countries of different sizes

Heterogeneity can affect supply and demand functions at the same time. This case, known as size asymmetry in the literature, has already been analyzed by Bond and Park (2002), with slightly different supply functions than ours. Consider the South to be a replica of the North. The demand functions are given by $D_j^N(p_j) = \alpha - \beta p_j^N$ for the North and $D_j^S(p_j) = \zeta(\alpha - \beta p_j^S)$, with $j \in \{x, y\}$ and ζ the size heterogeneity parameter. The North's supply functions are given by $Q_x^N(p_x^N) = \beta p_x^N$ and $Q_y^N(p_y^N) = \alpha + \beta p_y^N$, and those of the South are $Q_x^S(p_x^S) = \zeta\left(\alpha + \beta p_x^S\right)$ and $Q_y^S(p_y^S) = \zeta\left(\beta p_y^S\right)$ respectively. If $\zeta < 1$ (resp. $\zeta^d > 1$), then the South is a small (resp. big) replica of the North; otherwise, countries are symmetric.

In this setting, import tariffs τ^N, τ^S are the only instrument available to governments to protect their import-competing industries.[21] Each country's demand of the import good becomes $D_x^N(p_x^N) = \alpha - \beta(p_x^w + \tau^N)$ and $D_y^S(p_y^S) = \zeta\left[\alpha - \beta(p_y^w + \tau^S)\right]$, where p_x^w and p_y^w are international prices. Under market clearing conditions given by (2.1), equilibrium world market prices are respectively .

$$p_x^w(\zeta) = \frac{\alpha - \beta\tau^N}{2\beta(1+\zeta)}; \;\; p_y^w(\zeta) = \frac{\zeta(\alpha - \beta\tau^S)}{2\beta(1+\zeta)} \tag{2.6}$$

Equation (2.6) shows that an increase in the size heterogeneity parameter lowers the international price of good x, but raises that of good y; in fact, comparative statics show that, for $\tau^N = \tau^S = 0$, $\partial p_x^w / \partial\zeta^d = -\partial p_y^w / \partial\zeta^d = -\alpha/2\beta(1+\zeta)^2$.[22] The intuition behind this results is as follows : *ceteris paribus*, an increase in ζ implies that the South produces and demands more of both goods x and y. Since x is its export good for which it has a comparative advantage, an increase in its production commands a smaller international price to equate the world supply with the world demand. Despite an increased production of good y, the South has to import that good from the North because of its high demand. Since the supply of good y in the South is unchanged, its international price goes up. Equation (2.6) can be used to determine the domestic price of the good x (y) in the North (the South):

[21] Trade volumes are positive if tariffs are non-prohibitive; prohibitive tariffs are found by setting imports to zero: $\tau_{M=0}^N = \frac{\alpha\zeta}{(1+2\zeta)\beta}$ and $\tau_{M=0}^S = \frac{\alpha}{(2+\zeta)\beta}$.

[22] This simplifying assumption is made to draw attention exclusively on the size heterogeneity parameter ζ. Moreover, the free trade case is interesting as it is also the outcome of the trade agreement as shown below.

$$p_x^N(\zeta) = \frac{\alpha + (1+2\zeta)\beta\tau^N}{2\beta(1+\zeta)};\ p_y^S(\zeta) = \frac{\zeta\alpha + (2+\zeta)\beta\tau^S}{2\beta(1+\zeta)} \tag{2.7}$$

It is obvious from equation (2.6) that the domestic price of the import good increases with with the tariff; the effect of the size parameter heterogeneity on these prices is the same as above. As the two previous sections, a country's tariff has a positive effect on its terms-of-trade, but a negative one on its partner's : $\partial p^i/\partial\tau^k < 0 < \partial p^i/\partial\tau^i$ with $i \neq k \in \{N, S\}$, $p^S \equiv p_x^w/p_y^w = \left(\alpha - \beta\tau^N\right)/\zeta\left(\alpha - \beta\tau^S\right)$ and $p^N = 1/p^S$. Section 2.2.1 has already discussed the terms-of-trade motive of trade agreement between symmetric countries. In this section, I show that countries' welfare change depends on the magnitude of the size heterogeneity parameter ζ and that there might be a winner (the small country) and a loser (the large country) if the size difference is sufficiently large. Therefore, as found by Bond and Park (2002), the small country has to compensate the large one with a compensation payment to induce him to sign the trade agreement.

Countries' import demand functions, $M_x^N(\zeta)$ and $M_y^S(\zeta)$, and their export supply functions, $E_y^N(\zeta)$ and $E_x^S(\zeta)$, are respectively given by the following

$$M_x^N(\zeta) = \alpha - 2\beta p_x^N \quad and \quad M_y^S(\zeta) = \zeta\left(\alpha - 2\beta p_y^S\right)$$

$$E_y^N(\zeta) = 2\beta p_y^N \quad and \quad E_x^S(\zeta) = 2\zeta\beta p_x^S$$

From the above expressions, it appears that the size heterogeneity parameter ζ has a negative effect on the South's imports of good y, but a positive one on its exports of good x. In equilibrium, $M_j^i = E_j^k$, $\partial M_x^N(\zeta)/\partial\zeta > 0$ and $\partial E_y^N(\zeta)/\partial\zeta < 0$. This happens since an increase in the South's capacity to produce good x makes it less dependent on foreign producers, while an increased production of good y fosters its capacity to sell abroad.

Each country's welfare (w^i) and the world welfare (ww) are defined as in the previous section. Once again, countries have to choose between a non-cooperative and a cooperative trade regime. Under the non-cooperative regime $\bar{r}$, each country applies its optimal tariff ($\overline{\tau}^i \equiv Arg\ max\ w^i$); thus, $\overline{\tau}^N(\zeta) = \frac{\zeta\alpha}{\beta(4\zeta^2+8\zeta+3)}$ and $\overline{\tau}^S(\zeta) = \frac{\zeta\alpha}{\beta(3\zeta^2+8\zeta+4)}$. Note that for $\zeta < 1$, the South's tariff level is strictly lower than North's tariff; this means that the small country's optimal tariff is lower than the large country, which reflects countries' market power.

As in previous sections, free trade prevails under the cooperative regime $\underline{r}$ ($\underline{\tau}^i \equiv Argmaxww = 0$) in the absence of political economy considerations. Using $\overline{\tau}^i$, $\underline{\tau}^i$, w^i and $\Delta w^i(\underline{r}-\overline{r})$ are expressed as functions of α, β, ζ. Fixing the values of α, β allows one to study the welfare implications of signing a trade agreement based on the demand heterogeneity parameter ζ.

Figure 2.3 describes the welfare effects of a free trade agreement (FTA) between the two countries, with the South being a replica of the North. It shows that changes in traded quantities of goods x, y (panel 1), in the international price ratio p_x/p_y (panel 2) and in the countries' welfare $\Delta w^N(\zeta)$ and $\Delta w^S(\zeta)$ (panel 3) all depend on the value of the size parameter ζ. I successively consider 2 cases. The benchmark corresponds to the situation where countries are symmetric ($\zeta = 1$). Panels 1 and 2 show that, under an FTA, countries make equivalent trade concessions - that is, when both countries liberalize trade, their imports increase by the same amount, $\alpha/10$, at an unchanged world terms-of-trade $p_x/p_y = 1$ [in other words,$\Delta p^S = 0$]. As illustrated in panel 3, each country's welfare gain amounts to $7\alpha^2/1800\beta$ vis-à-vis the Nash welfare that they would enjoy in the absence of the FTA.[23]

[23]This result is reminiscent of Bagwell and Staiger (1999, 2001) who find that a trade agreement between two large countries benefits both symmetric parties, as they experience a welfare increase without terms-of-trade externalities. However, their analysis does not extend to heterogeneous countries.

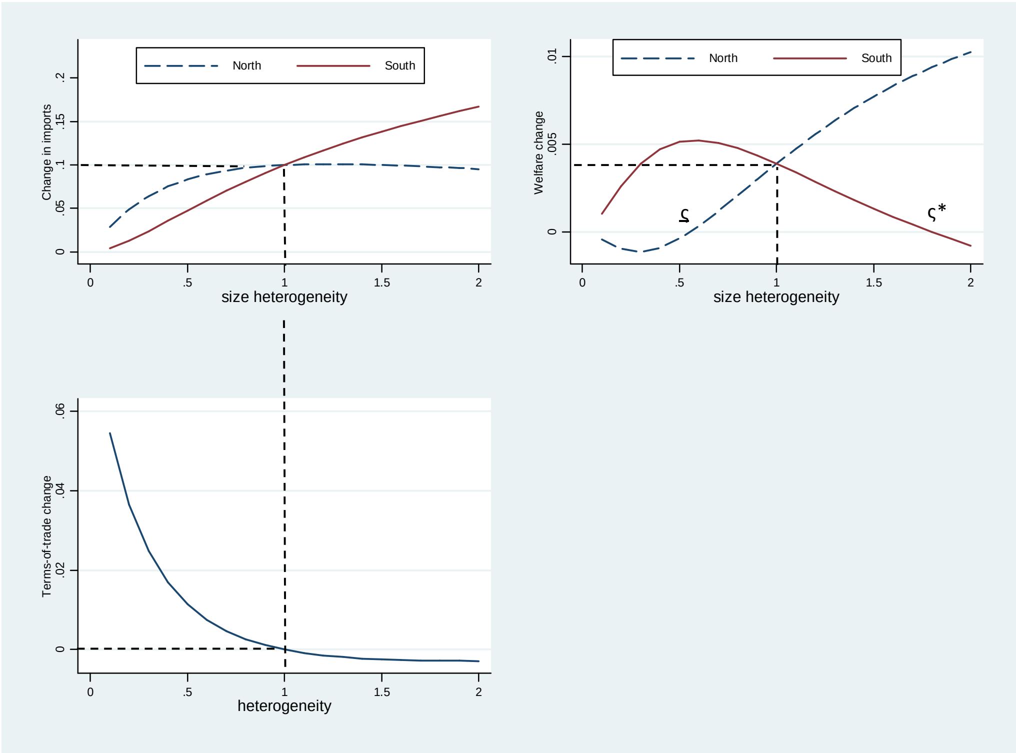

Figure 2.3: welfare change when the South is a replica of the North (ζ) (with $\alpha^2/\beta = 1$)

Consider the case where the South is smaller than the North ($\zeta < 1$). As shown in panel 1 of figure 2.1, the North's exports of y to the South increase less than its imports of x from the South after the reciprocal trade liberalization ($\triangle M_y^S < \triangle M_x^N$), thus the FTA is more advantageous to the South (see panel 3). In fact, this higher import demand of good x pushes the world terms-of-trade upward ($\Delta p^S > 0$ in panel 2), which affects countries' welfare.[24] Panel 3 illustrates that the South's welfare always increases, while the net welfare change in the North depends on the value of the parameter ζ. If the South is sufficiently small compared to the North $\left(\zeta < \underline{\zeta}\right)$, the North is worse off under an FTA. Then, the North will not sign the treaty to open up its large market to the South unless it provides for a compensation mechanism to transfer welfare from the South to the North. This well-known result is a rationale for the inclusion of non-trade concerns (NTCs) such IPRs, environment protection in either bilateral or WTO multilateral trade negotiations. When $\zeta = \underline{\zeta}$, the North is indifferent regarding signing the tariff cut since its Nash welfare equals its welfare under

[24] Recall that, in a two-country model, a country's exports to its partner are necessarily equal to its partner's imports.

an FTA. However, for $\underline{\zeta} < \zeta < 1$, both countries benefit from signing the FTA, although the South's welfare gain is higher than the North's because of the price externality.

Consider now that the South is bigger than the North ($\zeta > 1$). From panel 1, it is easily seen that the North's exports of y to the South increase more than its imports of x from the South ($\triangle M_y^S > \triangle M_x^N$), and hence the FTA is more beneficial to the North (see panel 3). Actually, the higher import demand of good y pushes the international terms-of-trade ($\Delta p^S < 0$) downward, which alters countries' welfare. As depicted in panel 3, for $\zeta > 1$, the North is always better off under an FTA, while the South's welfare change depends on the value of ζ. If the North is sufficiently small compared to the South ($\zeta > \zeta^*$), the South is worse off under an FTA. Then, there will be no agreement unless international transfers are allowed to compensate the South for its welfare loss. If $\zeta = \zeta^*$, the South's welfare under the treaty equals its Nash welfare, so that it is indifferent regarding signing the FTA. However, at some values of If $1 < \zeta < \zeta^*$, both countries benefit from signing the FTA, even if the North gains more than the South due to the terms-of-trade effect.

From all the above, I can state the following proposition

Proposition 2.3: *Let $w^i(\overline{r})$ and $w^i(\underline{r})$ be a country's welfare under the Nash and the free trade regimes; given the size heterogeneity parameter ζ, the per-period compensation transfer $T^i(\zeta)$ that the country i gaining from the FTA is willing to pay to its trading partner for its welfare loss due to the FTA is given by*

1. *for $\zeta < \underline{\zeta}$, the South (the small consumer of good y) is ready to compensate the North (the large consumer of good y) with a per-period transfer $T^S(\zeta) = \Delta w^N(\underline{r} - \overline{r})$,*

2. *for $\underline{\zeta} \leq \zeta < \zeta^*$, no transfer is made since both countries are better off under FTA,*

3. *for $\zeta > \zeta^*$, the North (the small consumer of good y) is ready to compensate the South (the small consumer of good y) with a per-period of transfer $T^N(\zeta) = \Delta w^N(\underline{r} - \overline{r})$.*

2.3 Empirical strategy

The purpose of this section is to test the theoretical predictions presented in the previous section. According to my theory, in the presence of supply heterogeneity, the large country is the one that makes a compensation transfer to the small country when both liberalize a trade. Therefore, the interaction between *EPA* and *supply heterogeneity* is expected to have a positive effect on foreign aid allocation.

On the contrary, the model shows that, in the presence of demand heterogeneity, the country with the small demand makes a compensation payment to the country with a large demand after signing the trade agreement.[25] In this case, the interaction between *EPA* and *demand heterogeneity* is expected to have a negative effect on foreign aid allocation.

Size heterogeneity is simply the presence of both supply and demand heterogeneity; the theory predicts that heterogeneity in demand dominates that of supply. Defining supply (resp. demand) heterogeneity as the ratio of the recipient's capital stock (resp. GDP) to the donor's capital stock (resp. GDP), these predictions imply the following hypotheses:

$H1$. The interaction term *EPA* $\times$ *supply heterogeneity* (*EPASUP*) has negative effect on aid allocation.

$H2$. The interaction term *EPA* $\times$ *demand heterogeneity* (*EPADEM*) has positive effect on aid allocation.

$H3$. In the size heterogeneity estimation, the effect of *EPADEM* dominates that of *EPASUP*.

To test the theory, I run one regression for each heterogeneity dimension, using foreign aid data between the EU donors and the ACP countries. The EU donor stands for the large country (or the one with a larger supply and demand) and the ACP recipient for the small country (or the one with a smaller supply and demand). For each of the two types of heterogeneity, I use two different variables. Demand heterogeneity is measured by recipient-donor country pair's total (Expenditure-side real) GDP ratio. Total GDP is used here rather than GDP per capita for two reasons: first, GDP per capita is commonly used in the aid literature as measure of recipient needs; second, total GDP makes more sense as a measure of demand or market potential.[26] The other variable used for demand heterogeneity is the recipient-donor population ratio.

[25] For brevity, I will just refer to the "small country" and to the "large country".

[26] see Neumayer (2003 b, p.19) for a similar argument.

Supply heterogeneity is measured with the ratio of recipient-donor capital stock (CK). This is preferred to the ratio of capital stock per worker, since we are interested in the total supply capacity. Looking at the data for a random year (2011, for example) is very eloquent in this regard. Germany has a smaller CK per worker than Belgium; the later is very close to France. CK per worker are respectively 340 341.8 (Belgium), 251 466.8 (Germany) and 327 442.3 (France). Yet, Germany's (Output-side real) GDP is 8.2 times higher than that of Belgium; in the case of France, the ratio is 5.7 times. This is easy to understand, once one knows that Germany's (France's) total CK is 6.5 (5.5) times that of Belgium. A similar observation can be made about the second supply heterogeneity's variable, which is the ratio of recipient-donor (Output-side real) GDP.

Since the values of the heterogeneity proxies are generally smaller than 1 (see table 3.1), an increase actually represents a reduction in heterogeneity between the recipient and the donor. Therefore, the coefficient of these variables and their interaction terms with *EPA* are expected to be negative.

Note that *EPA* itself is expected to positively affect aid allocation by donors; indeed, the EU is committed to compensate ACP countries engaged in EPAs with adjustment transfers. Since the EPA affects trade flow, I measure the quantity imported by ACP countries from their European counterparts.

This research is closely related to the work of Baccini and Uperlainen (2012) who find that foreign aid is a strategic transfer made by major powers to developing countries to facilitate politically costly economic reforms defined in the preferential trade agreements. By studying the three dimensions of heterogeneity, the present work contributes to the empirical literature on the determinants of foreign aid. Actually, country heterogeneity has been overlooked in most studies, which use the recipients' population and GDP to test if aid allocation is a response to recipients' needs or to donor interests (Alesina and Dollar, 2000; Berthélemy and Tichit, 2004; Boone, 1996; Feeny and McGillivray, 2008; Neumayer, 2003; Younas, 2008).

Before moving to analysis, the potential endogeneity problem needs to be addressed in order to prevent biased and inconsistent results with the ordinary least squares (OLS) estimation. In particular, I tackle two types of endogeneity bias problem identified by Wooldridge (2002), namely omitted variables and simultaneity. Regarding reverse causality between aid and trade, I use the one period lag of the import variable as an instrument for the contemporaneous import, as suggested by Anderson (1979, p. 111) and Wooldridge (2000, p. 517).

To address the omitted variable bias and the unobserved heterogeneity, I take on several steps. First, I use donor countries' fixed effects to account for unobserved donor heterogeneity. Despite the fact that some aid policies are decided at the European level, donor countries still have a large amount of autonomy in making decisions on their aid allocation; in fact, donor fragmentation and lack of coordination are well-known phenomena in the aid literature (Bigsten, 2006; Dollar and Levin, 2006). Second, I control for missing variables that are specific to donor-recipient country pair by including dummies for colonial linkages and common language. Since ACP-EU treaties also encompass political cooperation in the international arena, I also account for this dimension by including a variable measuring the correlation in UN voting patterns in general assemblies for each donor-recipient pair.

Geographical distance is also included to control for time-invariant factors between each donor-recipient pair; it is a good proxy for transport costs. Recipient heterogeneity is taken into account through the EBA dummy that distinguishes the least developed countries (LDCs) within the ACP group. Unlike other ACP countries, LDCs can still benefit from a privileged access into the European market through the Everything But Arms (EBA) initiative. Finally, I include a variable to capture the "raw material diplomacy", which is simply the share of primary commodities in ACP exports to European countries.

Data and Methodology

The data on EU-ACP bilateral aid flows (Official Development Assistance, ODA) is taken from the Development Assistance Committee (DAC) of the OECD; it is reported in the online World Development Indicators (WDI). The sample covers the the 2000-2011 period and includes 45 ACP countries and 15 European donors (see appendix)[27]; each observation is a donor-recipient for which there is a positive amount of foreign aid and correlation data on UN voting patterns. It should be noted four countries give about 69 % of the total aid in the sample : France (22 %), the United Kingdom (22 %), Germany (15 %) and the Netherlands (10 %) (Figure 3.4). The aid data has been converted into real terms using the unit value of the world import price index (taken from WDI online) as in Neumayer (2003 a.).

My goal is to check if the initiation of an EPA and country heterogeneity influence the aid allocation decision of European donors. The variable *EPA* is an indicator that equals 1 from the moment an ACP recipient initiates

[27] The data starts in 2000, which coincides to the moment the ACP countries and the EU signed the Cotonou agreement, which was a transitory step from the preferential treatment to the EPAs.

an EPA with the EU (see appendix for details). I rely on the the European Commission (2013) document "overview of EPA negotiations" to build the EPA variable. Data used for building heterogeneity variables are all taken from the Penn World Table 8.0 (PWT8.0) built by Feenstra, Inklaar and Timmer (2013). Demand heterogeneity is measured by $\frac{CGDPE_{ACP}}{CGDPE_{EU}}$ and $\frac{Population_{ACP}}{Population_{EU}}$; supply heterogeneity is proxied by $\frac{CGDPO_{ACP}}{CGDOP_{EU}}$ and $\frac{CK_{ACP}}{CK_{EU}}$. $CGDPE$ and $CGDPO$ correspond respectively to the expenditure-side and to the output-side real GDP at current PPPs (in million 2005 US$); CK is the capital stock at current PPPs (in mil. 2005US$).

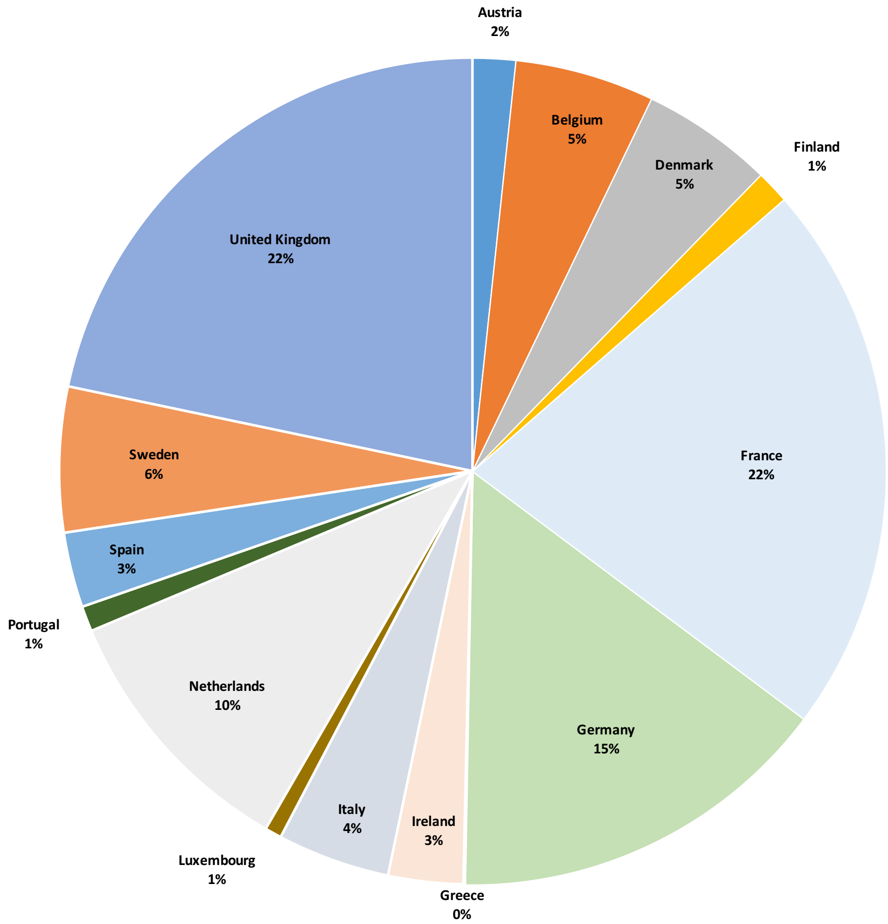

Figure 2.4. Cumulative bilateral aid (%), from 2000 to 2011.

Trade data come from UNCTADSTAT website; ACP imports have been converted into real terms using the unit value of the world import price index. $\frac{PRIM.EXP}{EXPORTS}$ is the share of primary commodities in ACP total exports. *UNGA vote* measures the correlation in UN voting patters between each donor-recipient pair; the data come from Strezhnev and Voeten's United Nations General Assembly Voting Data (2013). Finally, distance is from

CEPII. Aid, imports and distance are reported below as their natural log, as they vary across a wide range; in this way, outlier effects on estimations are reduced. Table 2.1 presents summary statistics; the correlation matrix is shown in table 2.2. The highest correlation of *Lnaid* is found with *Lnimports*; this suggests that the more ACP countries import from European donors, the more they receive aid. *Lnaid* is negatively associated with all four heterogeneity measures, as expected. one may expect that a reduction in supply or demand heterogeneity is associated with less foreign aid. The population measure displays the smaller correlation in absolute terms (0.09). $\frac{GDPO_{ACP}}{GDPO_{EU}}$ and $\frac{GDPE_{ACP}}{GDPE_{EU}}$ are highly correlated (0.95); therefore, both variables will not be used in a same regression. A more detailed description of the data and sources is included in the Appendix.

Table 2.1: Description of data used in the analysis

Variables	N	Mean	Std. dev.	Min	Max
lnaid	4091	15.403	2.200	8.871	21.823
lnimports	4091	9.82	2.145	0.122	15.982
$\frac{CK_{ACP}}{CK_{EU}}$	4092	0.056	0.072	0.003	0.528
$\frac{GDPE_{ACP}}{GDPE_{EU}}$	4092	0.063	0.069	0.003	0.534
$\frac{CGDPO/worker_{ACP}}{CGDPO/worker_{EU}}_{t-1}$	4092	0.075	0.085	0.006	0.662
$\frac{Population_{ACP}}{Population_{EU}}$	4092	4.062	13.595	0.002	164.233
$\frac{PRIM.EXP}{EXPORTS}$	3774	0.775	0.289	0	1
UNGA vote	4092	0.368	0.142	-0.4	1
Ln distance	4092	8.700	0.282	7.880	9.680

Notes: This table presents basic statistics for the variables used in the analysis. The appendix contains sources and descriptions of the variables.

The dummy variable for colonial ties is from Head, Mayer and Ries (2010), while the common language dummy is taken from Santos Silva and Tenreyro (2006); the online *Encyclopédie Larousse* was used as a complementary source for countries not included in their sample.

Table 2.2. Correlation between *Ln aid* and key variables

	$lnaid$	$lnimports$	$\frac{CK_{ACP}}{CK_{EU}}$	$\frac{GDPE_{ACP}}{GDPE_{EU}}$	$\frac{CGDPO_{ACP}}{CGDPO_{EU}}$	$\frac{Population_{ACP}}{Population_{EU}}$	$\frac{PRIM.EXP}{EXPORTS}$	$UNGA\ vote$	$Ln\ distance$
$lnaid$	1.000								
$lnimports$	0.411	1.000							
$\frac{CK_{ACP}}{CK_{EU}}$	-0.194	0.166	1.000						
$\frac{GDPE_{ACP}}{GDPE_{EU}}$	-0.217	0.210	0.755	1.000					
$\frac{CGDPO/worker_{ACP}}{CGDPO/worker_{EU}}\ _{t-1}$	-0.205	0.227	0.772	0.952	1.000				
$\frac{Population_{ACP}}{Population_{EU}}$	-0.087	-0.109	-0.032	-0.068	-0.015	1.000			
$\frac{PRIM.EXP}{EXPORTS}$	0.125	0.141	-0.132	-0.100	-0.101	-0.073	1.000		
$UNGA\ vote$	-0.184	-0.103	0.096	0.116	0.101	0.058	-0.097	1.000	
$Ln\ distance$	0.068	-0.144	0.227	0.255	0.220	0.036	-0.099	0.011	1.000

Fig. 3.5 presents scatterplots of the key explanatory variables versus the natural logarithm of real total aid. Panels 1 and 4 show that all ACP recipients have a smaller total capital GDP than EU donors; actually, most of the dots in the two scatterplots have a y-axis value smaller than 0.4. This suggests that aid allocation is concentrated on ACP countries with low supply capacities and a small market demand. From panel 2, one can easily see that most ACP countries have larger populations than their European counterparts; only few ACP countries have populations 50 times or more than EU donors. Panel 3 shows that all aid recipients have lower total stock of capital than donors; in fact, the stock of capital of most ACP countries is no more than two tenths of their donor counterparts. Panel 5 displays the relationship between the correlation in UNGA votes for each donor-recipient pair and aid allocation; most of the dots in the plot have a y-axis value between 0.2 and 0.5, suggesting that having the same voting pattern might not be a major determinant of EU aid allocation. Finally, in panel 6, one can see a high density of dots in the top of the chart where the share of primary commodities in exports is greater than 0.6; this indicates that ACP countries that export a large share of raw materials to European donors are more likely to receive aid.

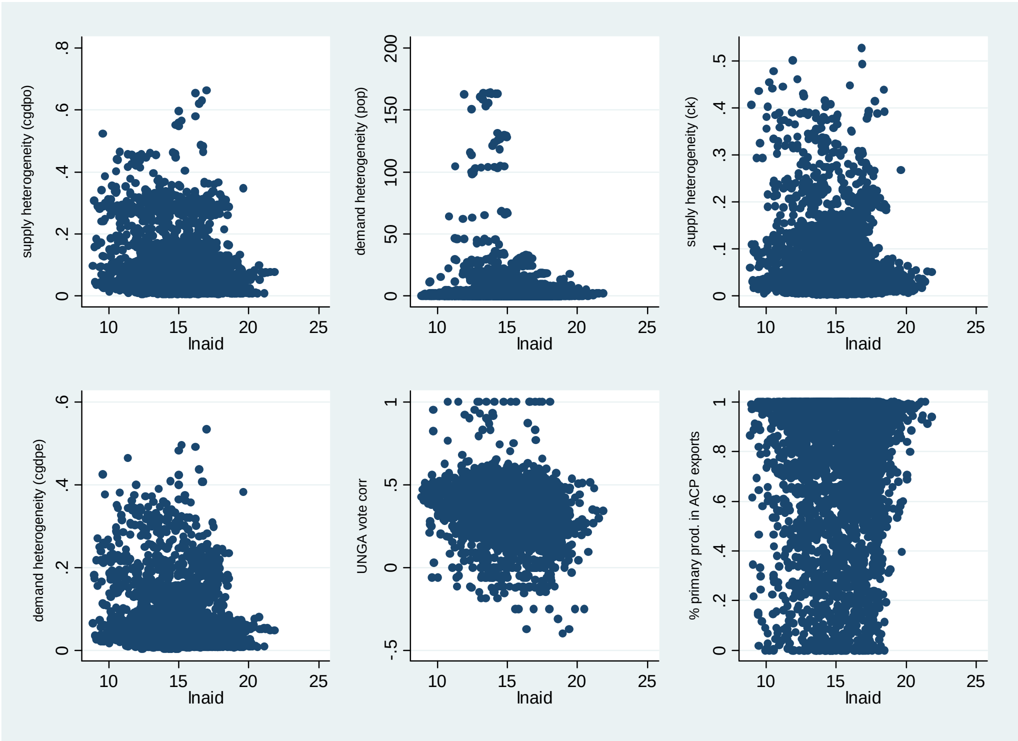

Figure 2.5. Correlations of bilateral foreign aid and five key explanatory variables

Before choosing the estimation method, I run a Hausman test that confirms that fixed effects need to be used instead of random effects to account for heterogeneity across countries in the panel data, so the estimations include fixed effects for each donor country. In addition, I test for autocorrelation and heteroskedasticity in the panel data. The standard Wooldridge test rejects the null hypothesis that there is no first-order serial correlation, while the Wald's test indicates the presence of heteroskedasticity. Finally, I test for the presence of cross-sectional dependence (CD); both Pesaran's and Frees' tests strongly reject the null hypothesis of no CD. Therefore, the appropriate estimation technique has to produce standard error estimates that are heteroskedasticity consistent and robust to to general forms of cross-sectional and temporal dependence. As suggested by Hoechle (2007), I use the pooled ordinary least squares (OLS) with Driscoll and Kraay (1998) standard errors and I include donor fixed effects. This approach is similar to Baccini and Urpelainen (2012). Note that all independent variables are lagged 1 period, except for *EPA* and other dummy variables; this is a reasonable approach as donors receive information about a recipient with some time lag (Neumayer, 2003 a.; Younas, 2008).

Estimation results

Graphs and the correlation table shown above highlight some interesting facts about the donors' allocation decision. In this section, I run several regressions and thus measure the marginal effects of the aid determinants studied in the previous section. The natural log of total bilateral aid is used as the dependent variable. Table 2.3 presents a pair of regressions for each heterogeneity dimension (supply, demand and size): in each case, there is a "base" estimation followed by an "augmented" estimation where dummy variables for colonial ties and common language are added. The coefficients are quite similar in both columns, suggesting that results are robust.

Columns (1) and (2) report the "supply heterogeneity" model: initiating an *EPA* is positive though not significantly associated with aid. The supply heterogeneity variable $\frac{CK_{ACP}}{CK_{EU}}_{t-1}$ is significant at the 1 % level and displays the highest coefficient. Its coefficient, which is strongly significant at 1 % level, takes on the value -6.677 in (1) and -6.957 in (2). However, the key finding is about the interaction term between the above variables, which is also negative and significant at the 5 % level. Its coefficient is the second in magnitude (in absolute terms) in both estimations (-1.207 and -1.177, respectively). The fact that *EPA* is not statistically significant, while $EPA \times \frac{CK_{ACP}}{CK_{EU}}_{t-1}$ is, suggests that signing an *EPA* does not induce more aid per se; what matters to the donors is its impact on recipient countries experiencing "heavy" supply-side constraints. As predicted by our theory, in the presence of sufficient supply heterogeneity, the recipient country (the South) cannot take advantage of trade liberalization, unlike the donor country (the North). As a result, the North is better off and the South, worse off. To convince the later to sign the EPA, the North dedicates a share of its aid envelope to compensate the South for the forgone fiscal revenue. Least developed ACPs can keep benefiting from a preferential access to the European market through the EBA initiative. Moreover, countries that qualify for the EBA seem to receive more aid than others, as shown by the positive and strongly significant dummy variable. The negative coefficient for $EPA \times \frac{CK_{ACP}}{CK_{EU}}_{t-1}$ may capture the fact that non-LDC countries had a much bigger interest in keeping preferences, since they would not benefit from EBA.

It is argued that EPAs are part of the the EU "raw material diplomacy"; $\frac{PRIM.EXP}{EXPORTS}_{t-1}$ is included to check whether the European aid policy is influenced by the share of primary products in ACP total exports. This seems to be the case, since the coefficient of this variable is significant at the 1 % level in both regressions. Correlation in *UNGA vote* has a positive effect on aid allocation

Table 2.3. Dependent Variable: Log of aid 2000 to 2011.

	Supply heterogeneity		Demand heterogeneity		Size heterogeneity	
Independent variables	(1)	(2)	(3)	(4)	(5)	(6)
EPA	0.216	0.192	0.179	0.146	0.282 *	0.231
	(0.150)	(0.143)	(0.125)	(0.117)	(0.139)	(0.130)
EBA	0.948 ***	0.878 ***			0.765 ***	0.698 ***
	(0.087)	(0.084)			(0.084)	(0.083)
$\frac{CK_{ACP}}{CK_{EU}}{}_{t-1}$	-6.677 ***	-6.957 ***			-4.296 ***	-4.392 ***
	(0.477)	(0.445)			(0.476)	(0.452)
$\frac{CGDPE_{ACP}}{CGDPE_{UE}}{}_{t-1}$			-10.985 ***	-11.075 ***	-4.706 ***	-4.950 ***
			(0.848)	(0.784)	(0.679)	(0.610)
EPA $\times \frac{CK_{ACP}}{CK_{EU}}{}_{t-1}$	-1.207 **	-1.177 **			0.949	0.305
	(0.449)	(0.434)			(0.612)	(0.634)
EPA $\times \frac{CGDPE_{ACP}}{CGDPE_{UE}}{}_{t-1}$			-0.762	-0.432	-2.308 ***	-1.130 *
			(0.706)	(0.647)	(0.675)	(0.654)
Ln imports$_{t-1}$	0.503 ***	0.458 ***	0.429 ***	0.392 ***	0.514 ***	0.470 ***
	(0.024)	(0.023)	(0.017)	(0.018)	(0.022)	(0.021)
$\frac{PRIM.EXP}{EXPORTS}{}_{t-1}$	0.498 ***	0.475 ***			0.419 ***	0.401 ***
	(0.090)	(0.095)			(0.092)	(0.097)
UNGA vote$_{t-1}$	0.077	0.149	0.147	0.221	0.195	0.273
	(0.263)	(0.266)	(0.271)	(0.257)	(0.233)	(0.240)
Ln distance	1.106 ***	1.142 ***	1.055 ***	1.103 ***	1.269 ***	1.302 ***
	(0.236)	(0.230)	(0.238)	(0.238)	(0.243)	(0.241)
Colonial ties		1.033 ***		1.104 ***		1.024 ***
		(0.102)		(0.092)		(0.094)
Common language		0.423 ***		0.418 ***		0.424 ***
		(0.108)		(0.104)		(0.111)
Constant	-0.739	-0.616	1.563	1.433	-1.990	-1.856
	(2.035)	(1.992)	(1.891)	(1.904)	(2.071)	(2.057)
R^2	0.443	0.469	0.414	0.442	0.452	0.478
Observations (N)	3455	3455	3749	3749	3455	3455
Number of clusters	336	336	341	341	336	336

Note: Pooled OLS estimation with Driscoll-Kraay standard errors (AR 1) including Donor Fixed Effects. Superscripts ***, ** and * indicate significance 1, 5 and 10 % levels, respectively.

though insignificant; further analysis reveals that *UNGA vote* only matters for the three big donors (France, Germany and UK) that make up to 59 % of the EU aid in the sample (see appendix). Contrary to Neumayer (2003 a.), *lndistance* has a positive and significant impact on aid; it accounts for time invariant factors. As usual, $Ln\,imports_{t-1}$, *common language* and *colonial ties* are also positively and very significantly associated with foreign aid allocation. Note that $Ln\,imports_{t-1}$ does not have the highest coefficient in the model, which suggests that the promotion of EU exports is not the most important determinant of aid allocation to ACP countries.[28]

Columns (3) and (4) present the "demand heterogeneity" model: as in the previous regressions, initiating an EPA affects positively but insignificantly EU donors' aid allocation decision. The demand heterogeneity variable, $\frac{CGDPE_{ACP}}{CGDPE_{EU}}_{t-1}$, is the most important determinant of the aid allocation decision in both regressions (3) and (4). It is strongly statistically significant at 1 % accordance with our theory; its coefficient is respectively given by -10.985 and to -11.075. As established in our theoretical prediction, freeing trade benefits more recipient countries than donors, as they have a better access to donors' large markets. Anticipating this effect, donors tend to reduce their aid envelopes. Therefore, $EPA \times \frac{GDPE_{ACP}}{GDPE_{EU}}_{t-1}$ negatively affects aid allocation; its coefficient amounts to -0.762 in (3) and to -0.431 in (4). However, its effect is not statistically significant. Contrary to *UNGA vote, colonial ties* and a *common language* are also positively and very significantly associated with foreign aid allocation. These 3 variables behave exactly as in the "supply heterogeneity" model.

Finally, columns (5) and (6) present the full model with both supply and demand heterogeneity. Signing an *EPA* has a positive impact on aid in both estimations, but it is significant only in (5). Both heterogeneity variables, $\frac{CK_{ACP}}{CK_{EU}}_{t-1}$ and $\frac{CGDPE_{ACP}}{CGDPE_{EU}}_{t-1}$, enter with negative sign and are significant at the 1 % level in both regressions. Moreover, their coefficients are of the same magnitude (around -4.500, which suggests that our hypothesis that $\zeta^s = \zeta^d$ makes sense). $EPA \times \frac{CK_{ACP}}{CK_{EU}}_{t-1}$ enters with the wrong sign and is not significant neither in (5) nor (6); actually, it seems that its impact vanishes in the presence of the other interaction term, $EPA \times \frac{CGDPE_{ACP}}{CGDPE_{EU}}_{t-1}$, that behaves as expected. This last finding corroborates the theory presented in section 2.2, where the welfare implications of size heterogeneity are qualitatively identical to those of the demand heterogeneity. As explained

[28]Is coefficient almost doubles when the sample is restricted to the three big donors (France, Germany, UK); this suggests that these countries have more commercial interests than the other donors (see appendix 2.6.1).

above, trade liberalization is expected to benefit more recipient countries than donors, as the latter imports more than the former because of their difference in size. Aware of this benefit, the latter lowers its aid allocation. All the control variables behave exactly as in (1) through (4).

These findings are new to the empirical aid literature, since studies on the determinants of aid allocation do not take into account the recipients' supply capacity, but rather focus on recipients' needs. In fact, all the papers reviewed do not include relative size indicators, but they usually include only recipients' GDP and population variables (log or level). Moreover, this result sheds light on the fact that a portion of the aid envelope serves as compensation transfer to poor countries facing supply-side constraints, which prevent them from taking advantage of free trade.

Robustness check

To test the robustness of the results, I replace $\frac{CK_{ACP}}{CK_{EU}}_{t-1}$ by $\frac{CGDPO_{ACP}}{CGDPO_{EU}}_{t-1}$ and $\frac{CGDPO/worker_{ACP}}{CGDPO/worker_{EU}}_{t-1}$ by $\frac{Population_{ACP}}{Population_{EU}}_{t-1}$ [29]. Results are reported in table 2.4. In what follows, attention will be focused on these variables, since the behavior of all the controls is similar to the previous section 2.3.2.[30] In columns (1) and (2) that report the "supply heterogeneity" model, the coefficient of $\frac{CGDPO/worker_{ACP}}{CGDPO/worker_{EU}}_{t-1}$ is negative and significant at the 1 % level; it takes values of -6.619 and -6.865 respectively. The interaction term $EPA \times \frac{CGDPO/worker_{ACP}}{CGDPO/worker_{EU}}_{t-1}$ has a negative impact on aid, which is statistically significant at the 10 % level in both estimations. Its coefficient equals -1.650 and -1.372. The values of these coefficients are comparable to the corresponding regressions in table 2.3.

Columns (3) and (4) present the basic and the augmented demand heterogeneity model. Both $\frac{Population_{ACP}}{Population_{EU}}_{t-1}$ and the interaction term $EPA \times \frac{Population_{ACP}}{Population_{EU}}_{t-1}$ are negative and statistically significant at the 1 % level. However, their coefficients are smaller than those obtained with $\frac{CGDPO/worker_{ACP}}{CGDPO/worker_{EU}}_{t-1}$. In both regressions, $\frac{Population_{ACP}}{Population_{EU}}_{t-1}$ has a coefficient of -0.01, while the interaction term $EPA \times \frac{Population_{ACP}}{Population_{EU}}_{t-1}$ has a coefficient of -0.2. These coefficients are far below those obtained in the corresponding regressions in table 2.3.

[29] $\frac{CGDPO/worker_{ACP}}{CGDPO/worker_{EU}}_{t-1}$ is used instead of $\frac{CGDPO_{ACP}}{CGDPO_{EU}}_{t-1}$ as countries' GDP is often used in the literature as a proxy for market size (Chen and Joshi, 2010). Because of the large number of missing values in $CTFP$ (total factor productivity) for ACP countries, this variable is not used since its inclusion would significantly reduce the sample size.

[30] The only exception concerns *UNGA vote* whose coefficient is unexpectedly negative and statistically significant in regressions (3) and (4).

The full model's results are quite similar to the one presented in the previous section. In columns (5) and (6), both heterogeneity variables remain strongly significant at the 1 % level and remain negative. Similarly to the full model of section 2.3.2, the interaction between *EPA* and the "supply heterogeneity" variable is no longer significant when combined with $EPA \times \frac{Population_{ACP}}{Population_{EU}}_{t-1}$. However, it has the expected negative sign. As usual, $Ln\,imports_{t-1}$, *colonial ties* and a *common language* have a positive and very significant effect on aid allocation decision. UNGA vote and $\frac{PRIM.EXP}{EXPORTS}_{t-1}$ have positive coefficient; however, only that of the later is statistically significant.

The above results show that the main empirical findings about the effects of signing an EPA between heterogeneous countries are robust to the use of alternative measures of heterogeneity variables.

Table 2.4. Dependent Variable: Log of aid 2000 to 2011.

	Supply heterogeneity		Demand heterogeneity		Size heterogeneity	
Independent variables	(1)	(2)	(3)	(4)	(5)	(6)
EPA	0.347 *	0.306 *	0.085	0.072	0.345 *	0.307 *
	(0.160)	(0.151)	(0.116)	(0.112)	(0.162)	(0.153)
EBA	0.829 ***	0.765 ***			0.831 ***	0.768 ***
	(0.068)	(0.068)			(0.068)	(0.068)
$\frac{CGDPO/worker_{ACP}}{CGDPO/worker_{EU}}_{t-1}$	-6.619 ***	-6.865 ***			-6.778 ***	-7.001 ***
	(0.827)	(0.792)			(0.824)	(0.790)
$\frac{Population_{ACP}}{Population_{UE}}_{t-1}$			-0.012 ***	-0.009 ***	-0.021 ***	-0.018 ***
			(0.001)	(0.001)	(0.003)	(0.002)
EPA $\times \frac{CGDPO/worker_{ACP}}{CGDPO/worker_{EU}}_{t-1}$	-1.650 *	-1.372 *			-1.403	-1.175
	(0.788)	(0.760)			(0.804)	(0.774)
EPA $\times \frac{Population_{ACP}}{Population_{UE}}_{t-1}$			-0.023 ***	-0.020 ***	-0.017 ***	-0.015 ***
			(0.003)	(0.003)	(0.004)	(0.004)
Ln imports$_{t-1}$	0.539 ***	0.496 ***	0.350 ***	0.309 ***	0.576 ***	0.528 ***
	(0.021)	(0.021)	(0.012)	(0.014)	(0.019)	(0.019)
$\frac{PRIM.EXP}{EXPORTS}_{t-1}$	0.483 ***	0.466 ***			0.501 ***	0.482 ***
	(0.087)	(0.091)			(0.082)	(0.086)
UNGA vote$_{t-1}$	0.127	0.197	-0.728 *	-0.649 *	0.104	0.172
	(0.199)	(0.208)	(0.345)	(0.323)	(0.196)	(0.199)
Ln distance	1.202 ***	1.229 ***	0.066	0.103	1.272 ***	1.280 ***
	(0.257)	(0.254)	(0.152)	(0.155)	(0.252)	(0.252)
Colonial ties		1.037 ***		1.100 ***		1.051 ***
		(0.092)		(0.087)		(0.101)
Common language		0.384 ***		0.393 ***		0.311 **
		(0.110)		(0.101)		(0.106)
Constant	-1.689	-1.507	10.721 ***	10.704 ***	-2.521	-2.153
	(2.168)	(2.145)	(1.099)	(1.132)	(2.106)	(2.115)
R^2	0.450	0.475	0.326	0.352	0.456	0.480
Observations (N)	3455	3455	3749	3749	3455	3455
Number of clusters	336	336	341	341	336	336

Note: Pooled OLS estimation with Driscoll-Kraay standard errors (AR 1) including Donor Fixed Effects. Superscripts ***, ** and * indicate significance 1, 5 and 10 % levels, respectively.

2.4 Conclusion

This paper studies the welfare effects of heterogeneity in a standard North-South trade agreement model. It has shown that "sufficient" heterogeneity in demand has a similar outcome as heterogeneity in size, in which one country is the small replica of the other. In both cases, a trade agreement benefits the small country or the country with the smaller demand, while the large country is worse off. To sign the agreement, the large country needs to be compensated for its welfare loss.

The result is reversed in the presence of heterogeneity in supply: in fact, the small country experiencing "sufficient" supply-side constraints is worse off after the agreement, while the bigger is better off. In this case, the transfer must flow from the large to the small country. This finding explain why Economic partnership agreements (EPAs) between the EU and the ACP countries provide for development assistance as an adjustment package.

Testing this theory with EU-ACP data, I find that supply (demand) heterogeneity measures are positively (negatively) associated with European donors' aid allocation. This study enriches the empirical works on the determinants of foreign aid by taking into account the supply-side of the economy, where only the demand side has traditionally been considered. Results suggest that European donors give more aid to countries that face supply-side constraints, which prevent them from taking advantage of free trade arrangements.

2.5 Appendix

Some results for the 3 major donors: France, Germany and UK

Table 2.5. Dependent Variable: Log of aid 2000 to 2011.

	Size heterogeneity	
Independent variables	France, Germany, UK	France, Germany
EPA	0.206 *	0.429 **
	(0.110)	(0.187)
EBA	0.455 ***	0.379 ***
	(0.068)	(0.102)
$\frac{CGDPO_{ACP}}{CGDPO_{UE}}_{t-1}$	-10.533 ***	-9.501 ***
	(0.872)	(0.981)
$\frac{Population_{ACP}}{Population_{UE}}_{t-1}$	-0.157	-0.803 ***
	(0.243)	(0.252)
EPA $\times \frac{CGDPO_{ACP}}{CGDPO_{UE}}_{t-1}$	-1.436	-0.984
	(0.905)	(0.963)
EPA $\times \frac{Population_{ACP}}{Population_{UE}}_{t-1}$	-0.167	-1.068 **
	(0.349)	(0.416)
Ln imports$_{t-1}$	0.774 ***	0.931 ***
	(0.047)	(0.030)
$\frac{PRIM.EXP}{EXPORTS}_{t-1}$	0.781 ***	1.005 ***
	(0.143)	(0.196)
UNGA vote$_{t-1}$	0.621 *	0.736 **
	(0.328)	(0.324)
Ln distance	0.925 **	0.405
	(0.310)	(0.305)
Colonial ties		
Common language		
Constant	-0.529	2.146
	(3.073)	(2.843)
R^2	0.564	0.624
Observations (N)	1021	771
Number of clusters	94	71

Note: Pooled OLS estimation with Driscoll-Kraay standard errors (AR 1) with Donor FEs. Superscripts ***, ** and * indicate significance 1, 5 and 10 % levels, respectively.

The 15 European-DAC donors in the sample

1. Austria	6. Germany	11. Netherlands
2. Belgium	7. Greece	12. Portugal
3. Denmark	8. Ireland	13. Spain
4. Finland	9. Italy	14. Sweden
5. France	10. Luxembourg	15. United Kingdom

The 45 ACP (recipient) countries, their outside options and the EPA initiation

Country	Option	EPA	COUNTRY	Option	EPA	Country	Option	EPA
1. Angola	EBA		16. Eq. Guinea	EBA		31. Namibia	GSP	2007
2. Belize	GSP	2007	17. Ethiopia	EBA		32. Nigeria	GSP	
3. Benin	EBA		18. Fiji	GSP	2009	33. Rwanda	EBA	2008
4. Botswana	GSP	2007	19. Gabon	GSP		34. Saint Lucia	GSP	2007
5. Burkina Faso	EBA		20. Gambia	EBA		35. Senegal	EBA	
6. Burundi	EBA	2008	21. Ghana	GSP	2007	36. Sierra Leone	EBA	
7. Cameroon	GSP	2007	22. Guinea	EBA		37. South Africa	GSP**	
8. Cape Verde	EBA		23. Jamaica	GSP	2007	38. Sudan	EBA	
9. Chad	EBA		24. Kenya	GSP	2008	39. Surinam	GSP	2007
10. Comoros	EBA		25. Lesotho	EBA	2007	40. Swaziland	GSP	2007
11. Congo	GSP		26. Madagascar	EBA	2007	41. Togo	EBA	
12. Côte d'Ivoire	GSP	2007	27. Malawi	EBA		42. Uganda	EBA	2008
13. D.R.Congo	EBA		28. Mali	EBA		43. URTanzania	EBA	2008
14. Djibouti	EBA		29. Mauritania	EBA		44. Zambia	EBA	
15. Dominican R.	GSP	2007	30. Mozambique	EBA	2007	45. Zimbabwe	GSP	2007

** There is also a Trade and Development Cooperation Agreement between the EU and South Africa

Source : 1) European Commission (EC), " Overview Of EPA negotiations," Updated on 16 October 2013 accessed onlin 2013 at http://trade.ec.europa.eu/doclib/docs/2009/september/tradoc_144912.pdf.

2) OPPD (2012) and various fact sheets on EPAs by regions from the EC

Data sources

Variables	Data source
Net aid from 15- EU DAC member countries of OECD	World Development Indicators (WBI, 2011), online access at http://data.worldbank.org/indicator
UNGA vote	Strezhnev and Voeten's UN General Assembly Voting Data (2013)
GDPE	Feenstra, R.C., Inklaar, R. and Timmer, M. P. (2013) (PWT 8.0)
GDPO	Feenstra, R.C., Inklaar, R. and Timmer, M. P. (2013) (PWT 8.0)
Trade (Imports and Exports)	UNCTADSTAT (2012), online access at http://unctadstat.unctad.org
Distance	CEPII
CK	Feenstra, R.C., Inklaar, R. and Timmer, M. P. (2013) (PWT 8.0)
Colonial ties	Table A.4 of Head, Mayer and Ries (2010)
Common language	Table A.2 of Santos Silva and Tenreyro (2006) supplemented with the Encyclopédie Larousse, online

2.6 Mathematical appendix

PROOF OF PROPOSITION 2.1:

In what follows, I prove the existence of the critical values $\underline{\zeta}^s$ and ζ^{s^*} of the size parameter; in addition, I show that countries' welfare change polynomial functions, $\Delta w^N(\zeta^s)$ and $\Delta w^S(\zeta^s)$, behave as depicted in panel 3 of figure 3.3. First, note that $\underset{\zeta^s\to 0}{lim}\Delta w^N(\zeta^s) = \frac{13}{288}\frac{\alpha^2}{\beta}$. Second, to determine the shape of the $\Delta w^N(\zeta^s)$ curve, consider its FOC $\frac{\partial\left(\Delta w^N(\zeta^s)\right)}{\partial\zeta^s} = \frac{\alpha^2 F1(\zeta^s)}{2\beta G1(\zeta^s)}$,

with

$$F1\left(\zeta^s\right) = \left(\begin{array}{c} -2200 - 9906\zeta^s - 18549\zeta^{s2} - 20367\zeta^{s3} - 13835\zeta^{s4} \\ -5091\zeta^{s5} - 475\zeta^{s6} + 299\zeta^{s7} + 99\zeta^{s8} + 9\zeta^{s9} \end{array}\right)$$

$$G1\left(\zeta^s\right) = \left(1+\zeta^s\right)^2\left(2+\zeta^s\right)^2\left(3+\zeta^s\right)^2\left(4+\zeta^s\right)^3$$

Solving numerically for $\partial\left(\Delta w^N(\zeta^s)\right)/\partial\zeta^s = 0$ brings one positive extremum $\zeta^s_n \cong 3.87$. The SOC test tells if this point is a maximum or a minimum. The SOC of $\Delta w^N(\zeta^s)$ equals to $\frac{\partial^2\left(\Delta w^N(\zeta^s)\right)}{\partial^2\zeta^s} = -\frac{\alpha^2 F2(\zeta^s)}{2\beta G2(\zeta^s)}$,

with

$$F2\left(\zeta^s\right) = \left(\begin{array}{c} -92256 - 562248\zeta^s - 1392576\zeta^{s2} - 2087580\zeta^{s3} - 2243261\zeta^{s4} \\ -1798460\zeta^{s5} - 1032220\zeta^{s6} - 393128\zeta^{s7} - 87046\zeta^{s8} \\ -6500\zeta^{s9} + 1540\zeta^{s10} + 396\zeta^{s11} + 27\zeta^{s12} \end{array}\right)$$

$$G2\left(\zeta^s\right) = \left(1+\zeta^s\right)^4\left(2+\zeta^s\right)^4\left(3+\zeta^s\right)^4\left(4+\zeta^s\right)^4$$

Since $\frac{\partial^2\left(\Delta w^N(\zeta^s_n)\right)}{\partial^2\zeta^s} = 0.0012\frac{\alpha^2}{\beta} > 0$, ζ^s_n is a minimum (the point where the welfare loss is maximum). $\Delta w^N\left(\zeta^s\right)$ intersects with the x-axis at $\underline{\zeta}^s \cong 1.2168$; this value is found by setting $\Delta w^N\left(\zeta^s\right) = 0$. Beyond the point $\underline{\zeta}^s$, $\Delta w^N\left(\zeta^s\right)$ becomes and remains negative, since $\underset{\zeta^s\to\infty}{lim}\Delta w^N(\zeta^s) = 0$[31]. Thus, it turns out that $\Delta w^N(\zeta^s) > 0$ for $\zeta^s < \underline{\zeta}^s$; on the contrary, $\Delta w^N(\zeta^s) < 0$ when $\zeta^s > \underline{\zeta}^s$.

Proceeding similarly with the South, $\underset{\zeta^s\to 0}{lim}\Delta w^S(\zeta^s) = -\frac{97}{4601}\frac{\alpha^2}{\beta}$. Its FOC is given by $\frac{\partial\left(\Delta w^S(\zeta^s)\right)}{\partial\zeta^s} = -\frac{\alpha^2 F^*1(\zeta^s)}{8\beta G^*1(\zeta^s)}$,

with

$$C^*1\left(\zeta^s\right) = \left(\begin{array}{c} -1900 - 15354\zeta^s - 45759\zeta^{s2} - 56819\zeta^{s3} - 30946\zeta^{s4} \\ -5240\zeta^{s5} + 1525\zeta^{s6} + 693\zeta^{s7} + 72\zeta^{s8} \end{array}\right)$$

[31] To compute this limit, divide both the numerator and the denominator by ζ^5; since $\underset{\zeta\to\infty}{lim}\left(1/\zeta^i\right) = 0$, with $i \geq 1$, then $\underset{\zeta\to\infty}{lim}\Delta W(\zeta) = 0$.

$E^{*}1\left(\zeta^{s}\right)=\left(1+\zeta^{s}\right)^{2}\left(2+\zeta^{s}\right)^{3}\left(3+\zeta^{s}\right)^{3}\left(4+\zeta^{s}\right)^{3}$

Setting $\partial\left(\Delta w^{S}(\zeta^{s})\right)/\partial\zeta^{s}=0$ and solving numerically gives a positive extremum candidate, $\zeta^{s'}\cong 3.6977$. I use the SOC test to determine whether this point is a maximum or a minimum; the SOC is given by $\frac{\partial^{2}\left(\Delta w^{S}(\zeta^{s})\right)}{\partial^{2}\zeta^{s}}=\frac{\alpha^{2}F^{*}2(\zeta^{s})}{2\beta G^{*}2(\zeta^{s})}$

with

$$F^{*}2\left(\zeta^{s}\right)=\left(\begin{array}{c}32274+169982\zeta^{s}+114897\zeta^{s2}-498272\zeta^{s3}-1128684\zeta^{s4}\\-1060266\zeta^{s5}-538068\zeta^{s6}-146942\zeta^{s7}-15354\zeta^{s8}\\+2084\zeta^{s9}+711\zeta^{s10}+54\zeta^{s11}\end{array}\right)$$

$G^{*}2\left(\zeta^{s}\right)=\left(1+\zeta^{s}\right)^{3}\left(2+\zeta^{s}\right)^{4}\left(3+\zeta^{s}\right)^{4}\left(4+\zeta^{s}\right)^{4}$

Given that $\frac{\partial^{2}\left(\Delta w^{S}(\zeta^{s'})\right)}{\partial^{2}\zeta^{s}}\cong-0.0023\frac{\alpha^{2}}{\beta}<0$, $\zeta^{s'}$ is a maximum (the point of the higher welfare gain). $\Delta w^{S}(\zeta^{s})$ cuts the x-axis at $\zeta^{s*}\cong 0.8341$; this value is found by setting $\Delta w^{S}(\zeta^{s})=0$. Beyond the point ζ^{s*}, $\Delta w^{S}(\zeta^{s})$ becomes and remains positive; actually $\underset{\zeta^{s}\to\infty}{lim}\Delta w^{S}(\zeta^{s})=0$. From the above, $\Delta w^{S}(\zeta^{s})<0$ for $\zeta^{s}<\zeta^{s*}$; conversely, $\Delta w^{S}(\zeta^{s})>0$ when $\zeta^{s}>\zeta^{s*}$. Moreover, for $\zeta^{s*}<\zeta^{s}<\underline{\zeta}^{s}$, $\Delta w^{S}(\zeta^{s})>0$ and $\Delta w^{S}(\zeta^{s})>0$ ■

PROOF OF PROPOSITION 2.2:

In what follows, I prove the existence of the critical values $\underline{\zeta}^{d}$ and $\zeta^{d^{*}}$ of the demand parameter; in addition, I show that countries' welfare change polynomial functions, $\Delta w^{N}(\zeta^{d})$ and $\Delta w^{S}(\zeta^{d})$, behave as depicted in panel 3 of figure 3.2. First, note that $\underset{\zeta^{d}\to 0}{lim}\Delta w^{N}(\zeta^{d})=-\frac{1}{32}\frac{\alpha^{2}}{\beta}$. Second, to determine the shape of the $\Delta w^{N}(\zeta^{d})$ curve, consider its FOC $\frac{\partial\left(\Delta w^{N}(\zeta^{d})\right)}{\partial\zeta^{d}}=\frac{\alpha^{2}H1\left(\zeta^{d}\right)}{18\beta I1\left(\zeta^{d}\right)}$,

with

$$H1\left(\zeta^{d}\right)=\left(\begin{array}{c}54675+287955\zeta^{d}+629127\zeta^{d2}+888975\zeta^{d3}+1204227\zeta^{d4}+1564245\zeta^{d5}\\+1500873\zeta^{d6}+941869\zeta^{d7}+372378\zeta^{d8}+88972\zeta^{d9}+11664\zeta^{d10}+640\zeta^{d11}\end{array}\right)$$

$I1\left(\zeta^{d}\right)=\left(1+\zeta^{d}\right)^{3}\left(2+\zeta^{d}\right)^{2}\left(3+\zeta^{d}\right)^{3}\left(3+2\zeta^{d}\right)^{3}\left(4+\zeta^{d}\right)^{2}$

Solving numerically for $\partial\left(\Delta w^{N}(\zeta^{d})\right)/\partial\zeta^{d}=0$ brings no positive extremum candidate; intersects with the x-axis at $\underline{\zeta}^{d}\cong 0.8639$; this value is found by setting $\Delta w^{N}\left(\zeta^{d}\right)=0$. Beyond the point $\underline{\zeta}^{d}$, $\Delta w^{N}\left(\zeta^{d}\right)$ becomes and remains positive; in fact, $\underset{\zeta^{d}\to\infty}{lim}\Delta w^{N}(\zeta^{d})=\frac{5}{9}\frac{\alpha^{2}}{\beta}$. Thus, it turns out that $\Delta w^{N}(\zeta^{d})<0$ for $\zeta^{d}<\underline{\zeta}^{d}$; on the contrary, $\Delta w^{N}(\zeta^{d})>0$ when $\zeta^{d}>\underline{\zeta}^{d}$.

Proceeding similarly with the South, $\underset{\zeta^d \to 0}{lim} \Delta w^S(\zeta^d) = \frac{31}{512}\frac{\alpha^2}{\beta}$. Its FOC is given by $\frac{\partial\left(\Delta w^S(\zeta^d)\right)}{\partial \zeta^d} = -\frac{\alpha^2 H^*1\left(\zeta^d\right)}{24\beta I^*1\left(\zeta^d\right)}$,

with

$$H^*1\left(\zeta^d\right) = \left(\begin{array}{c} 378108 + 1638306\zeta^d + 2876715\zeta^{d2} + 2855763\zeta^{d3} + 2194698\zeta^{d4} + 1779196\zeta^{d5} \\ +1345575\zeta^{d6} + 726483\zeta^{d7} + 249864\zeta^{d8} + 51612\zeta^{d9} + 5808\zeta^{d10} + 272\zeta^{d11} \end{array}\right)$$

$$I^*1\left(\zeta^d\right) = \left(1+\zeta^d\right)^2\left(2+3\zeta^d\right)^2\left(2+\zeta^d\right)^3\left(3+\zeta^d\right)^3\left(4+\zeta^d\right)^3$$

Setting $\partial\left(\Delta w^S(\zeta^d)\right)/\partial\zeta^d = 0$, it turns out that $\Delta w^S(\zeta^d)$ admits no positive solution, but cuts the x-axis at $\zeta^{d^*} \cong 1.1492$; this value is found by setting $\Delta w^S\left(\zeta^d\right) = 0$. Beyond the point ζ^{d^*}, $\Delta w^S\left(\zeta^d\right)$ becomes and remains negative; indeed, $\underset{\zeta^d \to \infty}{lim} \Delta w^S(\zeta^d) = -\frac{1}{3}\frac{\alpha^2}{\beta}$. From the above, $\Delta w^S(\zeta^d) > 0$ for $\zeta^d < \underline{\zeta}^d$; conversely, $\Delta w^S(\zeta^d) < 0$ when $\zeta^d > \underline{\zeta}^d$. Moreover, for $\underline{\zeta}^d < \zeta^d < \zeta^{d^*}$, $\Delta w^S(\zeta^d) > 0$ and $\Delta w^S(\zeta^d) > 0$ ■

PROOF OF PROPOSITION 2.3:

In what follows, I prove the existence of the critical values $\underline{\zeta}$ and $\zeta^*$of the size parameter; in addition, I show that countries' welfare change polynomial functions, $\Delta w^N(\zeta)$ and $\Delta w^S(\zeta)$, behave as depicted in panel 3 of figure 2.1. First, note that $\underset{\zeta\to 0}{lim}\Delta w^N(\zeta) = 0$. Second, to determine the shape of the $\Delta w^N(\zeta)$ curve, consider its FOC $\frac{\partial\left(\Delta w^N(\zeta)\right)}{\partial\zeta} = -\frac{\alpha^2\psi C1(\zeta)}{\beta E1(\zeta)}$,

with

$$C1\left(\zeta\right) = \left(\begin{array}{c} 96 + 488\zeta + 100\zeta^2 - 4466\zeta^3 - 13346\zeta^4 - 18366\zeta^5 \\ -13527\zeta^6 - 4874\zeta^7 - 282\zeta^8 + 330\zeta^9 + 72\zeta^{10} \end{array}\right)$$

$$E1\left(\zeta\right) = \left(1+2\zeta\right)^2\left(1+\zeta\right)^3\left(2+\zeta\right)^3\left(2+3\zeta\right)^3\left(3+2\zeta\right)^3$$

Solving numerically for $\partial\left(\Delta w^N(\zeta)\right)/\partial\zeta = 0$ brings two positive extrema candidates: $\zeta_m \cong 0.2885$ and $\zeta^m \cong 4.1161$. To check whether they are maxima or minima, I get the SOC of $\Delta w^N(\zeta)$ equals to $\frac{\partial^2(\Delta W(\zeta))}{\partial^2\zeta} = \frac{\alpha^2 C2(\zeta)}{\beta E2(\zeta)}$,

with

$$C2\left(\zeta\right) = \left(\begin{array}{c} -1152 - 1728\zeta + 71280\zeta^2 + 525440\zeta^3 + 174464\zeta^4 + 320059\zeta^5 \\ +2942072\zeta^6 - 271368\zeta^7 - 4413683\zeta^8 - 6029602\zeta^9 - 4455192\zeta^{10} \\ -1977008\zeta^{11} - 488370\zeta^{12} - 39744\zeta^{13} + 8712\zeta^{14} + 1728\zeta^{15} \end{array}\right)$$

$$E2\left(\zeta\right) = \left(1+\zeta\right)^4\left(1+2\zeta\right)^3\left(2+\zeta\right)^4\left(2+3\zeta\right)^3\left(3+2\zeta\right)^3$$

Since $\frac{\partial^2\left(\Delta w^N(\zeta_m)\right)}{\partial^2\zeta} = 0.0401\frac{\alpha^2}{\beta} > 0$, ζ_m is a minimum (the point where the welfare loss is maximum) and ζ^m is a maximum given that $\frac{\partial^2\left(\Delta w^N(\zeta_2)\right)}{\partial^2\zeta} =$

$-0.0006\frac{\alpha^2}{\beta} < 0$. $\Delta w^N(\zeta)$ intersects with the x-axis at $\underline{\zeta} \cong 0.5562$; this value is found by setting $\Delta w^N(\zeta) = 0$. Beyond the point $\underline{\zeta}$, $\Delta w^N(\zeta)$ becomes and remains positive, since $\lim\limits_{\zeta\to\infty} \Delta w^N(\zeta) = 0$. Thus, it turns out that $\Delta w^N(\zeta) < 0$ for $\zeta < \underline{\zeta}$; on the contrary, $\Delta w^N(\zeta) > 0$ when $\zeta > \underline{\zeta}$.

Proceeding similarly with the South, $\lim\limits_{\zeta\to 0} \Delta w^S(\zeta) = 0$. Its FOC is given by $\frac{\partial\left(\Delta w^S(\zeta)\right)}{\partial\zeta} = \frac{\alpha^2 C^*1(\zeta)}{4\beta E^*1(\zeta)}$,

with

$$C^*1(\zeta) = \left(\begin{array}{c} 576 + 4140\zeta + 10548\zeta^2 + 6887\zeta^3 - 19483\zeta^4 - 48621\zeta^5 \\ -47743\zeta^6 - 23092\zeta^7 - 4388\zeta^8 + 384\zeta^9 + 192\zeta^{10} \end{array}\right)$$

$$E^*1(\zeta) = (1+2\zeta)^3(1+\zeta)^3(2+\zeta)^3(2+3\zeta)^3(3+2\zeta)^3$$

Setting $\partial\left(\Delta w^S(\zeta)\right)/\partial\zeta = 0$ and solving numerically gives two positive extrema candidates: $\zeta_t \cong 0.5820$ and $\zeta^t \cong 6.1508$. With the SOC of $\Delta w^S(\zeta)$ these points can qualify as maxima or minima; the SOC is given by $\frac{\partial^2\left(\Delta w^S(\zeta)\right)}{\partial^2\zeta} = -\frac{\alpha^2 C^*2(\zeta)}{\beta E^*2(\zeta)}$

with

$$C^*2(\zeta) = \left(\begin{array}{c} -1758 - 8712\zeta + 39744\zeta^2 + 488370\zeta^3 + 1977008\zeta^4 + 4455192\zeta^5 \\ +6029602\zeta^6 + 4413683\zeta^7 + 271368\zeta^8 - 2942072\zeta^9 - 3200596\zeta^{10} \\ -1744644\zeta^{11} - 525440\zeta^{12} - 71280\zeta^{13} + 1728\zeta^{14} + 1152\zeta^{15} \end{array}\right)$$

$$E^*2(\zeta) = (1+\zeta)^4(1+2\zeta)^4(2+\zeta)^3(2+3\zeta)^3(3+2\zeta)^4$$

Since $\frac{\partial^2\left(\Delta w^S(\zeta_t)\right)}{\partial^2\zeta} \cong -0.0247\frac{\alpha^2}{\beta} < 0$, ζ_t is a maximum (the point of the higher welfare gain) and ζ^t is a minimum given that $\frac{\partial^2\left(\Delta w^S(\zeta^t)\right)}{\partial^2\zeta} \cong 0.0001\frac{\alpha^2}{\beta} > 0$. $\Delta w^S(\zeta)$ intersects with the x-axis at $\zeta^* \cong 1.7978$; this value is found by setting $\Delta w^S(\zeta) = 0$. Beyond the point ζ^*, $\Delta w^S(\zeta)$ becomes and remains negative, since $\lim\limits_{\zeta\to\infty} \Delta w^S(\zeta) = 0$. From the above, $\Delta w^S(\zeta) > 0$ for $\zeta < \zeta^*$; conversely, $\Delta w^S(\zeta) < 0$ when $\zeta > \zeta^*$. Moreover, for $\underline{\zeta} < \zeta < \zeta^*$, $\Delta w^S(\zeta) >$ 0 and $\Delta w^S(\zeta) > 0$ ■

2.7 Supplement [not necessary for publication]

Heterogeneity in the supply of both good x, y

Each government is assumed to maximize the aggregate welfare, w. The North's aggregate welfare can be expressed as a function of tariffs τ^N , τ^S and the supply heterogeneity parameter ζ^s: $w^N\left(\tau^N,\tau^S,\zeta^s\right) = w_x^N\left(\tau^N,\zeta^s\right) + w_y^N(\tau^S,\zeta^s)$,

where

$$w_x^N\left(\tau,\zeta^s\right) = \frac{\left(1+\zeta^{s2}\right)5\alpha^2 + \left(3\zeta^s-1\right)2\alpha\beta\tau^N - \left(8+6\zeta^s+\zeta^{s2}\right)2\beta^2\left(\tau^N\right)^2}{2\beta\left(3+\zeta^s\right)^2}$$

$$w_y^N(\tau^S,\zeta^s) = \frac{\left(11+6\zeta^s+\zeta^{s2}\right)\alpha^2 - 4\alpha\beta\tau^S + 2\beta^2\left(\tau^S\right)^2}{2\beta\left(3+\zeta^s\right)^2}$$

Proceeding similarly with the South , $w^S\left(\tau^N,\tau^S,\zeta^s\right) = w_x^S\left(\tau,\zeta^s\right) + w_y^S(\tau^S,\zeta^s)$,

where

$$w_x^S\left(\tau^N,\zeta^s\right) = \frac{\left(1-\zeta^{s3}+20\zeta^s-2\zeta^{s2}\right)\alpha^2 + \left(1-3\zeta^s\right)2\alpha\beta\tau^N + \left(1+\zeta^s\right)\beta^2\left(\tau^N\right)^2}{2\beta\left(3+\zeta^s\right)^2}$$

$$w_y^S\left(\tau^S,\zeta^s\right) = \frac{4\alpha\beta\tau^S - \left(8+14\zeta^s+7\zeta^{s2}+\zeta^{s3}\right)\beta^2\left(\tau^S\right)^2 + \left(4+5\zeta^s+\zeta^{s2}\right)\alpha^2}{2\beta\left(3+\zeta^s\right)^2}$$

Countries' aggregate welfare functions, $w^N(\tau^N,\tau^S,\zeta^s)$ and $w^S(\tau^N,\tau^S,\zeta^s)$ are given by

$$w^N(\cdot) = \frac{1}{2\beta(3+\zeta^s)^2}\left(\begin{array}{c}\left(1+\zeta^{s2}\right)5\alpha^2 + \left(3\zeta^s-1\right)2\alpha\beta\tau^N - \left(8+6\zeta^s+\zeta^{s2}\right)2\beta^2\left(\tau^N\right)^2 \\ +\left(11+6\zeta^s+\zeta^{s2}\right)\alpha^2 - 4\alpha\beta\tau^S + 2\beta^2\left(\tau^S\right)^2\end{array}\right)$$

$$w^S(\cdot) = \frac{1}{2\beta(3+\zeta^s)^2}\left(\begin{array}{c}\left(1-\zeta^{s3}+20\zeta^s-2\zeta^{s2}\right)\alpha^2 + \left(1-3\zeta^s\right)2\alpha\beta\tau^N + \left(1+\zeta^s\right)\beta^2\left(\tau^N\right)^2 \\ +4\alpha\beta\tau^S - \left(8+14\zeta^s+7\zeta^{s2}+\zeta^{s3}\right)\beta^2\left(\tau^S\right)^2 + \left(4+5\zeta^s+\zeta^{s2}\right)\alpha^2\end{array}\right)$$

$w^N(\tau^N, \tau^S, \zeta^s)$ and $w^S(\tau^N, \tau^S, \zeta^s)$ are now being used to determine the Nash tariffs and tariffs enforced under the trade agreement. Then introducing these tariffs back into w^N and w^S allows one to compute countries' welfare under both trade regimes. Finally, the welfare change, Δw, can be easily computed as the difference between a country's welfare under both tariff regimes. Result are presented in table 2.8.1 below. Panel 3 of figure 2.1 depicts Δw as a function of the size parameter ζ^s.

Table 2.8.1	Welfare change in the presence of heterogeneity in the supply of both goods x, y	
	North	South
Nash tariffs	$\overline{\tau}^N(\zeta^s) = \frac{\alpha(3\zeta^s-1)}{\beta(8+6\zeta^s+\zeta^{s2})}$	$\overline{\tau}^S(\zeta^s) = \frac{2\alpha}{\beta(\zeta^s+1)(\zeta^s+2)(\zeta^s+4)}$
GOTs	$\underline{\tau}^N(\zeta^s) = 0$	$\underline{\tau}^S(\zeta^s) = 0$
Nash welfare	$\frac{\alpha^2 A2(\zeta^s)}{4\beta\, B2(\zeta^s)}$	
Cooperative welfare	$\frac{\alpha^2\left(8+3\zeta^s+3\zeta^{s2}\right)}{\beta(3+\zeta^s)^2}$	$\frac{\alpha^2(5+25\zeta^s-\zeta^{s2}-\zeta^{s3})}{2\beta(3+\zeta^s)^2}$
Welfare change $\Delta w(\zeta^s)$	$\frac{\alpha^2\Delta 2(\zeta^s)}{4\beta\,\mathcal{D}2(\zeta^s)}$	$\frac{\alpha^2\Delta 2^*(\zeta^s)}{8\beta\,\mathcal{D}2(\zeta^s)}$

with
$\mathcal{A}2(\zeta^s) = 12\zeta^{s6} + 108\zeta^{s5} + 377\zeta^{s4} + 748\zeta^{s3} + 965\zeta^{s2} + 710\zeta^s + 216$
$\mathcal{B}2(\zeta^s) = (\zeta^s+1)^2(\zeta^s+2)^2(\zeta^s+4)^2$
$\mathcal{A}2^*(\zeta^s) = -(3+\zeta^s)\left(4\zeta^{s5} + 20\zeta^{s4} - 80\zeta^{s3} - 364\zeta^{s2} - 313\zeta^s - 51\right)$
$B2^*(\zeta^s) = (1+\zeta^s)(2+\zeta^s)^2(4+\zeta^s)^2$
$\Delta 2(\zeta^s) = -9\zeta^{s6} - 66\zeta^{s5} - 142\zeta^{s4} - 64\zeta^{s3} + 151\zeta^{s2} + 250\zeta^s + 104$
$\Delta 2^*(\zeta^s) = 36\zeta^{s5} + 219\zeta^{s4} + 328\zeta^{s3} - 34\zeta^{s2} - 228\zeta^s - 97$
$\mathcal{D}2(\zeta^s) = (1+\zeta^s)^2(2+\zeta^s)^2(3+\zeta^s)^2(4+\zeta^s)^2$
$\mathcal{D}2^*(\zeta^s) = (1+\zeta^s)(2+\zeta^s)^2(3+\zeta^s)^2(4+\zeta^s)^2$

Heterogeneity in the demand of both good x, y

The North's aggregate welfare can be expressed as a function of τ^N , τ^S and ζ^d: $w_S^N\left(\tau^N,\tau^S,\zeta^d\right) = w_x^N\left(\tau^N,\zeta^d\right) + w_y^N(\tau^S,\zeta^d)$,

where

$$w_x^N(\tau^N,\zeta^d) = \frac{\alpha^2\left(9+\zeta^{d2}\right)+2\left(3-\zeta^d\right)\alpha\beta\tau^N-2\left(8+6\zeta^d+\zeta^{d2}\right)\beta^2\left(\tau^N\right)^2}{2\beta\left(3+\zeta^d\right)^2}$$

$$w_y^N(\tau^S,\zeta^d) = \frac{3\alpha^2\left(3+2\zeta^d+\zeta^{d2}\right)-4\alpha\beta\zeta^{d2}\tau^S+2\beta^2\zeta^{d2}\left(\tau^S\right)^2}{2\beta\left(3+\zeta^d\right)^2}$$

Proceeding similarly with the South, $w^S\left(\tau^N,\tau^S,\zeta^d\right) = w_x^S\left(\tau^N,\zeta^d\right) + w_y^S(\tau^S,\zeta^d)$,

where

$$w_x^S(\tau,\zeta^d) = \frac{15\zeta^d\alpha^2+3\alpha^2\zeta^{d2}+2\alpha\beta\zeta^d\tau^N-6\alpha\beta\tau^N+\beta^2\left(\tau^N\right)^2+\beta^2\zeta^d\left(\tau^N\right)^2}{2\beta\left(3+\zeta^d\right)^2}$$

$$w_y^S(\tau^S,\zeta^d) = \frac{9\alpha^2\zeta^d+\alpha^2\zeta^{d2}+4\alpha\beta\zeta^{d2}\tau^S-15\beta^2\zeta^d\tau^{S2}-9\beta^2\tau^{S2}-6\beta^2\zeta^{d2}\tau^{S2}}{2\beta\left(3+\zeta^d\right)^2}$$

Countries' total welfare functions, $w^N(\tau^N,\tau^S,\zeta^d)$ and $w^S(\tau^N,\tau^S,\zeta^d)$ are given by

$$w^N(\tau^N,\tau^S,\zeta^d) = \frac{1}{2\beta\left(3+\zeta^d\right)^2}\left(\begin{array}{c}\alpha^2\left(9+\zeta^{d2}\right)+2\left(3-\zeta^d\right)\alpha\beta\tau-2\left(8+6\zeta^d+\zeta^{d2}\right)\beta^2\tau^{N2}\\+3\alpha^2\left(3+2\zeta^d+\zeta^{d2}\right)-4\alpha\beta\zeta^{d2}\tau^S+2\beta^2\zeta^{d2}\tau^{S2}\end{array}\right)$$

$$w^S(\tau^N,\tau^S,\zeta^d) = \frac{9\alpha^2-2\alpha\beta\tau^N+\beta^2\tau^{N2}}{32\beta}+\frac{\left(3\zeta^d-2\right)2\alpha\beta\tau^S-\left(15\zeta^d+16\right)\beta^2\tau^{S2}+5\zeta^d\alpha^2}{32\beta}$$

Now that $w^N(\tau^N,\tau^S,\zeta^d)$ and $w^S(\tau^N,\tau^S,\zeta^d)$ are known, they can be used to find countries' Nash tariffs and tariffs enforced under the trade agreement. Plugging these tariffs back into w^N and w^S gives countries' welfare under both trade regimes. The last step is to find the welfare change, $\Delta w\left(\zeta^d\right)$, which is simply the difference between a country's welfare under both tariff regimes. Results are presented in table 2.8.2 below. Panel 3 of figure 2.2 depicts Δw as a function of the size parameter ζ^d.

Table 2.8.2 Welfare change in the presence of heterogeneity in the demand of both goods x, y

	North	South
Nash tariffs	$\overline{\tau}^N\left(\zeta^d\right)=\frac{\alpha\left(3-\zeta^d\right)}{2\beta\left(8+6\zeta^d+\zeta^{d2}\right)}$	$\overline{\tau}^S\left(\zeta^d\right)=\frac{2\zeta^{d2}\alpha}{3\beta\left(5\zeta^d+3+2\zeta^{d2}\right)}$
GOTs	$\underline{\tau}^N\left(\zeta^d\right)=0$	$\underline{\tau}^S\left(\zeta^d\right)=0$
Nash welfare	$\frac{\alpha^2 \mathcal{A}3\left(\zeta^d\right)}{36\beta\,\mathcal{B}3\left(\zeta^d\right)}$	$\frac{\alpha^2 \mathcal{A}3^*\left(\zeta^d\right)}{24\beta\,\mathcal{B}3^*\left(\zeta^d\right)}$
Cooperative welfare	$\frac{\alpha^2(9+3\zeta^d+2\zeta^{d2})}{\beta(3+\zeta^d)^2}$	$\frac{2\zeta^d\alpha^2(6+\zeta^d)}{\beta(3+\zeta^d)^2}$
Welfare change	$\frac{\alpha^2\triangle 3\left(\zeta^d\right)}{36\beta\,\mathcal{D}3\left(\zeta^d\right)}$	$\frac{\alpha^2\triangle 3^*\left(\zeta^d\right)}{24\beta\,\mathcal{D}3\left(\zeta^d\right)}$

with

$\mathcal{A}3\left(\zeta^d\right)=208\zeta^{d6}+1632\zeta^{d5}+5804\zeta^{d4}+12000\zeta^{d3}+14841\zeta^{d2}+9882\zeta^d+2673$

$\mathcal{B}3\left(\zeta^d\right)=\left(1+\zeta^d\right)^2\left(2+\zeta^d\right)\left(3+2\zeta^d\right)^2\left(4+\zeta^d\right)$

$\mathcal{A}3^*\left(\zeta^d\right)=112\zeta^{d6}+1488\zeta^{d5}+7240\zeta^{d4}+16170\zeta^{d3}+16465\zeta^{d2}+5844\zeta^d-279$

$\mathcal{B}3^*\left(\zeta^d\right)=\left(1+\zeta^d\right)\left(2+\zeta^d\right)^2\left(3+2\zeta^d\right)\left(4+\zeta^d\right)^2$

$\triangle 3\left(\zeta^d\right)=80\zeta^{d8}+720\zeta^{d7}+2188\zeta^{d6}+2820\zeta^{d5}+1575\zeta^{d4}+108\zeta^{d3}-1458\zeta^{d2}-1944\zeta^d-729$

$\triangle 3^*\left(\zeta^d\right)=-\left(16\zeta^{d8}+192\zeta^{d7}+808\zeta^{d6}+1482\zeta^{d5}+1429\zeta^{d4}+948\zeta^{d3}-1350\zeta^{d2}-4374\zeta^d-2511\right)$

$\mathcal{D}3\left(\zeta^d\right)=\left(1+\zeta^d\right)^2\left(2+\zeta^d\right)\left(3+2\zeta^d\right)^2(3+\zeta^d)^2\left(4+\zeta^d\right)$

$\mathcal{D}3^*\left(\zeta^d\right)=\left(1+\zeta^d\right)\left(2+\zeta^d\right)^2\left(3+2\zeta^d\right)(3+\zeta^d)^2\left(4+\zeta^d\right)^2$

Size heterogeneity (in the supply and the demand of both goods x, y)

The North's aggregate welfare can be expressed as a function of τ^N , τ^S, ζ^s and ζ^d (for simplicity, $\zeta^s = \zeta^d = \zeta$): $w_S^N\left(\tau^N, \tau^S, \zeta\right) = w_x^N\left(\tau^N, \zeta\right) + w_y^N(\tau^S, \zeta)$,

where

$$w_x^N(\tau^N, \zeta) = \frac{\alpha^2 - 3\beta^2\left(\tau^N\right)^2 + 2\zeta\left[\zeta\left(\alpha^2 - \beta^2\left(\tau^N\right)^2\right) + \alpha^2 + \beta\tau^N\left(\alpha - 4\beta\tau^N\right)\right]}{4\beta\left(1+\zeta\right)^2}$$

$$w_y^N(\tau^S, \zeta) = \frac{2\alpha^2 + \zeta\left[4\alpha^2 + \zeta\left(\beta^2\left(\tau^S\right)^2 - 2\alpha\beta\tau^S + 3\alpha^2\right)\right]}{4\beta\left(1+\zeta\right)^2}$$

Proceeding similarly with the South , $w^S\left(\tau^N, \tau^S, \zeta\right) = w_x^S\left(\tau^N, \zeta\right) + w_y^S(\tau^S, \zeta)$,

where

$$w_x^S\left(\tau^N, \zeta\right) == \frac{\zeta\left(\beta^2\left(\tau^N\right)^2 - 2\alpha\beta\tau^N + 3\alpha^2 + 2\zeta\alpha^2\left(2+\zeta\right)\right)}{4\beta\left(1+\zeta\right)^2}$$

$$w_y^S\left(\tau^S, \zeta\right) == \frac{\zeta\left[2\alpha^2 - 4\beta^2\tau^{S2} + \zeta\left(\zeta\alpha^2 - 3\zeta\beta^2\tau^{S2} + 2\alpha^2 + 2\alpha\beta\tau^S - 8\beta^2\tau^{N2}\right)\right]}{4\beta\left(1+\zeta\right)^2}$$

Countries' aggregate welfare functions, $w^N(\tau^N, \tau^S, \zeta)$ and $w^S(\tau^N, \tau^S, \zeta)$ are given by

$$w^N(\tau^N, \tau^S, \zeta) = \frac{(5\zeta^2 + 6\zeta + 3)\alpha^2 + 2\zeta\alpha\beta\tau^N - (4\zeta^2 + 8\zeta + 3)\beta^2\left(\tau^N\right)^2 + \zeta^2\beta^2\left(\tau^S\right)^2 - 2\alpha\beta\zeta^2\tau^S}{4\beta\left(1+\zeta\right)^2}$$

$$w^S(\tau^N, \tau^S, \zeta) = \frac{\zeta\left[\beta^2\left(\tau^N\right)^2 - 2\alpha\beta\tau^N + (3\zeta^2 + 6\zeta + 5)\alpha^2 + 2\zeta\alpha\beta\tau^S - (4 + 8\zeta + 3\zeta^2)\beta^2\left(\tau^S\right)^2\right]}{4\beta\left(1+\zeta\right)^2}$$

The goal of this tedious exercise is to express the welfare change, $\Delta w(\zeta)$ as a function of the size parameter ζ, as depicted in panel 3 of figure 2.3 depicts. For this purpose, one needs first to find countries' Nash tariffs and tariffs enforced under the trade agreement. $\Delta w(\zeta)$ is obtained as difference between a country's welfare under both tariff regimes. All the results are presented in table 2.8.3 below.

Table 2.8.3 Welfare change when South is a replica of the North

	North	South
Nash tariffs	$\overline{\tau}^N(\zeta) = \frac{\zeta\alpha}{\beta(4\zeta^2+8\zeta+3)}$	$\overline{\tau}^S(\zeta) = \frac{\zeta\alpha}{\beta(3\zeta^2+8\zeta+4)}$
GOTs	$\underline{\tau}^N(\zeta) = 0$	$\underline{\tau}^S(\zeta) = 0$
Nash welfare	$\frac{\alpha^2 A1(\zeta)}{\beta B1(\zeta)}$	$\frac{\alpha^2 A1^*(\zeta)}{\beta B1^*(\zeta)}$
Cooperative welfare	$\frac{\alpha^2(5\zeta^2+6\zeta+3)}{4\beta(1+\zeta)^2}$	$\frac{\zeta\alpha^2(3\zeta^2+6\zeta+5)}{4\beta(1+\zeta)^2}$
Welfare change	$\frac{\alpha^2\zeta^2\triangle1(\zeta)}{4\beta\mathcal{D}1(\zeta)}$	$\frac{\alpha^2\zeta^2\triangle1^*(\zeta)}{4\beta\mathcal{D}1(\zeta)}$

with
$\mathcal{A}1(\zeta) = (\zeta+1)(45\zeta^5 + 243\zeta^4 + 488\zeta^3 + 454\zeta^2 + 204\zeta + 36)$
$\mathcal{B}1(\zeta) = (\zeta+2)^2(3\zeta+2)^2(2\zeta+3)(2\zeta+1)$
$\mathcal{A}1^*(\zeta) = \zeta(\zeta+1)(36\zeta^5 + 204\zeta^4 + 454\zeta^3 + 488\zeta^2 + 243\zeta + 45)$
$B1^*(\zeta) = (\zeta+2)(1+\zeta)(2\zeta+3)^2(2\zeta+1)^2$
$\triangle1(\zeta) = 24\zeta^5 + 99\zeta^4 + 122\zeta^3 + 21\zeta^2 - 40\zeta - 16$
$\triangle1^*(\zeta) = 24 + 99\zeta + 122\zeta^2 + 21\zeta^3 - 40\zeta^4 16\zeta^5$
$\mathcal{D}1(\zeta) = (1+\zeta)^2(\zeta+2)^2(3\zeta+2)^2(2\zeta+3)(2\zeta+1)$
$\mathcal{D}1^*(\zeta) = (1+\zeta)^2(\zeta+2)(3\zeta+2)(2\zeta+3)^2(2\zeta+1)^2$

Heterogeneity in the supply and the demand of good x

In section 2, I analyze the case where the heterogeneity affects either the supply or the demand of both goods. It is also possible that the heterogeneity parameter only affects the production (consumption) of a single good. Here, I successively consider heterogeneity in the supply (ζ_x^s) and the demand $\left(\zeta_x^d\right)$ of good x. Results presented below and the underlying intuition are qualitatively similar to those obtained in section where heterogeneity in both goods was analyzed. For brevity, I only present key results and graphs.

In the presence of heterogeneity in the supply of good x, supply functions in the North are given by $Q_x^N(p_x^N) = \beta p_x^N$ and $Q_y^N(p_y^N) = \alpha + \beta p_y^N$. Similarly, the South's supply functions are given by $Q_x^S(p_x^S) = \zeta_x^s\left(\alpha + \beta p_x^S\right)$ and $Q_y^S(p_y^S) = \beta p_y^S$ with $\zeta_x^s \in (0, \infty\}$, while demand functions are defined as in section 2.2.1. In particular, if $\zeta_x^s < 1$, then the South faces supply-side constraints (SSCs) for its exported good. International prices are given by $p_x^w = \frac{(2-\zeta_x^s)\alpha - \beta\tau^N}{\beta(3+\zeta_x^s)}$ and $p_y^w = \frac{\alpha-\beta\tau^S}{4\beta}$. The local price of x (y) in the North's (South's) market: $p_x^N \equiv p_x^w + \tau^N = \frac{(2-\zeta_x^s)\alpha+(2+\zeta_x^s)\beta\tau^N}{\beta(3+\zeta_x^s)}$ and $p_y^S \equiv p_y^w + \tau^S = \frac{\alpha+3\beta\tau^S}{4\beta}$. Welfare functions are given by

$$w^N(\tau^N, \tau^S, \zeta_x^s) = \frac{-\left(8+6\zeta_x^s+\zeta_x^{s\,2}\right)2\beta^2\tau^2+(3\zeta_x^s-1)2\alpha\beta\tau^N+\left(\zeta_x^{s\,2}+1\right)5\alpha^2}{2\beta(3+\zeta_x^s)^2} + \frac{9\alpha^2-2\alpha\beta\tau^S+\beta^2\tau^{S\,2}}{16\beta}$$

$$w^S(\tau^N, \tau^S, \zeta_x^s) = \frac{(1+\zeta_x^s)\beta^2\tau^2+(1-3\zeta_x^s)2\alpha\beta\tau^N+\left(1+20\zeta_x^s-2\zeta_x^{s\,2}-\zeta_x^{s\,3}\right)\alpha^2}{2\beta(3+\zeta_x^{s\,2})^2} + \frac{5\alpha^2+2\alpha\beta\tau^S-15\beta^2\tau^{S\,2}}{16\beta}$$

After integrating Nash tariffs and those set under the trade agreement into the above welfare functions, I compute the welfare change, $\Delta w\left(\zeta_x^s\right)$ in terms of the size parameter ζ_x^s, as shown in panel 3 of figure 2.8.4 a. All the results are presented in table 2.8.4 a. below.

Table 2.8.4 a.	Welfare change in the presence of heterogeneity in the supply of the good x	
	North	South
Nash tariffs	$\overline{\tau}^N\left(\zeta_x^s\right) = \frac{\alpha(3\zeta_x^s-1)}{2\beta(8+6\zeta_x^s+\zeta_x^{s\,2})}$	$\overline{\tau}^S\left(\zeta_x^s\right) = \frac{\alpha}{15\beta}$
GOTs	$\underline{\tau}^N\left(\zeta_x^s\right) = 0$	$\underline{\tau}^S\left(\zeta_x^s\right) = 0$
Nash welfare	$\frac{\alpha^2 A4(\zeta_x^s)}{900\beta\, B4(\zeta_x^s)}$	$\frac{\alpha^2 A4^*(\zeta_x^s)}{120\beta\, B4^*(\zeta_x^s)}$
Cooperative welfare	$\frac{\alpha^2(121+54\zeta_x^s+49\zeta_x^{s\,2})}{16\beta(3+\zeta_x^s)^2}$	$\frac{\alpha^2(53+190\zeta_x^s-11\zeta_x^{s\,2}-8\zeta_x^{s\,3})}{16\beta(3+\zeta_x^s)^2}$
Welfare change	$\frac{\alpha^2\triangle 4(\zeta_x^s)}{3600\beta\,\mathcal{D}4(\zeta_x^s)}$	$\frac{\alpha^2\triangle 4^*(\zeta_x^s)}{\beta\,\mathcal{D}4^*(\zeta_x^s)}$

with

$\mathcal{A}4\left(\zeta_x^s\right) = 6017 + 2994\zeta_x^s + 2749\zeta_x^{s\,2}$

$\mathcal{B}4\left(\zeta_x^s\right) = \left(\zeta_x^s + 2\right)\left(\zeta_x^s + 4\right)$

$\mathcal{A}4^*\left(\zeta_x^s\right) = 2807 + 12843\zeta_x^s + 7856\zeta_x^{s\,2} + 516\zeta_x^{s\,3} - 442\zeta_x^{s\,4} - 60\zeta_x^{s\,5}$

$B4^*\left(\zeta_x^s\right) = \left(2 + \zeta_x^s\right)^2\left(4 + \zeta_x^s\right)^2$

$\triangle 4\left(\zeta_x^s\right) = 1188 + 8358\zeta_x^s - 6563\zeta_x^{s\,2} + 348\zeta_x^{s\,3} + 29\zeta_x^{s\,4}$

$\triangle 4^*\left(\zeta_x^s\right) = 354 - 6138\zeta_x^{s\,2} + 3242\zeta_x^{s\,2} + 4974\zeta_x^{s\,3} + 947\zeta_x^{s\,4} - 18\zeta_x^{s\,5} - \zeta_x^{s\,6}$

$\mathcal{D}4\left(\zeta_x^s\right) = \left(2 + \zeta_x^s\right)\left(3 + \zeta_x^s\right)^2\left(4 + \zeta_x^s\right)$

$\mathcal{D}4^*\left(\zeta_x^s\right) = \left(2 + \zeta_x^s\right)^2\left(3 + \zeta_x^s\right)^2\left(4 + \zeta_x^s\right)^2$

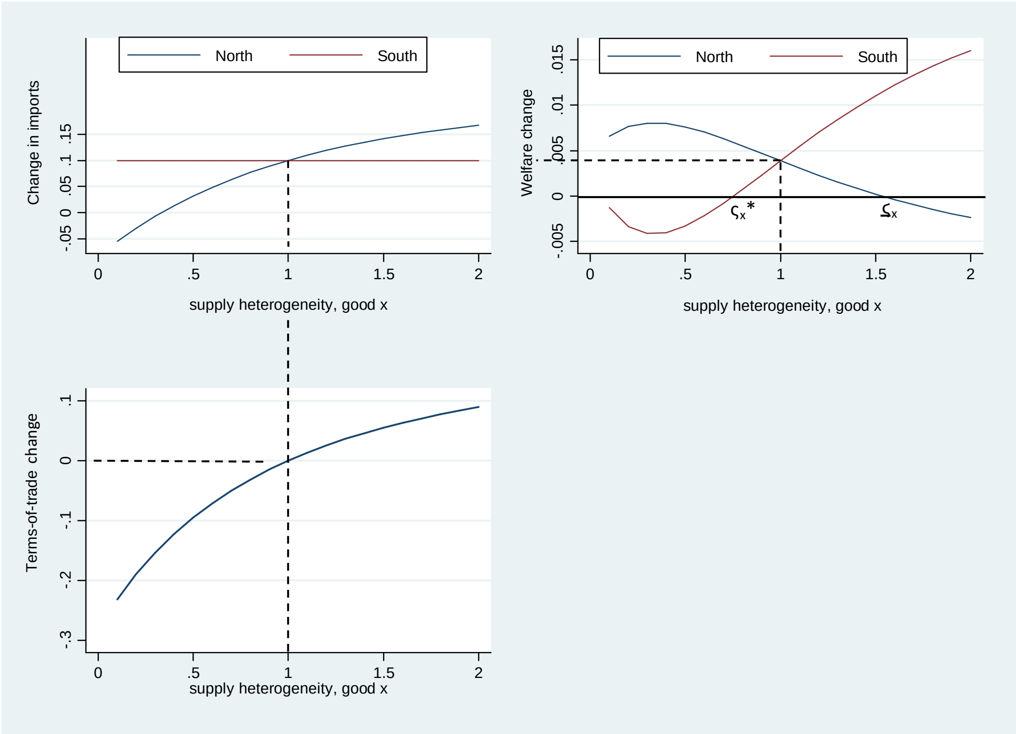

Figure 2.8.4 a. welfare change in the presence of supply heterogeneity in good x (ζ_x^s) (with $\frac{\alpha^2}{\beta} = 1$)

In the presence of heterogeneity in the demand of good x, the North's demands are given by $D_j^N(p_j^N) = \alpha - \beta p_j^N$, with $j = x, y$ for the North. Likewise, the South's demand functions are defined as $D_x^S(p_x^S) = \zeta_x^d\left(\alpha - \beta p_x^S\right)$ and $D_y^S(p_y^S) = \alpha - \beta p_y^S$, with $\zeta_x^d \in (0, \infty\}$. If $\zeta_x^d < 1$ ($\zeta_x^d > 1$), then the South has limited (higher) market demand for its exported good than the North. Supply functions are identical to those presented in section 2.2.2 International prices are given by $p_x^w = \frac{\zeta_x^d\alpha - \beta\tau^N}{\beta\left(3+\zeta_x^d\right)}$ and $p_y^w = \frac{\alpha-\beta\tau^S}{4\beta}$. The domestic price of x (y) in the North's (the South's) market: $p_x^N \equiv p_x^w + \tau^N = \frac{\alpha\zeta_x^d+\left(2+\zeta_x^d\right)\beta\tau^N}{\beta\left(3+\zeta_x^d\right)}$ and $p_y^S \equiv p_y^w + \tau^S = \frac{\alpha+3\beta\tau^S}{4\beta}$. Welfare functions are given by

$$w^N(\tau^N, \tau^S, \zeta_x^d) = \frac{-\left(8+6\zeta_x^d+\zeta_x^{d2}\right)2\beta^2\left(\tau^N\right)^2+\left(3-\zeta_x^d\right)2\alpha\beta\tau^N+2\alpha+\left(9+\zeta_x^{d2}\right)\alpha^2}{2\beta\left(3+\zeta_x^d\right)^2} + \frac{9\alpha^2-2\alpha\beta\tau^S+\beta^2\left(\tau^S\right)^2}{16\beta}$$

$$w^S(\tau^N, \tau^S, \zeta_x^d) = \frac{\left(\zeta_x^d+1\right)\beta^2\left(\tau^N\right)^2+\left(\zeta_x^d-3\right)2\alpha\beta\tau^N+\left(5\zeta_x^d+\zeta_x^{d2}\right)3\alpha^2}{2\beta\left(3+\zeta_x^d\right)^2} +$$

$\frac{5\alpha^2+2\alpha\beta\tau^S-15\beta^2\left(\tau^S\right)^2}{16\beta}$

After integrating Nash tariffs and those applied under the trade agreement into the above welfare functions, I compute the welfare change, $\Delta w\left(\zeta_x^d\right)$ in terms of the size parameter ζ_x^d, as shown in panel 3 of figure 2.8.4 b. All the results are presented in table 2.8.4 b. below.

Table 2.8.4 b — Welfare change in the presence of heterogeneity in the demand of the good x

	North	South
Nash tariffs	$\overline{\tau}^N\left(\zeta_x^d\right)=\frac{\alpha\left(3-\zeta_x^d\right)}{2\beta\left(8+6\zeta_x^d+\zeta_x^{d\,2}\right)}$	$\overline{\tau}^S\left(\zeta_x^d\right)=\frac{\alpha}{15\beta}$
GOTs	$\underline{\tau}^N\left(\zeta_x^d\right)=0$	$\underline{\tau}^S\left(\zeta_x^d\right)=0$
Nash welfare	$\frac{\alpha^2 A5\left(\zeta_x^d\right)}{900\beta\, B5\left(\zeta_x^d\right)}$	$\frac{\alpha^2 A5^*\left(\zeta_x^d\right)}{120\beta\, B5^*\left(\zeta_x^d\right)}$
Cooperative welfare	$\frac{\alpha^2(153+54\zeta_x^d+17\zeta_x^{d\,2})}{16\beta\left(3+\zeta_x^d\right)^2}$	$\frac{\alpha^2(45+150\zeta_x^d+29\zeta_x^{d\,2})}{\beta\left(3+\zeta_x^d\right)^2}$
Welfare change	$\frac{\alpha^2\triangle 5\left(\zeta_x^d\right)}{3600\beta\,\mathcal{D}5\left(\zeta_x^d\right)}$	$\frac{\alpha^2\triangle 5^*\left(\zeta_x^d\right)}{\beta\,\mathcal{D}5^*\left(\zeta_x^d\right)}$

with

$\mathcal{A}5\left(\zeta_x^d\right)=7817+2994\zeta_x^d+949\zeta_x^{d\,2}$

$\mathcal{B}5\left(\zeta_x^d\right)=\left(\zeta_x^d+2\right)\left(\zeta_x^d+4\right)$

$\mathcal{A}5^*\left(\zeta_x^d\right)=1967+10323\zeta_x^d+8576\zeta_x^{d\,2}+2436\zeta_x^{d\,3}+218\zeta_x^{d\,4}$

$B5^*\left(\zeta_x^d\right)=\left(3+\zeta_x^d\right)^2\left(3+\zeta_x^d\right)^4$

$\triangle 5\left(\zeta_x^d\right)=-6012+29\zeta_x^{d\,4}+348\zeta_x^{d\,3}+637\zeta_x^{d\,2}+8358\zeta_x^d$

$\triangle 5^*\left(\zeta_x^d\right)=7794-618\zeta_x^d-3238\zeta_x^{d\,2}-546\zeta_x^{d\,3}-13\zeta_x^{d\,4}-18\zeta_x^{d\,5}-\zeta_x^{d\,6}$

$\mathcal{D}5\left(\zeta_x^d\right)=\left(2+\zeta_x^d\right)\left(3+\zeta_x^d\right)^2\left(4+\zeta_x^d\right)$

$\mathcal{D}5^*\left(\zeta_x^d\right)=\left(2+\zeta_x^d\right)^2\left(3+\zeta_x^d\right)^2\left(4+\zeta_x^d\right)^2$

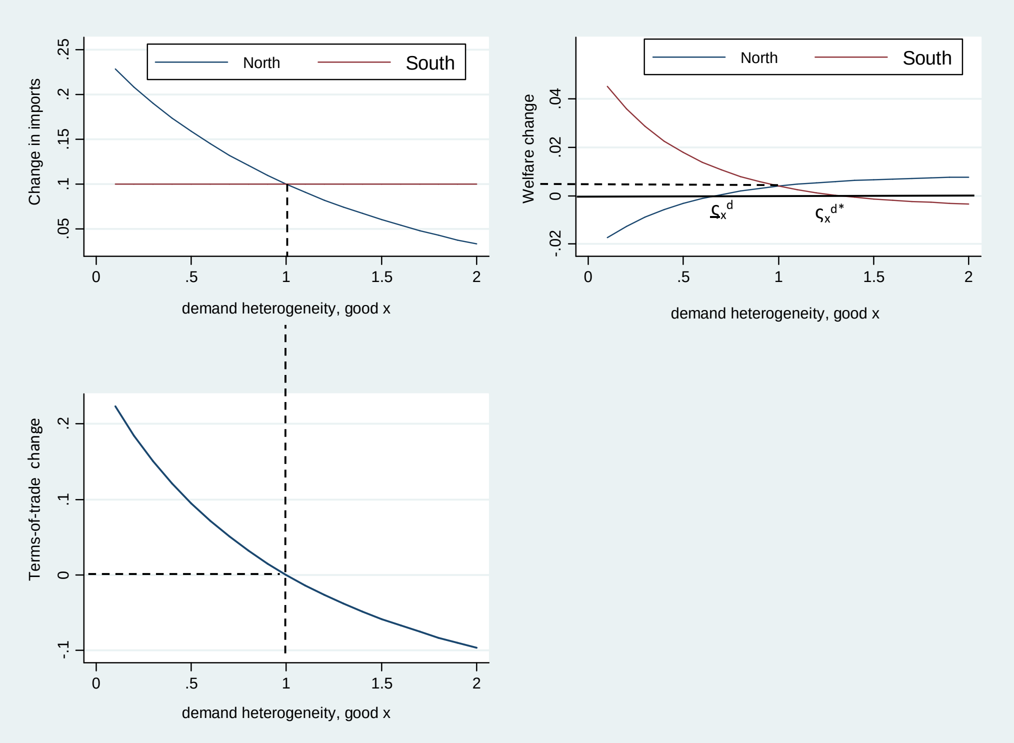

Figure 2.8.4 b: welfare change in the presence of demand heterogeneity in good $x(\zeta_x^d)$ with $(\frac{\alpha^2}{\beta} = 1)$

Heterogeneity in the supply and the demand of good y

Here, I successively consider heterogeneity in the supply (ζ_y^s) and the demand (ζ_y^d) of good y. Results presented below and the underlying intuition are qualitatively similar to those obtained in section where heterogeneity in both goods was analyzed. For brevity, I only present key results and graphs.

In the presence of heterogeneity in the supply of good x, supply functions in the North are given by $Q_x^N(p_x^N) = \beta p_x^N$ and $Q_y^N(p_y^N) = \alpha + \beta p_y^N$. Similarly, the South's supply functions are given by $Q_x^S(p_x^S) = \alpha + \beta p_x^S$ and $Q_y^S(p_y^S) = \zeta_y^s \beta p_y^S$ with $\zeta_y^s \in (0, \infty\}$, while demand functions are defined as in section 2.2.1. In particular, if $\zeta_y^s < 1$, then the South faces supply-side constraints (SSCs) for its imported good. International prices are given by $p_x^w = \frac{\alpha - \beta\tau^N}{4\beta}$ and $p_y^w = \frac{\alpha - \beta\tau^S}{\beta\left(3+\zeta_y^s\right)}$. The local price of x (y) in the North's (South's) market: $p_x^N \equiv p_x^w + \tau^N = \frac{\alpha+3\beta\tau^N}{4\beta}$ and $p_y^S \equiv p_y^w + \tau^S = \frac{\alpha+\left(\zeta_y^s+2\right)\beta\tau^S}{3\beta}$. Welfare functions are given by

$$w^N(\tau^N,\tau^S,\zeta_y^s) = \frac{10\alpha^2+4\alpha\beta\tau^N-30\beta^2\left(\tau^N\right)^2}{32\beta} + \frac{\left(11+6\zeta_y^s+\zeta_y^{s\,2}\right)\alpha^2-4\alpha\beta\tau^S+2\beta^2\left(\tau^S\right)^2}{2\beta\left(3+\zeta_y^s\right)^2}$$
$$w^S(\tau^N,\tau^S,\zeta_y^s) = \frac{9\alpha^2-2\alpha\beta\tau^N+\beta^2\left(\tau^N\right)^2}{16\beta} + \frac{\left(2-\zeta_y^s\right)2\alpha\beta\tau^S-\left(14\zeta_y^s+7\zeta_y^{s\,2}+8\right)\beta^2\left(\tau^S\right)^2+\zeta_y^s\left(\zeta_y^s+4\right)\alpha^2}{2\beta\left(3+\zeta_y^s\right)^2}$$

Once Nash tariffs and those prevailing under the trade agreement are introduced into the above welfare functions, I compute the welfare change, $\Delta w\left(\zeta_y^s\right)$ in terms of the size parameter ζ_y^S, as shown in panel 3 of figure 2.8.5 a. All the results are presented in table 2.8.5. a. below.

Table 2.8.5 a	Welfare change in the presence of heterogeneity in the supply of the good y	
	North	South
Nash tariffs	$\overline{\tau}^N\left(\zeta_y^s\right) = \frac{\alpha}{15\beta}$	$\overline{\tau}^S\left(\zeta_y^s\right) = \frac{2\alpha}{\beta\left(\zeta_y^s+1\right)\left(\zeta_y^s+2\right)\left(\zeta_y^s+4\right)}$
GOTs	$\underline{\tau}^N\left(\zeta_y^s\right) = 0$	$\underline{\tau}^S\left(\zeta_y^s\right) = 0$
Nash welfare	$\frac{\alpha^2 A6\left(\zeta_y^s\right)}{\beta\, B6\left(\zeta_y^s\right)}$	$\frac{\alpha^2 A6^*\left(\zeta_y^s\right)}{900\beta\, B62^*\left(\zeta_y^s\right)}$
Cooperative welfare	$\frac{\alpha^2\left(133+78\zeta_y^s+13\zeta_y^{s\,2}\right)}{16\beta\left(3+\zeta_y^s\right)^2}$	$\frac{\alpha^2(113+94\zeta_y^s+17\zeta_y^{s\,2})}{16\beta(3+\zeta_y^s)^2}$
Welfare change	$\frac{\alpha\triangle 6\left(\zeta_y^s\right)}{240\beta\,\mathcal{D}6\left(\zeta_y^s\right)}$	$\frac{\alpha^2\triangle 6^*\left(\zeta_y^s\right)}{3600\beta\,\mathcal{D}6\left(\zeta_y^s\right)}$

with
$\mathcal{A}6\left(\zeta_y^s\right) = 3376 + 11936\zeta_y^s + 16292\zeta_y^{s\,2} + 10868\zeta_y^{s\,3} + 3833\zeta_y^{s\,4} + 686\zeta_y^{s\,5} + 49\zeta_y^{s\,6}$
$\mathcal{B}6\left(\zeta_y^s\right) = \left(\zeta_y^s+1\right)^2\left(\zeta_y^s+2\right)^2\left(\zeta_y^s+4\right)^2$
$\mathcal{A}6^*\left(\zeta_y^s\right) = 949\zeta_y^{s\,3} + 6193\zeta_y^{s\,2} + 10586\zeta_y^s + 5792$
$B6^*\left(\zeta_y^s\right) = (\zeta_y^s+4)(\zeta_y^s+2)(\zeta_y^s+1)$
$\triangle 6\left(\zeta_y^s\right) = 6144 + 11040\zeta_y^s + 2540\zeta_y^{s\,2} - 3020\zeta_y^{s\,3} - 2273\zeta_y^{s\,4} - 800\zeta_y^{s\,5} - 170\zeta_y^{s\,6} - 20\zeta_y^{s\,7} - \zeta_y^{s\,8}$
$\triangle 6^*\left(\zeta_y^s\right) = -5112 + 5046\zeta_y^s + 4495\zeta_y^{s\,2} + 1885\zeta_y^{s\,3} + 377\zeta_y^{s\,4} + 29\zeta_y^{s\,5}$
$\mathcal{D}6\left(\zeta_y^s\right) = (1+\zeta_y^s)^2(2+\zeta_y^s)^2(3+\zeta_y^s)^2(4+\zeta_y^s)^2$
$\mathcal{D}6^*\left(\zeta_y^s\right) = (1+\zeta_y^s)(2+\zeta_y^s)(3+\zeta_y^s)^2(4+\zeta_y^s)$

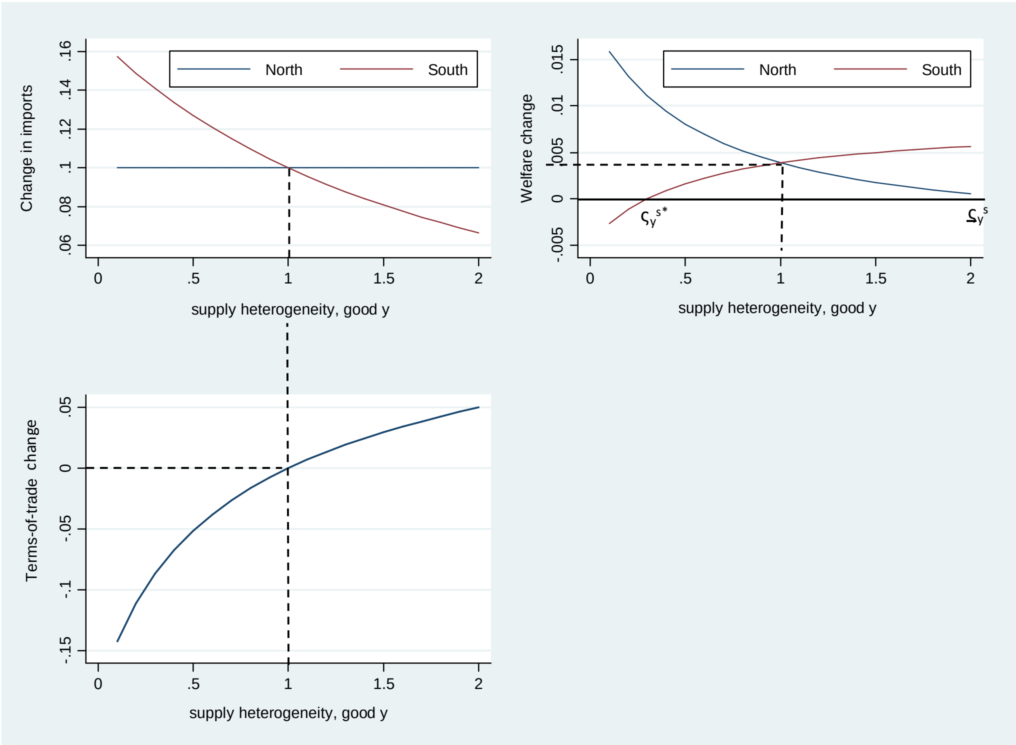

Figure 2.8.5 a welfare change in the presence of supply heterogeneity in good y $\left(\zeta_y^s\right)$ (with $\frac{\alpha^2}{\beta}=1$)

In the presence of heterogeneity in the demand of good y, the North's demands are given by $D_i^N(p_j^N) = \alpha - \beta p_j^N$, with $j = x, y$. Likewise, the South's demand functions are defined as $D_x^S(p_x^S) = \alpha - \beta p_x^S$ and $D_y^S(p_y^S) = \zeta_y^d\left(\alpha - \beta p_y^S\right)$, with $\zeta_y^d \in (0, \infty\}$. If $\zeta_y^d < 1$ ($\zeta_y^d > 1$), the South has limited (higher) market demand for its imported good than the North. Supply functions are identical to those presented in section 2.2.2. International prices are given by $p_x^w = \frac{\alpha - \beta\tau^N}{4\beta}$ and $p_y^w = \frac{\zeta_y^d\left(\alpha-\beta\tau^S\right)}{\beta\left(3+\zeta_y^d\right)}$. The domestic price of x (y) in the North's (South's) market: $p_x^N(\tau) \equiv p_x^w + \tau^N = \frac{\alpha+3\beta\tau^N}{4\beta}$ and $p_y^S\left(\tau^S\right) \equiv p_y^w + \tau^S = \frac{\alpha\zeta_y^d+3\beta\tau^S}{\beta\left(3+\zeta_y^d\right)}$. Welfare functions are given by

$$w^N(\tau^N, \tau^S, \zeta_y^d) = \frac{5\alpha^2+2\alpha\beta\tau^N-15\beta^2\left(\tau^N\right)^2}{16\beta} + \frac{18\alpha^2-4\alpha\beta\tau^S+2\beta^2\left(\tau^S\right)^2}{2\beta\left(3+\zeta_y^d\right)^2}$$

$$w^S(\tau^N, \tau^S, \zeta_y^d) = \frac{9\alpha^2-2\alpha\beta\tau^N+\beta^2\left(\tau^N\right)^2}{16\beta} + \frac{4\zeta_y^d\alpha\beta\tau^S-\left(9+15\zeta_y^d+6\zeta_y^{d\,2}\right)\beta^2\left(\tau^S\right)^2+(9\zeta_y^d+\zeta_y^{d\,2})\alpha^2}{2\beta\left(3+\zeta_y^d\right)^2}$$

Once Nash tariffs and those prevailing under the trade agreement are introduced into the above welfare functions, I compute the welfare change, $\Delta w\left(\zeta_y^d\right)$ in terms of the size parameter ζ_y^d, as shown in panel 3 of figure 2.8.5 b. All the results are presented in table 2.8.5. b. below.

Table 2.8.5. b	Welfare change in the presence of heterogeneity in the demand of the good y	
	North	South
Nash tariffs	$\overline{\tau}^N\left(\zeta_y^d\right)=\frac{\alpha}{15\beta}$	$\overline{\tau}^S\left(\zeta_y^d\right)=\frac{2\zeta_y^{d\,2}\alpha}{3\beta\left(5\zeta_y^d+3+2\zeta_y^{d\,2}\right)}$
GOTs	$\underline{\tau}^N\left(\zeta_y^d\right)=0$	$\underline{\tau}^S\left(\zeta_y^d\right)=0$
Nash welfare	$\frac{\alpha^2 A7\left(\zeta_y^d\right)}{180\beta\, B7\left(\zeta_y^d\right)}$	$\frac{\alpha^2 A7^*\left(\zeta_y^d\right)}{900\beta\, B3^*\left(\zeta_y^d\right)}$
Cooperative welfare	$\frac{\alpha^2(117+78\zeta_y^d+29\zeta_y^{d\,2})}{16\beta(3+\zeta_y^d)^2}$	$\frac{\alpha^2(81+126\zeta_y^d+17\zeta_y^{d\,2})}{16\beta(3+\zeta_y^d)^2}$
Welfare change	$\frac{\alpha\triangle 7\left(\zeta_y^d\right)}{720\beta\,\mathcal{D}7\left(\zeta_y^d\right)}$	$\frac{\alpha^2\triangle 7^*\left(\zeta_y^d\right)}{3600\beta\,\mathcal{D}7\left(\zeta_y^d\right)}$

with

$\mathcal{A}7\left(\zeta_y^d\right)=1323+4410\zeta_y^d+5619\zeta_y^{d\,2}+3420\zeta_y^{d\,3}+908\zeta_y^{d\,4}$

$\mathcal{B}7\left(\zeta_y^d\right)=\left(1+\zeta_y^d\right)^2\left(3+2\zeta_y^d\right)^2$

$\mathcal{A}7^*\left(\zeta_y^d\right)=1497+3845\zeta_y^d+2498\zeta_y^{d\,2}$

$B7^*\left(\zeta_y^d\right)=\left(1+\zeta_y^d\right)\left(3+2\zeta_y^d\right)$

$\triangle 7\left(\zeta_y^d\right)=-243-972\zeta_y^d-1566\zeta_y^{d\,2}-1296\zeta_y^{d\,3}+2301\zeta_y^{d\,4}+4668\zeta_y^{d\,5}+1588\zeta_y^{d\,6}$

$\triangle 7^*\left(\zeta_y^d\right)=783+1827\zeta_y^d+1479\zeta_y^{d\,2}+493\zeta_y^{d\,3}-2342\zeta_y^{d\,4}$

$\mathcal{D}7\left(\zeta_y^d\right)=\left(1+\zeta_y^d\right)^2\left(3+2\zeta_y^d\right)^2(3+\zeta_y^d)^2$

$\mathcal{D}7^*\left(\zeta_y^d\right)=\left(1+\zeta_y^d\right)\left(3+2\zeta_y^d\right)(3+\zeta_y^d)^2$

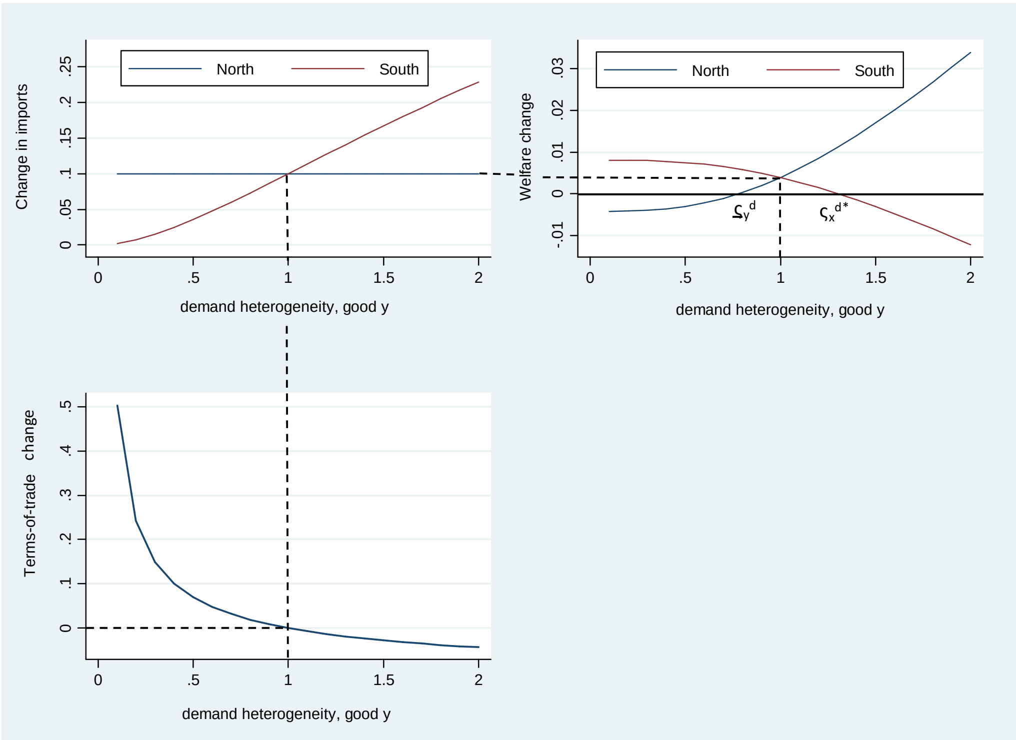

Figure 2.8.5 b welfare change in the presence of demand heterogeneity in good y $\left(\zeta_y^d\right)$ (with $\frac{\alpha^2}{\beta} = 1$)

Chapter 3

Foreign aid and habit formation in a trade model

3.1 Introduction

Several empirical papers establish a positive relationship between foreign aid and donor exports.[1] This evidence points to the fact that, besides altruistic - namely the promotion of economic development - and political or strategic motivations for giving, transfer payments might be an instrument to promote donors' export products in recipient countries. In a theoretical perspective, Bhagwati, Brecher and Hatta (1983, 1985) and many trade economists after them have shown that, in some circumstances, a transfer benefits the donor country at the expense of the recipient country. The so-called "transfer paradox" is likely to happen if the terms-of-trade change in favor of the donor country prevails over the direct income loss of the transfer. Using a two-period model, Djajic, Lahiri, and Raimondos-Moller (2004, hereafter, DLR) explain the improvement of the donor's intertemporal terms-of-trade by the existence of habit formation. They argue that the first-period transfer changes the second-period preferences of the recipient in favor of the donor's export product. Unfortunately, this paper just mentions without explicitly modeling the recipient's habit forming behavior. The aim of this paper is to help filling this gap in the literature, by modeling habit formation in a simple two-country two-good trade model.

In this paper, I study the welfare effects of foreign aid in the presence of habit formation within a two-period pure exchange model of free trade between the North (the donor) and the South (the recipient). As in DLR

[1] See for instance Lloyd, McGillivray, Morrissey, and Osei (2000), Martínez-Zarzoso, Nowak-Lehmann, Klasen and Larch (2009) and Nilsson (1997).

(2004), foreign aid is temporary, that is, the North makes a transfer only in the first period. In both countries, consumers have Stone-Geary utility preferences.[2] In particular, the Northern representative consumer (RC) has exactly the same utility in each period, while the second-period utility of the Southern RC displays a myopic and additive habit forming behavior towards the donor's export good. This simple modeling with normal goods ensures that the first-period transfer does not induce terms-of-trade effects, and this allows to isolate the habit formation effect.

The main contribution of this article is to show that the terms-of-trade effect of the transfer operates through the habit parameter; in other words, in the absence of habit formation, the transfer does not distort relative prices and thus, there is no transfer paradox. The mechanism described above is a particular feature of this paper compared to previous work on the transfer paradox in a two-period trade model (DLR, 1998 and 2004; Galor and Polemarchakis, 1987).

To the best of my knowledge, this study is the first trade model to show that foreign aid promotes donor exports through habit formation. The graphical analysis developed in this paper shows that foreign aid induces a downward (resp. upward) shift of the North's (resp. the South's) indifference curve (IC) in the first period. This shift is the consequence of the revenue (direct) effect of foreign aid in the first period. Since habit formation alters the South's preferences, its second-period IC rotates instead of undergoing a parallel shift as in the first period. As the North's preferences are unchanged, this shift in the South's preferences induces a change in countries' terms-of-trade (in the Edgeworth box, one can see that the new budget is steeper than the one corresponding to an equilibrium without habit formation). Actually, the North's terms-of-trade (TOT) improve, while the South's deteriorate. In addition, the South increases its demand for the North's export good for the North's export product at deteriorated TOT; as a result, its second-period IC moves downward and that of the North, upward. Finally, the Northern donor is better off in the second-period, while the Southern recipient is worse off.

When countries have identical endowments in both periods, the North experiences an intertemporal utility loss, while the South ends up being better off. This happens because the direct revenue loss of the first-period transfer outweighs the indirect TOT effect in the second period. I show that the existence of the transfer paradox crucially depends on the growth of total endowments. Using numerical simulations, I find this to be the case

[2]Note that the results do not depend on this functional form; they obtain even with Cobb-Douglas preferences.

when the world endowment of the North's import (the South's export) good increases sufficiently more than of its export (import) good. The intuition behind this result is that a donor is likely to benefit from giving if the recipient country is a fast-growing economy that can import more of its export good.

However, the model shows that the export-enhancing effect of the transfer is short-lived, since the habit formation effect decreases over time. To test this claim, I use aid and trade data between France and 32 ACP countries that receive foreign aid each year between 1980 and 2011. Results show that only one period lagged transfer promotes french exports in ACP countries.

The rest of this article is divided as follows: section 3.2 presents the theoretical model. Section 3.3 shows the empirical results and section 3.4 concludes.

3.2 The Model

Consider a pure exchange economy *à la* Kennan and Riezman (1988, hereafter KR) in which the North (no *) and the South (with *) trade two goods in two periods $t = 1, 2$. In each period, the world endowment for each good is normalized to 1 and each country is initially endowed with both goods. The endowment structure is as follows: each period, the North has $1-\gamma$ of units x and μ of y, while the South has γ units of x and $1-\mu$ of y.[3] Assuming that $0.5 < \gamma < \mu \leq 1$, the North (resp. the South) has a comparative advantage in y (resp. x) and that the South is either of equal size or a smaller country than the North. This assumption describes the fact that aid donors are larger (richer) than recipient countries. In both countries, the representative consumer's utility function takes a Stone-Geary (SG) form[4]:

$$u(x, y) = \left(1 + x^{(*)}\right)\left(1 + y^{(*)}\right) \tag{3.1}$$

where x, y are non negative quantities of good x, y consumed in each country.

Beside their trade relationships, the North makes a transfer to the South under its foreign aid policy. As in Djajic, Lahiri and Raimondos-Møller (2004), foreign aid is temporary in the sense that the transfer is only made in the first period, while the trade of both goods, x and y, takes place in both periods. The North finances the transfer by means of a lump-sum tax and distributes the proceeds in the South in the form of a lump-sum transfer, T_1 ($T_1 < \gamma$).

RCs' incomes, I_{t_1} and $I^*_{t_1}$, are given by their endowments of x and y valued at their domestic prices; under free trade, domestic prices equal to international prices, so that $p_x = p^*_x = p^w_x$ and $p_y = p^*_y = p^w_y$. To simplify notations, I drop the superscripts. Equations (3.2) and (3.4) below respectively describe the North's and the South's income as functions of their endowments (*IF*) in the first-period. Owing to the transfer, the North (the South) consumes less (more) than its income allows to in the first period. This is shown by expenditure functions (*EF*) (3.3) and (3.5):

[3]This assumption is not essential to obtain the results presented in this paper; however, it greatly simplifies the maths.

[4]I verify that that the qualitative results obtained with a SG utility also hold with Cobb-Douglas preferences used in KR (1988). This is reassuring since the conclusions presented below are not based on a particular utility form, but are quite general.

The North

$$p_{x_1}(1-\gamma)+p_{y_1}\mu = I_1 \tag{3.2}$$

$$p_{x_1}x_1+p_{y_1}y_1 = I_1 - T_1 \tag{3.3}$$

The South

$$p_{x_1}\gamma+p_{y_1}(1-\mu) = I_1^* \tag{3.4}$$

$$p_{x_1}x_1^*+p_{y_1}y_1^* = I_1^* + T_1 \tag{3.5}$$

Both countries' trade expenditure functions (TE_1) are as follows: $TE_1 = EF_1 - IF_1 = T_1$ for the North and $TE_1^* = EF_1^* - IF_1^* = T_1$ for the South.

In the second period, the South develops a particular taste for its import good; therefore, its first-period consumption of good y represents its habit stock of the current period. In other words, the South becomes used to a certain consumption standard of good y and hence, a higher amount of the North's export good y increases its satisfaction.[5]

Following Becker and Murphy (1988), the second-period utility depends not only on the current consumption of two goods, x and y, but also on a measure of the first-period consumption of y but not of x as in $u_2^*(x,y) = (1+x_1^*)\left[1+y_2^*+\phi\left(y_2^*-y_1^*\right)\right]$, where the coefficient $\phi \in [0,1]$ measures the strength of habits. For $0 < \phi \leq 1$, the preferences of the South are not time separable; in other words, the consumption level of the previous period y_1^* forms its consumption habits in $t = 2$. When $\phi = 0$, the South's preferences become time-separable whereas the second-period utility depends only on y_2^*, not on y_1^*; habits play no role on the South's utility. $\phi\left(y_2^*-y_1^*\right)$ measures the South's benefit from one-period habit formation. If the South's second-period consumption of good y is greater than its consumption in the previous period, i.e. $y_2^* > y_1^*$, then the South experiences a gain amounting to $\phi\left(y_2^*-y_1^*\right)$. On the contrary, if its second period consumption is smaller than its consumption in the previous

[5] By so doing, the present analysis departs from Djajic, Lahiri, and Raimondos-Møller (2004) who maximize the intertemporal utility of consumers, without modeling explicitly habits.

period, i.e. $y_2^* < y_1^*$, then the South experiences a utility loss in the second period.

With additive habit formation, the South considers its first-period consumption of good y as a reference point and pays a cost if the second-period consumption is smaller than its first-period level (Rozen, 2010). In the macroeconomics literature, habit formation is often modeled in the subsequent form $y_2^{'*} - \varphi y_1^{'*}$ (Carroll, 2000); following this tradition brings this utility function $u_{t_2}^{'*}(x,y) = \left(1 + x_2^{'*}\right)\left[1 + y_2^{'*} - \varphi y_1^{'*}\right]$. However, both utility functions, $u_2^*(x,y)$ and $u_2^{'*}(x,y)$, yield brings the same qualitative results. In this study, $u_2^*(x,y)$ is used instead of $u_2^{'*}(x,y)$, since it expresses the cost as a linear function of the discrepancy between the second-period and the first-period consumption levels (Leventoglu, 2012).

The first-period equilibrium

The problem of the Northern representative consumer is to choose the consumption bundle (x_1, y_1) that maximizes its utility given by (3.1) subject to the budget constraint (3.3). In equilibrium, the marginal rate of substitution between good x and good y $(MRS_{x,y})$ must be equal to the price ratio between the two goods (p_x/p_y):

$$MRS_{x,y} \equiv \frac{1 + y_1}{1 + x_1} = \frac{p_{x_1}}{p_{y_1}} \tag{3.6}$$

Likewise, the equilibrium condition can be obtained for the Southern RC:

$$MRS_{x,y}^* \equiv \frac{1 + y_{t_1}^*}{1 + x_{t_1}^*} = \frac{p_{x_1}^*}{p_{y_1}^*} \tag{3.7}$$

Following Kennan and Riezman (1988), I find the quantities traded in equilibrium. Let Z_i denote the volume of trade for good $i \in \{x, y\}$; if $Z_i < 0\,(Z_j > 0)$, then the country exports (imports) good $i\,(j)$. Recalling that $\frac{1}{2} < \gamma \leq \mu$, the pattern of trade is as follows: the North (the South) imports good x (y) and exports good y (x). Therefore, equilibrium consumptions can expressed as the difference between countries' endowments and traded quantities : $x_1 = 1 - \gamma + Z_{x_1}$, $y_1 = \mu - Z_{y_1}$, $x_1^* = \gamma - Z_{x_1}^*$ and $y_1^* = 1 - \mu + Z_{y_1}^*$. Putting these expressions into (3.6) and (3.7) brings the following system of equations

$$\begin{cases} p_{x_1}\left(2-\gamma+Z_{x_1}\right)-p_{y_1}\left(1+\mu-Z_{y_1}\right)=0 \\ p^*_{x_1}\left(1+\gamma-Z^*_{x_1}\right)-p^*_{y_1}\left(2-\mu+Z^*_{y_1}\right)=0 \end{cases} \tag{3.8}$$

Let good x be the *numeraire* good so that $p_{x_1}=1$ $(p^*_x=1)$. In order to solve the system of equations (3.8), one needs to find the trade balance equation. This is done by subtracting (3.3) from (3.2) (or alternatively, (3.5) from (3.4)):

$$\begin{aligned} p_{x_1}(\underbrace{1-\gamma-x_1}_{Z_x<0})+p_{y_1}(\underbrace{\mu-y_1}_{Z_y>0}) &= T_1 \\ p^*_{x_1}(\underbrace{\gamma-x^*_1}_{Z^*_x>0})+p^*_{y_1}(\underbrace{1-\mu-y^*_1}_{Z^*_y<0}) &= -T_1 \end{aligned} \tag{3.9}$$

Isolating p_{y_1} $\left(p^*_{y_1}\right)$ brings

$$p_{y_1}=p^*_{y_1}=\frac{Z_x+T_{t_1}}{Z_y} \tag{3.10}$$

This expression is equivalent to the North's terms-of-trade. Since trade is balanced, isolating p_y from each equation in (3.9) conveys the same result. Putting the expression of p_{y_1} into (3.8) and assuming that trade is balanced ($Z_x=Z^*_x$ and $Z_y=Z^*_y$), the system of equations becomes

$$\begin{cases} Z_{y_1}\left(2-\gamma+Z_{x_1}\right)-\left(Z_{x_1}+T_1\right)\left(1+\mu-Z_{y_1}\right)=0 \\ Z_{y_1}\left(1+\gamma-Z_{x_1}\right)-\left(Z_{x_1}+T_1\right)\left(2-\mu+Z_{y_1}\right)=0 \end{cases} \tag{3.11}$$

The solution to the system of equations (3.11) is given by

$$Z^{E_1}_{x_1}=\frac{1}{2}\left(\gamma+\mu-T_1-1\right); \quad Z^{E_1}_{y_1}=\frac{1}{2}\left(\gamma+\mu+T_1-1\right)$$

As expected, one can easily see that the transfer increases the North's exports but decreases the South's by the same amount. Moreover, one can see why it is assumed that countries' initial endowments must be higher than 1/2. In fact, this ensures that countries exchange positive quantities in equilibrium. Subtracting these quantities from countries' endowments gives the equilibrium consumption of x,y :

- for the North

$$\begin{pmatrix} x_1^E \\ \\ y_1^E \end{pmatrix} = \begin{pmatrix} \frac{1}{2}\left(1-\gamma+\mu-T_1\right) \\ \\ \frac{1}{2}\left(1-\gamma+\mu-T_1\right) \end{pmatrix}$$

- for the South

$$\begin{pmatrix} x_1^{*E} \\ \\ y_1^{*E} \end{pmatrix} = \begin{pmatrix} \frac{1}{2}\left(1+\gamma-\mu+T_1\right) \\ \\ \frac{1}{2}\left(1+\gamma-\mu+T_1\right) \end{pmatrix}$$

Equilibrium consumptions are expressed as functions of endowments and the amount of transfer; putting them back into countries' utility functions allows to study the welfare effects of a foreign transfer on each country. Starting with the North, inserting x_1^E, y_1^E into (3.1) brings $u_1 = \left[3/2 - 1/2\left(\gamma-\mu+T_1\right)\right]^2$; differentiating this expression w.r.t T_1: $\frac{\partial u}{\partial T_1} = \frac{1}{2}\left(\gamma-\mu+T_1-3\right) < 0$, which shows that foreign aid has a negative effect on the North's welfare.

Proceeding similarly with the South : $u_1^* = \left[3/2 + 1/2\left(\gamma-\mu+T_1\right)\right]^2$ and $\frac{\partial u^*}{\partial T_1} = \frac{1}{2}\left(\gamma-\mu+T_1+3\right) > 0$, which means that the transfer is welfare enhancing for the recipient (the South). This result is very intuitive: in an exchange economy, the international transfer reduces (increases) the income of the North (the South), so that it imports less (more) of x (y) and consumes less (more) of both goods. Actually, the consumption of x and y decreases by one half in the North and increases by the same amount in the South $\left(\frac{\partial x_1^E}{\partial T_1} = \frac{\partial y_1^E}{\partial T_1} = \frac{\partial Z_{x_1}}{\partial T_1} = -\frac{1}{2} \text{ and } \frac{\partial x_1^{*E}}{\partial T_1} = \frac{\partial y_1^{*E}}{\partial T_1} = \frac{\partial Z_{y_1}}{\partial T_1} = \frac{1}{2}\right)$. Results show that 1 \$ of foreign aid translates into 0.5 \$ increase of donor's exports of good y, as the other 0.5 \$ of the transfer leaks into the consumption of good x, thus reducing the recipient country's exports by the same amount.

Since the increase in the consumption of both goods x and y in the South is equivalent to its decrease in the North, the world spending on x and y is unchanged. Thus, foreign aid has no effect on terms-of-trade in the first period.[6] To prove this, put quantities traded $Z_{x_1}^{E_1}$, $Z_{y_1}^{E_1}$ into expression (4.17) (which corresponds to the North's terms-of-trade, ToT_1) to get $ToT_1 = 1 = ToT_1^*$; it is trivial to show that $\frac{\partial ToT_1}{\partial T_1} = \frac{\partial ToT_1^*}{\partial T_1} = 0$. These results show that in the first period, the transfer creates only a revenue effect in both countries. The above discussion can be summarized as follows:

[6] Although no explicit analysis is made for each period, DLR (2004) mention that the transfer paradox is ruled out in a static framework.

Proposition 3.1 : *In a static pure exchange model of free trade, a foreign transfer,T_1, from the North to the South creates a redistribution of income that always increases (resp. decreases) the South's welfare (resp. the North's welfare), in the absence of a terms-of-trade externality. As a consequence, the North (resp. the South) imports (resp. exports) less good x, but exports (imports) more of good y $\left(\frac{\partial Z_{x_1}}{\partial T_1} = -\frac{\partial Z_{y_1}}{\partial T_1} = -\frac{1}{2}\right)$. This revenue effect leads to a higher (resp. lower) consumption of both goods in the South (resp. the North) ($\frac{\partial x_1^{*E}}{\partial T_1} = \frac{\partial y_1^{*E}}{\partial T_1} = \frac{1}{2}$ and $\frac{\partial x_1^{E}}{\partial T_1} = \frac{\partial y_1^{E}}{\partial T_1} = -\frac{1}{2}$).*

The above proposition 3.1 is depicted in an Edgeworth box (figure 3.1), where point 0 corresponds to the initial endowments of both countries' consumers.[7] Given their endowments and preferences, the equilibrium consumption bundle is at point A where foreign aid is zero. At this point, the North (resp. the South) exports (resp. imports) $Z_{y_1} \equiv \mu - y_A = (1-u) + y_B^*$ of good y and imports (resp. exports) $Z_{x_A} \equiv x_A - (1-\gamma) = \gamma - x_A^*$ of good x. For a given good, the consumption increases (decreases) by the amount of imports (exports). The corresponding utility levels (indifference curves) are respectively u_A for the North and u_A^* for the South.

When the South receives a transfer T_1 from the North, its imports of good y increase by $\Delta Z_y = y_B^* - y_A^* = -(y_B - y_A)$, while its exports of good x diminish by $\Delta Z_x = x_B^* - x_A^* = -(x_B - x_A)$. At the new equilibrium (point B), the Southern (resp. Northern) consumer reaches a higher (resp. lower) utility level: $u_B < u_A$ and $u_B^* > u_A^*$. Actually, we have that $\Delta u = (1/4)\, T_1 \left[2(\gamma - \mu) + T_{t_1} - 6\right] < 0$ and $\Delta u^* = (1/4)\, T_{t_1} \left[2(\gamma - \mu) + T_{t_1} + 6\right] > 0$.

As shown in figure 3.1, both equilibrium points 1 and 2 lie on the same contract curve that goes through the line $O_S O_N$ (the diagonal of the Edgeworth box). This curve is such that $MRS_{North} = MRS_{South}$, which implies that $x = y$. Note also that the slopes of countries' budget constraints, which are just the marginal rate of transformation (the price ratio of the two goods p_x/p_y), are equal at both points A and B. One can see graphically that both red lines going through points A and B are parallel. This means that the transfer does not induce a terms-of-trade externality.

[7] Both figures 3.1 and 3.2 are drawn assuming for values $\gamma = 0.6$, $\mu = 0.9$ and $T_{t_1} = 0.2$.

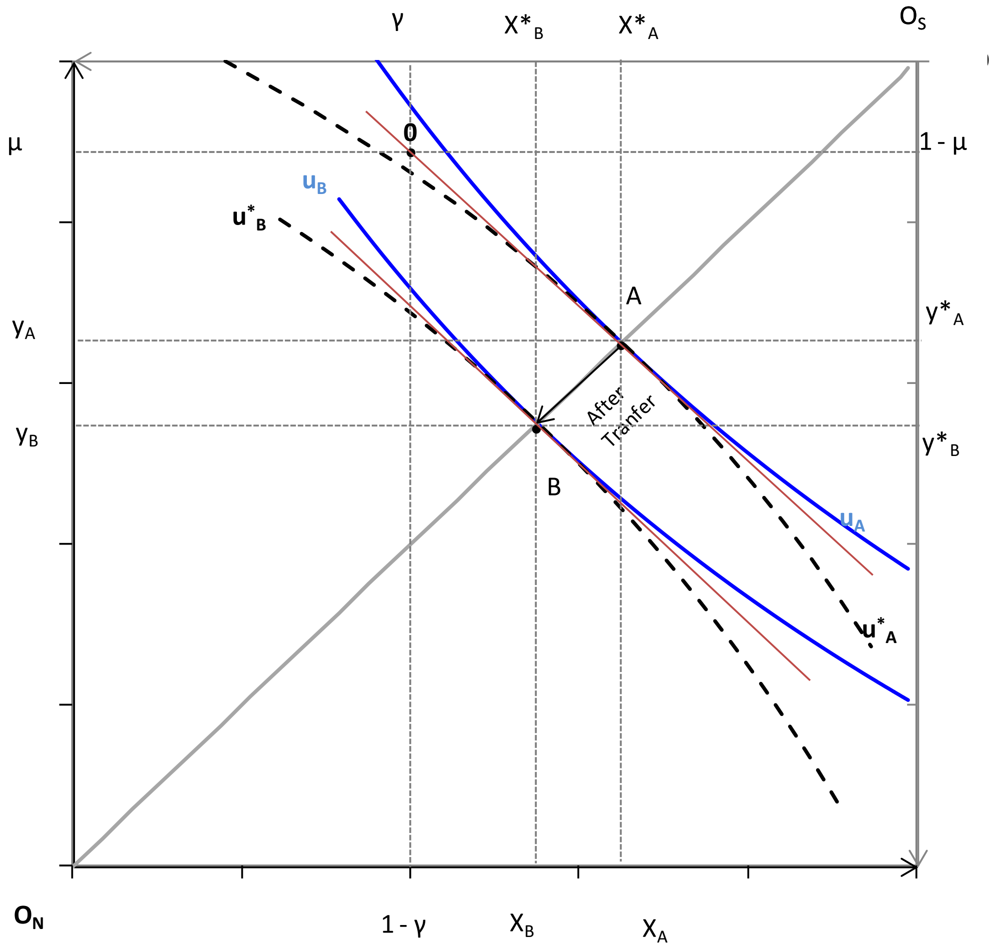

Figure 3.1: Countries' trade equilibrium with transfer

The second-period equilibrium

The South's second period utility is given by

$$u_2^*(x, y) = (1 + x_2^*)\left[1 + y_2^* + \phi\left(y_2^* - y_1^*\right)\right] \tag{3.12}$$

The Northern consumer's utility remains the same as in the first-period (3.1) and so does its equilibrium condition (3.6). The Southern consumer equilibrium condition becomes

$$\frac{1 + y_2^* + \phi\left(y_2^* - y_1^*\right)}{(1 + \phi)\left(1 + x_2^*\right)} = \frac{p_{x_2}}{p_{y_2}} \tag{3.13}$$

Since there is no foreign aid in the second period, the trade balance reduces to $p_{y_2} = Z_{x_2}/Z_{y_2}$. Combining (3.6) , (3.13) with the second-period trade brings the system of equations described below

$$\begin{cases} Z_{y_2}\left(2 - \gamma + Z_{x_2}\right) - Z_{x_2}\left(1 + \mu - Z_{y_2}\right) = 0 \\ \\ Z_{y_2}\left(1 + \phi\right)\left(1 + \gamma - Z_{x_2}\right) \\ -Z_{x_2}\left[2 - \mu + Z_{y_2} - \phi\left(Z_{y_2} - Z_{y_1}^{E_1}\right)\right] = 0 \end{cases} \tag{3.14}$$

At the equilibrium, countries exchange the following quantities of both goods

$$Z_{x_2}^E = \frac{1}{2}\frac{6\left(\gamma + \mu - 1\right) + \phi\left(5\gamma + 2T_1 + 4\mu - \gamma^2 - T_1\gamma + \gamma\mu\right)}{6 + \phi\left(3 + \mu - \gamma - T_1\right)} \tag{3.15}$$

$$Z_{y_2}^E = \frac{1}{12}\frac{6\left(\gamma + \mu - 1\right) + \phi\left(5\gamma + 2T_1 + 4\mu - \gamma^2 - T_1\gamma + \gamma\mu\right)}{(1 + \phi)} \tag{3.16}$$

Consumptions of x and y by RCs are respectively given by

- for the North

$$\begin{pmatrix} x_2^E \\ \\ y_2^E \end{pmatrix} = \begin{pmatrix} \frac{1}{2}\frac{6(1-\gamma+\mu)+\phi\left(6+6\mu-3g-\gamma\mu+\gamma^2+T_1\gamma\right)}{6+\phi(3+\mu-\gamma-T_1)} \\ \\ \frac{6(1-\gamma+\mu)+\phi\left(8\mu-5\gamma-2T_1+\gamma^2+T_1\gamma-\gamma\mu\right)}{12(1+\phi)} \end{pmatrix} \tag{3.17}$$

- for the South

$$\begin{pmatrix} x_2^{*E} \\ \\ y_2^{*E} \end{pmatrix} = \begin{pmatrix} \frac{1}{2}\frac{6(1+\gamma-\mu)+\phi\left(\gamma+\gamma\mu-\gamma^2-T_1\gamma-2T_1-4\mu\right)}{6+\phi(3+\mu-\gamma-T_1)} \\ \\ \frac{6(1+\gamma-\mu)+\phi\left(12-8\mu+5\gamma+2T_1-\gamma^2-T_1\gamma+\gamma\mu\right)}{12(1+\phi)} \end{pmatrix} \tag{3.18}$$

In the absence of habits and foreign aid, the second-period equilibrium is identical to the first-period equilibrium without transfer. In fact, $Z_{x_2}^{E_2} \mid_{\phi=0}= Z_{y_2}^{E_2} \mid_{\phi=0}= \frac{1}{2}(\gamma+\mu-1)$; $x_2^E \mid_{\phi=0}= y_2^E \mid_{\phi=0}= \frac{1}{2}(1-\gamma+\mu)$ and $x_2^{*E} \mid_{\phi=0}= y_2^{*E} \mid_{\phi=0}= \frac{1}{2}(1+\gamma-\mu)$.[8]

Assumption 3.1: *In the absence of habit formation ($\phi = 0$), foreign aid has no effect on the second-period equilibrium.*

Expressions (3.15) through (3.18) show that the first-period transfer affects both trade and consumption in the second period though the habit formation parameter ϕ. In other words, without habits, the transfer has no effect neither on the second-period nor on the intertemporal equilibrium. This is a special feature of this paper, which contrasts with previous studies on the transfer paradox in a two-period model, where there is no habit formation (Djajic, Lahiri and Raimondos-Moller, 1998, 2004; Galor and Polemarchakis, 1987).

[8] See that these quantities are the same as in section 2.1 for $T_{t_1} = 0$.

Habits and foreign aid: some comparative statics

Comparative statics analysis shows that habit formation is export-promoting for both countries. Moreover, in each country, the consumption of the import (export) good increases (decreases) with the strength of habits.
Formally,

$$\frac{\partial Z_{x_{t_2}}}{\partial \phi} = \frac{\partial x_{t_2}^E}{\partial \phi} = \frac{3}{2}\frac{(1+\mu)(\gamma-\mu+T_{t_1}+3)}{\left[6+\phi\left(3+\mu-\gamma-T_1\right)\right]^2} > 0$$

$$\frac{\partial Z_{y_{t_2}}}{\partial \phi} = \frac{\partial y_{t_2}^{*E}}{\partial \phi} = \frac{(2-\gamma)\left(\gamma-\mu+T_{t_1}+3\right)}{12\left(1+\phi\right)^2} > 0$$

$$\frac{\partial y_{t_2}^E}{\partial \phi} = -\frac{\partial Z_{y_{t_2}}}{\partial \phi} < 0 \quad \text{and} \quad \frac{\partial x_{t_2}^{*E}}{\partial \phi} = -\frac{\partial Z_{x_{t_2}}}{\partial \phi} < 0$$

The intuition behind these results is as follows: habit formation causes the South to import more of good y from the North to satisfy its consumption habit. Since there is no financial market from which to borrow and no transfer in the second period, this consumption increase must be compensated by a decrease of the consumption of good x. Finally, at the equilibrium of this pure exchange economy, the North (resp. the South) ends up importing and consuming more of x (y). The higher relative demand for good y induced by strong habits pushes its relative price, p_{y_2}/p_{x_2}, upward, thus improving (resp. deteriorating) the North's (resp. the South) terms-of-trade (ToT).

To prove the positive effect of foreign aid on the North's terms-of-trade, I insert $Z_{x_2}^{E_2}$; $Z_{y_2}^{E_2}$ into the trade balance to obtain the North's terms-of-trade:

$$ToT_{t_2} = \frac{6\left(1+\phi\right)}{6+\phi\left(3+\mu-\gamma-T_1\right)} \tag{3.19}$$

The first-derivative of (3.19) w.r.t the habit parameter, ϕ, equals:

$$\frac{\partial ToT_{t_2}}{\partial \phi} = \frac{6(\gamma-\mu+T_{t_1}+3)}{\left[6+\phi\left(3+\mu-\gamma-T_1\right)\right]^2} > 0$$

Knowing that $ToT_{t_2}^* = 1/ToT_{t_2}$, it is easy to measure the effect on habits on the South's terms-of-trade in the second period:

$$\frac{\partial ToT_{t_2}^*}{\partial \phi} = -\frac{(\gamma - \mu + T_{t_1} + 3)}{(1+\phi)^2} < 0$$

The above discussion on the effects of habit strength on countries' terms-of-trade is new to most two-period 2×2 trade models. Indeed, previous studies (Djajic, Lahiri and Raimondos-Møller, 1998, 2004; Galor and Polemarchakis, 1987) ignore the question of habits, while I argue in this paper that the strength of habits operates jointly with the revenue effect of the transfer in the second period.

In what follows, I present the classical channel through which the transfer affects countries' terms-of-trade. Starting with the North, it turns out that

$$\frac{\partial ToT_2}{\partial T_1} = \frac{6\phi(1+\phi)}{[6+\phi(3+\mu-\gamma-T_1)]^2} > 0$$

Proceeding similarly with the South,

$$\frac{\partial ToT_{t_2}^*}{\partial T_{t_1}} = -\frac{\phi}{6(1+\phi)} < 0$$

Remember that there is no terms-of-trade effect of foreign aid in the first period; given that $\partial ToT_{t_2}/\partial T_{t_1} > 0$ and $\partial ToT_{t_2}^*/\partial T_{t_1}^* < 0$, the North's intertemporal terms-of-trade change is positive, while that of the South is negative.

The effects of the transfer described above are not the only one at play; the amount of the first-period transfer also exerts a direct effect on consumption and trade in the second period. In fact, $\frac{\partial Z_{x_2}^E}{\partial T_1} = \frac{\partial x_2^E}{\partial T_1} = \frac{3\phi(1+\mu)(1+\phi)}{[6+\phi(3+\mu-\gamma-T_1)]^2} > 0$ and $\frac{\partial Z_{y_{t_2}}^E}{\partial T_{t_1}} = \frac{\partial y^{*E_2}}{\partial T_{t_1}} = \frac{\phi(1+(1-\gamma))}{3(1+\phi)} > 0$. In addition, $\frac{\partial x^{*E_2}}{\partial T_{t_1}} = -\frac{\partial x^{E_2}}{\partial T_{t_1}} < 0$ and $\frac{\partial y^E}{\partial T_{t_1}} = -\frac{\partial y^{*E}}{\partial T_{t_1}} < 0$. Contrary the first period, foreign aid stimulates trade in both goods; however, the increase is biased towards good y. This is true because, the North's terms-of-trade increase while the South's deteriorate. The intuition behind this result is that, given the change in his tastes, the Southern consumer is ready to give up his consumption of good x in favor of that of good y which he values more. Numerical simulations show that the first-period transfer benefits the North (donor) at the expenses of the South (recipient) in the second-period : $\frac{\partial u_{t_2}(\gamma,\mu,\phi,T_{t_1})}{\partial T_{t_1}} > 0$ and $\frac{\partial u_{t_2}^*(\gamma,\mu,\phi,T_{t_1})}{\partial T_{t_1}} < 0$.

These results can be summarized as follows:

Proposition 3.2 : *In the presence of habit formation measured by the parameter ϕ, the first-period transfer T_{t_1} improves the donor (the North) second-period terms-of-trade ($\partial ToT_{t_2}/\partial T_{t_1} > 0$ and $\partial ToT_{t_2}/\partial \phi > 0$) but worsens the recipient's terms-of-trade (the South) ($\partial ToT^*_{t_2}/\partial T_{t_1} < 0$ and $\partial ToT^*_{t_2}/\partial \phi < 0$). Both the transfer T_{t_1} and the habit strength ϕ promote trade in both goods so that the North (resp. the South) consumes more of its import good x (resp. good y) and less of its export good y (resp. good x) ($\frac{\partial Z^E_{x_{t_2}}}{\partial \theta} = \frac{\partial x^E_{t_2}}{\partial \theta} > 0$, $\frac{\partial Z^E_{y_{t_2}}}{\partial \theta} = \frac{\partial y^{*E_2}}{\partial \theta} > 0$, $\frac{\partial x^{*E_2}}{\partial \theta} = -\frac{\partial x^{E_2}}{\partial \theta} < 0$* and *$\frac{\partial y^E}{\partial \theta} = -\frac{\partial y^{*E}}{\partial \theta} < 0$, with $\theta \in \{\phi, T_{t_1}\}$). Since the North (the South) ends up selling its export good at improved (deteriorated) terms-of-trade, it is better (worse) off.*

The Edgeworth box presented in figure 3.2 depicts proposition 3.2. Note that countries have identical endowments as in the first-period. Point 0 corresponds to countries' initial endowments of both goods; point C depicts the exchange equilibrium that prevails in the absence of the transfer, but when the South has a habit forming behavior. The most noticeable change in figure 3.2 is the fact that habit formation induces a change in the South's preferences.

In fact, one can see that the North's indifference curves are identical to those shown in figure 3.1; this is not the case for the South, since the change in tastes induce a rotation of its indifference curve. This change in the South's preferences implies that the equilibrium points lie on a different contract curve compared to the first period. In addition, the slope of countries' budget constraints (the price ratio of the two goods p_x/p_y) in figure 3.2 is different from figure 3.1 ($\frac{p_x}{p_y}(A) < \frac{p_x}{p_y}(C)$). This implies that habit formation induces a terms-of-trade externality in the second period in favor of the donor (the North).

Figure 3.2 also shows that countries trade more in the presence of habit formation. Let's compare point C to point A where $\phi = 0$ and $T_1 = 0$: the South imports more of good y ($\Delta Z_y = y^*_C - y^*_A = -(y_C - y_A)$) and the North, more of good x ($\Delta Z_x = x_C - x_A = -(x^*_C - x^*_A)$). As a consequence, each country consumes more of its import good, contrary to the first period where the fall (resp. the rise) in the North's (resp. the South) revenue induces a reduction (resp. an increase) in consumption of both goods.

To measure the second-period effect of the transfer, one needs to compare point C with point D, where $T_1 > 0$. The Northern consumer reaches a higher utility level ($u_D > u_C$), while the effect on the Southern consumer is worse off ($u^*_D < u^*_C$).

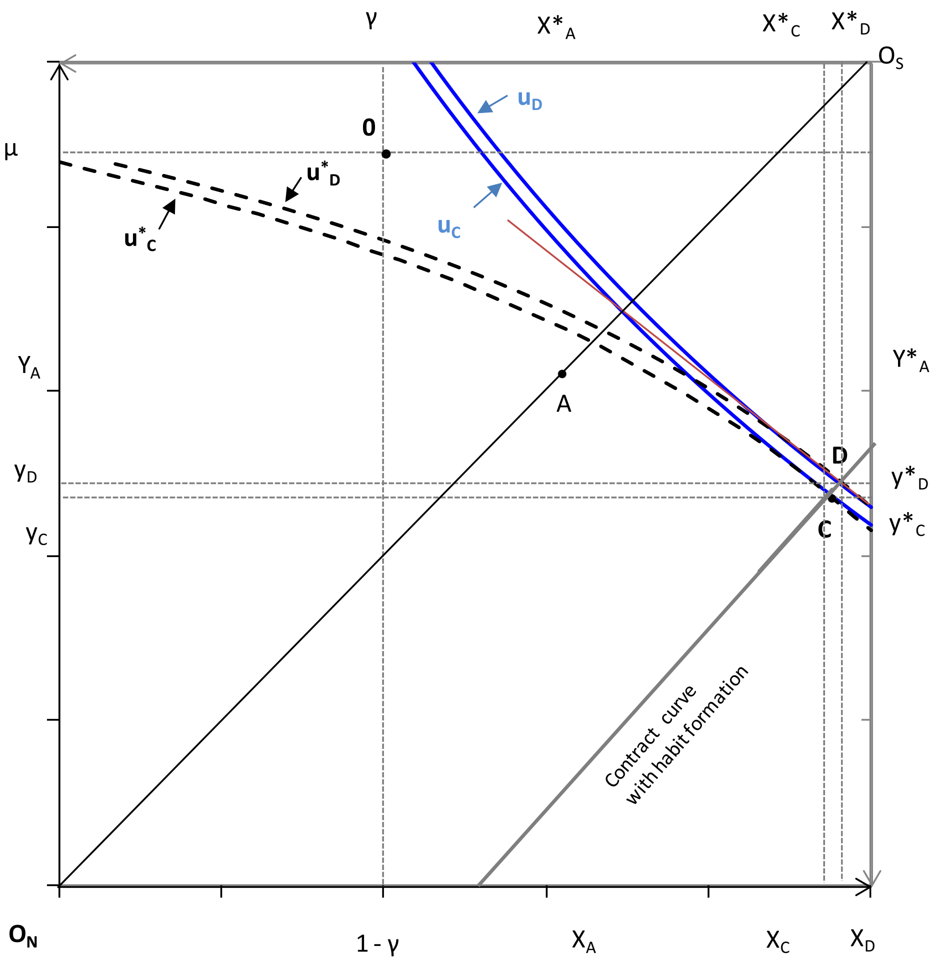

Figure 3.2: Countries' trade equilibrium with habit formation

The intertemporal welfare

The graphical analysis presented in the previous sections gives an intuition about the intertemporal welfare effect of the first-transfer on each country. Comparing the distance between a country's indifference curves from one period to another, one can easily see that, when countries have the same endowments in both periods, the North is worse off, and the South better off.[9] Actually, the line segment $\overline{AB}$ from figure 3.1 is larger than $\overline{CD}$ in figure 3.2 ($\overline{AB} > \overline{CD}$) which evidences the fact that the North (the South) experiences an intertemporal utility loss (gain) from giving (from receiving). This happens because the improvement in the North's terms-of-trade plus the increase in the value of trade are not high enough to offset the direct revenue effect of the transfer.

Under such circumstances, the North will not to make any transfer to the South. However, when endowments vary from one period to another, it can be shown that the North may experience an intertemporal utility gain, while the South suffers a loss. This happens in particular when the world endowment of the North's import (the South's export) good x increases sufficiently more that of its export (import) good y.

A numerical example

Consider now that the world endowment of good x increase by a factor α and that of the good y by a factor β. It can be shown that for some values of $\alpha > \beta$, the transfer improves the North's intertemporal utility (IU) but decreases the South's for all possible combinations of endowments. Table 3.1 presents two examples, where the North makes a transfer of 0.01 to the South. It can be shown that for $\alpha = 2$ and $\beta = 1.2$, the North experiences an intertemporal utility loss, while the South sees its utility improving.

When the increase in the world endowment of the South's export good x increases far more abundantly than that of its import export y, we get the opposite result. Actually, for parameter values $\alpha = 74$ and $\beta = 1.2$, countries find themselves in a situation of a transfer paradox. In fact, the North's (the South's) second-period gain (loss) is now higher than the first-period loss (gain) for the North (the South) for any pair of endowments (γ, μ). I verify that, for $\beta = 1.2$, the North is always worse off whenever $\alpha < 74$; the South's intertemporal utility change depends on the distribution of endowments (γ, μ).

[9] The following analysis rests on the assumption that countries attribute an equal weight to both periods and that the strength of habits equals 1 ($\phi = 1$); moreover, it is trivial to show that maximizing the intertemporal utility of agents with respect to x_t and y_t, with $t = 1, 2$ brings the FOCs presented in the previous sections.

Although this second numerical example may seem unrealistic (as the endowment of good x increases more than 60 times than that of good y from one period to another), it points to the fact that a transfer may be welfare improving for the donor under the two following conditions: first, the recipient country develops habits for the donor export good; second, the recipient must be a fast-growing economy compared to the donor.

Yet, aid recipient countries that experience a high rate of economic growth are not a majority; we can consider that the habit formation argument sheds additional light on donor motive for giving.

n-period equilibrium

Habits are likely to persist for more than a single period. In this section, I present intuitively the effects of the first-period transfer on trade, consumption and countries' utilities in the n^{th} period. I assume that the habit parameter $\phi \leq 1$ is constant over time and that countries have the same endowments in each period. Let $n = 3$; (3.12) becomes $u_3^*(x, y) = (1 + x_3^*) \left[1 + y_3^* + \phi \left(y_3^* - y_2^{E*}\right)\right]$, where y_2^{E*} is defined in (3.18). Since y_2^{E*} is expressed in terms of γ, μ, ϕ, solving for the third-period consumer problem yields the equilibrium quantities traded and consumed as a function of γ, μ, ϕ and ϕ^2.

The presence of the squared term ϕ^2 suggests that the effect of the first-period transfer on trade, consumption and countries' utilities decreases over time. This very intuitive result is very useful for the empirical analysis of the next section: in fact, I test that the hypothesis that aid has a positive effect on donor exports, but this effect deceases over time.

Due to the decreasing effect of aid over time, the North (the South) experiences an IU loss (gain) after n periods.

Table 3.1: welfare change resulting from a transfer $T = 0.01$ when the strength of habits equals 1 ($\phi = 1$)

Endowments		1st period utility		$\alpha = 2,\ \beta = 1.2$				$\alpha = 74,\ \beta = 1.2$			
				2nd period utility		Intertemporal gain (loss)		2nd period utility		Intertemporal gain (loss)	
γ	μ	Δu_1	Δu_1^*	Δu_2	Δu_2^*	$\Delta u_1 + \Delta u_2$	$\Delta u_1^* + \Delta u_2^*$	Δu_2	Δu_2^*	$\Delta u_1 + \Delta u_2$	$\Delta u_1^* + \Delta u_2^*$
0.6	0.6	-0.015	0.015	0.001	-0.010	-0.014	0.005	0.016	-0.196	0.001	-0.181
0.6	0.7	-0.015	0.015	0.001	-0.009	-0.015	0.005	0.019	-0.190	0.003	-0.175
0.6	0.8	-0.016	0.014	0.001	-0.009	-0.015	0.005	0.022	-0.184	0.006	-0.170
0.6	0.9	-0.016	0.014	0.001	-0.009	-0.015	0.005	0.025	-0.178	0.007	-0.164
0.6	1.0	-0.017	0.013	0.001	-0.008	-0.016	0.005	0.028	-0.172	0.009	-0.159
0.7	0.7	-0.015	0.015	0.001	-0.010	-0.014	0.005	0.022	-0.219	0.007	-0.204
0.7	0.8	-0.015	0.015	0.001	-0.010	-0.014	0.005	0.025	-0.213	0.010	-0.199
0.7	0.9	-0.016	0.014	0.001	-0.009	-0.015	0.005	0.028	-0.207	0.012	-0.193
0.7	1.0	-0.016	0.014	0.001	-0.009	-0.015	0.005	0.032	-0.201	0.016	-0.187
0.8	0.8	-0.015	0.015	0.001	-0.015	-0.014	0.005	0.028	-0.244	0.013	-0.229
0.8	0.9	-0.015	0.015	0.001	-0.010	-0.014	0.004	0.032	-0.238	0.017	-0.223
0.8	1.0	-0.016	0.014	0.002	-0.010	-0.014	0.004	0.035	-0.231	0.019	-0.217
0.9	0.9	-0.015	0.015	0.002	-0.010	-0.013	0.004	0.034	-0.271	0.019	-0.256
0.9	1.0	-0.015	0.015	0.002	-0.011	-0.014	0.004	0.037	-0.264	0.022	-0.249
1.0	1.0	-0.015	0.015	0.002	-0.011	-0.013	0.004	0.038	-0.298	0.023	-0.283

3.3 Empirical strategy

The main predictions of the model presented above about the relationship between donor exports and past transfer imply the following hypotheses:

*H*1. A transfer made by a donor in period t_1 has significant lagged effects on recipients' imports in period t_2 ($\partial Z_{y_2}/\partial T_1 > 0$).

*H*2. The export promoting effect of the first-period transfer decreases considerably in subsequent periods $t_3, t_4, ...(\partial Z_{y_3}/\partial T_1 < \partial Z_{y_2}/\partial T_1)$

To test these hypotheses, I use foreign aid data as the main independent variable to capture the transfer, T, paid by a donor country (namely, France) to aid recipients (ACP countries). Hereafter the trade equation to be estimated

$$Z_{y_{it}} = a_0 + a_1 T_{it} + a_2 T_{it-1} + a_3 T_{it-2} + a_4 T_{it-3} + a_5 \gamma_{it} + a_6 \mu_{it} + \epsilon_{it} \quad (3.20)$$

where i is a recipient country, t is time and ϵ_{it} is the error term. γ_{it} and μ_{it} are measures of recipients' endowments.

Two variables are used to measure countries' endowments, namely, the GDP per capita and the population size, which are commonly used in the trade literature. A common problem in empirical research is the possible endogeneity of RHS variables. It might happen that a RHS variable, say x_i, in Eq. (3.20) is correlated with the error term, ϵ_{it}; in such case, x_i is said to be "endogenous" and then the ordinary least squares (OLS) method may produce biased and inconsistent estimations. Wooldridge (2002) identifies three sources of endogeneity problem, namely omitted variables, simultaneity and measurement error.

To tackle the endogeneity bias resulting from omitted variables, I use (recipient) countries' fixed effects (RCFEs), as suggested in trade literature (Baier and Bergstrand, 2004, 2007). In fact, these dummies capture fixed and "structural" factors; that is, variables which do not change over time (e.g. geographical distance) and those experiencing little change over time (e.g. factor endowments) (Liu and Ornelas, 2014). They also control for unobserved time-invariant heterogeneity across (recipient) countries (Foster and Stehrer, 2011; Head, Mayer and Ries, 2010).

The simultaneity problem between aid and trade is well documented. To address this reverse causality issue, I follow the usual practice in the aid literature to use the lag aid variable as an instrument for the contemporaneous aid variable; indeed, lagged variables are considered good instruments for endogenous regressors (Anderson, 1979, p. 111; Wooldridge, 2000, p. 517). Therefore, one year lagged aid serves as instrument for T_{ij}, while two year lagged aid serves for T_{it-1} and so on.

To control for time effects, year dummies are included in the model. In addition, colonial linkages and common language dummies are included to account for missing variables that are specific to donor-recipient country pair.

Panel Data and methodology

The bilateral panel dataset covers the period 1980-2011 and 32 ACP countries that receive a positive amount of aid from France.[10] Therefore, each observation is associated with a dyad (country pair) composed of the donor country (France) and an ACP recipient.

Foreign aid is measured by the Official Development Assistance (ODA) provided by official agencies of the members of the Development Assistance Committee (DAC) to foster economic development and improve recipient countries' well-being. The trade data is from the UNCTAD database (2012) available online, while population and GDPe are from the Penn World Table (PWT 8.0); GDPe is measured in constant 2005 U.S. dollars. Following Baier and Bergstrand, I use the exporter (here, France) GDP deflator to obtain real trade flows for the panel analysis; I also apply this procedure to convert aid data into constant US $ 2005. France GDP deflator comes from the World Bank Development Indicators (WDI) online database. Since all the above variables vary across a wide range distribution, I use their natural log in all regressions reported below. Table 3.2 provides data summary statistics.[11]

Table 3.2: Description of data used in the analysis

Variables	N	Mean	Std. dev.	Min	Max
ln exports	1024	24.996	1.595	20.894	28.893
ln Aid	1022	16.745	1.799	10.052	21.409
ln GDPe cap	1024	7.107	0.699	2.715	9.609
ln pop	1024	15.263	1.503	11.515	18.903

Notes: This table presents basic statistics for the variables used in the analysis. The appendix contains sources and descriptions of the variables.

[10] Zimbabwe is the only country for which there is no data in 1997 and 1998.

[11] Panel tariff data is not used due to the large number of missing values; using this variable would substantially reduce the sample size.

Following the aid and trade literature, some specifications of our basic model include dummy variables for colonial ties or common language, which have a positive effect on trade. Colonial ties dummy data come from Head, Mayer and Ries (2010), while the common language dummy is taken from Santos Silva and Tenreyro (2006); for countries not included in their sample, the online *Encyclopédie Larousse* has been used to complete the data. Both dummies are not used in the same estimation, given their high correlation in the data (see table 3.3 below).

Table 3.3: CORRELATION MATRIX

	ln exports	*ln Aid*	*ln GDPe cap*	*ln pop*	*colony*	*language*
ln exports	1.000					
ln Aid	0.642	1.000				
ln GDPe cap	0.062	-0.104	1.000			
ln pop	0.617	0.361	-0.236	1.000		
colony	0.577	0.714	0.034	0.074	1.000	
language	0.525	0.702	0.011	0.093	0.939	1.000

I use standard panel estimation techniques, namely the fixed (FE) and the random effects (RE) models. The RE is used when language or colony are included in the model; in fact, these dummies drop in the FE models. Since the panel database covers a period of 32 years, one needs to test for the presence of serial correlation. The Wooldridge test for serial correlation in panel data leads to the rejection of the nil hypothesis. Baltagi (2008) notes that cross-sectional dependence can be an issue in panels with long time series (over 20-30 years). However, the Pesaran's test of cross sectional independence reveals that this is not a problem in our data.

The Wald's test confirms the presence of heteroskedasticity in the data. To solve for both problems, I run the regressions with clustered robust standard errors as suggested in Hoechle, 2007 (table 1. p. 285).

Results

Table 3.4 presents the estimation results for donor exports. Column (1) reports the results of the baseline model that includes only the most basic variables, where $Ln\,Aid_{t-1}$ is the instrument for the current aid and $Ln\,Aid_{t-2}$ for the one-period lagged aid. As expected, both variables have a positive coefficient, but only $Ln\,Aid_{t-2}$ is statistically significant at the 5 % level. In addition, its coefficient is larger than that of $Ln\,Aid_{t-1}$.

This suggests that past development aid promotes more donors' exports than current development aid. Variables capturing recipient endowments have the strongest effect on trade : the coefficients of $LnGDP\, cap_{ACP}$ and $Ln\, pop_{ACP}$ are 8 to 9 times higher than that of $Ln\, Aid_{t-2}$ and are significant at the 1 % level.

Column (2) presents the same model with two additional lagged aid variables. $Ln\, Aid_{t-1}$ and $Ln\, Aid_{t-3}$ are both insignificant; moreover, the later enters with the wrong sign. On the contrary, $Ln\, Aid_{t-2}$ and $Ln\, Aid_{t-4}$ are both statistically significant at the 1 % and the 5 % level respectively. They also display the highest coefficient among aid variables. $LnGDP\, cap_{ACP}$ behaves as in the first regression, while $Ln\, pop_{ACP}$ is still positive but becomes insignificant.

One would have expected all aid variables to have at least a positive effect on donor exports; in addition, further investigation is needed as to why the amount of aid given at $t-1$ and $t-3$ has no significant effect on trade, while the transfer at $t-2$ and $t-4$ does. For that purpose, I run two additional regressions with, on the one hand, lagged aid at odd periods, and on the other hand, lagged aid at even periods. Results are presented in columns 3 and 4.

Column 3 shows that neither $Ln\, Aid_{t-1}$ nor $Ln\, Aid_{t-3}$ has a significant effect on trade. $LnGDP\, cap_{ACP}$ remains very significant at the 1 % level, while $Ln\, pop_{ACP}$ becomes significant again at the 10 % level. In column 4, only $Ln\, Aid_{t-2}$ is significant at the 10 % level, whilst $Ln\, Aid_{t-4}$ is not. Here, both endowment variables are strongly significant at the 1 % level, as does the (common) *language* variable introduced in this regression. The later seems to be the most important determinant of french exports to ACP countries included in the sample. As noted above, the correlation between *language* and *colony* is close to 1, so that this might be the reflection of colonial ties rather than a common language per se.

The fact that only $Ln\, Aid_{t-2}$ appears to be statistically significant supports the hypotheses $H1$ and $H2$ presented above: actually, lagged one period transfer has a positive effect on donor exports, while further lagged aid has no promoting effect on donor products. This matches the intuition presented in the previous section that the effects of the transfer decreases with time.

Column (5) presents a regression where $Ln\, Aid_{t-2}$ is the only aid variable. As expected its coefficient is statistically significant; $LnGDP\, cap_{ACP}$ and $Ln\, pop_{ACP}$ are significant at 1 % level. Similar regressions with the other aid variables reveal that none of them individually affects french exports to ACP countries; they are not presented to save space.

Finally, column (6) presents the last regression where *language* is replaced by *colony*. The coefficient of the later is higher and strongly significant at 1 %. Once again, $Ln\,Aid_{t-1}$ does not affect french exports; instead of using $Ln\,Aid_{t-2}$ and $Ln\,Aid_{t-4}$ individually, I verify the effect of cumulative aid defined as $Ln\,Aid_{t-2} + Ln\,Aid_{t-4}$. Its effect is positive and significant at the 10 % level; it becomes insignificant if the amount of aid given at $t + 3$ is added.

The France-ACP case points to the fact that the export-enhancing effect of foreign aid can be short-lived as it lasts only one period and vanishes beyond.

Table 3.4. Dependent Variable: LN (France Exports to ACP), 1980-2011.

Ind. variables	(1) FE	(2) FE	(3) FE	(4) RE	(5) FE	(6) RE
Ln Aid_{t-1}	0.047	0.043	0.082			0.045
	(0.046)	(0.039)	(0.049)			(0.043)
Ln Aid_{t-2}	0.064**	0.072 ***		0.079*	0.089*	
	(0.027)	(0.021)		(0.043)	(0.048)	
Ln Aid_{t-3}		-0.038	0.038			
		(0.029)	(0.031)			
Ln Aid_{t-4}		0.049*		0.041		
		(0.027)		(0.032)		
Ln Aid_{t-2} + Ln Aid_{t-4}						0.046*
						(0.024)
LnGDP cap_{ACP}	0.601 ***	0.545 ***	0.572***	0.542***	0.603***	0.536***
	(0.074)	(0.075)	(0.062)	(0.069)	(0.071)	(0.071)
Ln pop_{ACP}	0.506***	0.429	0.339*	0.579***	0.502***	0.590***
	(0.167)	(0.514)	(0.181)	(0.141)	(0.163)	(0.116)
Colonial ties						1.347***
						(0.242)
Common language				1.204***		
				(0.294)		
Constant	11.501***	12.466***	13.723***	9.730***	11.962***	9.326 ***
	(3.652)	(8.512)	(3.760)	(2.646)	(3.285)	(2.445)
Time effects	Yes	Yes	Yes	Yes	Yes	Yes
Recipient Fixed effects	Yes	Yes	Yes	No	Yes	No
R-squared	0.5391	0.5518	0.5268	0.6674	0.5138	0.7172
Observations (N)	957	891	924	892	958	891
AIC	1261.276	1129.21	1187.589		1266.731	
BIC	1412.053	1277.772	1206.904		1417.541	

Note: Estimated with heteroscedasticity-robust standard errors. Superscripts ***, ** and * indicate significance 1, 5 and 10 % levels, respectively.

3.4 Conclusion

In this paper, I analyze the welfare implications of temporary foreign aid in a two-period pure exchange model of trade. The main contribution of this paper is to describe the habit formation mechanism by which a donor is better off and the recipient worse in an intertemporal setting. The so-called transfer is likely to happen only if the world endowment of the recipient export good increases much more than that of its export good. This result suggests that giving aid is welfare improving for the donor if the recipient country exhibit habit formation for the donor export good and also if the recipient grows faster than the donor. The intuition behind this result is that the first-period transfer pushes a fast-growing recipient to consume more of the donor export good. If countries' endowments are identical from one period to another, the first-period revenue effect of the transfer dominates the second-period terms-of-trade effect created by habits, so that the donor looses from giving while the recipient gains.

Concerning the aid and trade relationship, the model shows that the transfer is export-promoting for the donor, but this effect decreases over time due to the fall of the habit formation effect.

Testing the model with France-ACP data over a 30 year period, I find that only lagged one aid stimulates donor exports. This suggests that habit formation is short-lived and also that the donor needs to make additional transfers to sustain its exports.

An interesting avenue of research is to develop a dynamic model of trade and growth with habit formation, with incorporates the supply-side of the economy and see how a more general framework, such as the Ricardo-viner model of trade may affect the results presented in this research. Moreover, the empirical analysis can be extended to included other DAC donors and different aid recipient countries.

3.5 Appendix

A. list of ACP (recipient) countries

1. Benin	17. Kenya
2. Burkina Faso	18. Liberia
3. Burundi	19. Madagascar
4. Cameroon	20. Mali
5. Cape Verde	21. Mauritania
6. Central African Republic	22. Mozambique
7. Chad	23. Niger
8. Comoros	24. Nigeria
9. Congo	25. Rwanda
10. Côte d'Ivoire	26. Sao Tome and Principe
11. Djibouti	27. Senegal
12. Equatorial Guinea	28. Sierra Leone
13. Gambia	29. Sudan
14. Ghana	30. Suriname
15. Guinea	31. Zambia
16. Guinea-Bissau	32. Zimbabwe

* These countries reveive a positive amount of aid each year between 1980 and 2011.

B. Data sources

Variables	Data source
Net aid from 15- EU DAC member countries of OECD	World Development Indicators (WDI, 2014), online access at http://data.worldbank.org/indicator
Colonial ties	Table A.4 of Head, Mayer and Ries (2010)
Common language	Table A.2 of Santos Silva and Tenreyro (2006) supplemented with the Encyclopédie Larousse, online
France GDP deflator	WDI (2014), at http://data.worldbank.org/indicator
GDPE	PWT8.0; Feenstra, R.C., Inklaar, R. and Timmer, M. P. (2013)
Imports	UNCTADSTAT (2014), online access at http://unctadstat.unctad.org
Population	PWT8.0; Feenstra, R.C., Inklaar, R. and Timmer, M. P. (2013)

General Conclusion

Main Results

The essays presented in this thesis aim at understanding the evolution of trade relations between countries of the African, Caribbean and Pacific (ACP) group and their European counterparts.

Therefore, they tackle real concerns of European policy makers as well as those of the ACP countries. Indeed, the European Union (EU) is still an important trading partner for the ACP states – particularly for their exports (about 23 %), although it has lost market share to the benefit of the BRIC countries. The presence of supply constraints in these countries raised concerns about their ability to compete with other developing countries of Asia or South America – to name a few, in the European markets in a context of the economic partnership agreements (EPAs). In addition, some fear the risk of de-industrialization, as European products tend to replace locally produced ones on the ACP markets after trade is liberalized. Thus, the ACP countries argue for binding commitments in the legal texts of EPAs on the provision of development assistance from the EU to address supply-side rigidities and thereby support the consolidation of their production as well as their export capacity. In this way, EPAs include not only a development but also a trade dimension, though aid disbursement should precede the implementation of trade reforms by ACP countries. Given the significant delay of implementation – of up 25 years, this ordering of aid and reforms gives ACP countries time to adjust and take advantage of free trade with the EU.

Despite the privileged market access of their products to the European market over the last 50 years, ACP has not diversified their exports; in addition, their share of EU trade has continually declined, unlike other developing countries that have not received such a privilege. The disappointing result has motivated the introduction of EPAs, which conform to the WTO regulations. EPAs will benefit more European exporters given the high level of protection of ACP markets than ACP exporters as European markets are already very open. Much more than promoting European exports in the tiny ACP markets, EPAs are primarily instruments of a "raw material diplomacy" whose purpose is to secure access to raw materials by eliminating export restrictions in face of competitors such as BRIC countries. These are probably the main reasons the EU wants to conclude EPAs with ACP states.

These real concerns have fueled the theoretical and empirical research presented in this dissertation. Chapter 1 develops a theoretical model to explain the transition from ACP-EU agreements where ACP countries imposed high tariffs while enjoying a privileged access to the European markets, to free trade agreements. For this purpose, I use a pure exchange model of trade in the spirit of Kennan and Riezman (1988, KR) with Stone-Geary preferences. This framework is used to study trade war equilibrium, where welfare levels under Nash tariffs and free trade are compared for all possible endowments. My simulation results show that both countries are always be better off under free trade than trade war for all distributions of endowments, while KR (1988) find that the trade war equilibrium dominates free trade when heterogeneity in endowment size is sufficiently large.

I go a first further than KR (1988) by studying the globally optimal tariff agreement, which maximizes the world welfare; I find that free trade is the corner solution to this optimization problem and thus, corresponds to the efficient trade agreement for all possible endowments. Interestingly enough, I find an interior candidate solution that corresponds to a tariff-subsidy combination where the South (the small country) applies a tariff against its imports, while the North (the large country) subsidies its imports when countries are asymmetric. This candidate solution is of course rejected as it corresponds to a saddle point. It can be inferred from this finding that Lomé / Cotonou-type agreements are inefficient; therefore, one can easily understand the transition to free trade agreements which are supposedly better for all.

Yet, concerns expressed about ACP capacities suggest that some countries may not necessarily be better off under free trade. This motivates the study of the welfare effects of a free trade agreement (FTA) in the presence of various sources of heterogeneity (chapter 2). I find that, in the presence of size asymmetry or demand heterogeneity, the North (the large country or the one with the larger demand) is worse off and the South (the small country or the one of the smaller demand) is better off. Therefore, the South has to make a compensation payment to the North if the FTA is to be incentive-compatible. On the contrary, with heterogeneous supply functions, the North is better off, while the South, that experiences supply-side constraints (SSCs) is worse off. In this latter case, the transfer is paid by the North to the South. Testing this prediction with ACP-EU data, I find that the interaction between EPA and supply heterogeneity has a positive and significant effect on foreign aid allocation by donors. This empirical finding supports the theoretical prediction that countries facing supply rigidities receive a financial compensation for their welfare loss resulting from signing a the trade agreement.

Beside compensation transfers, ACP countries have long-lasting trade and foreign aid relations, which can promote European exports through consumption habits. This points is theoretically and empirically investigated in chapter 3. In fact, I study the effects of habits in a two-period pure exchange model of free trade with temporary aid. When the South's preferences for the North's export good are stronger in the second period, the transfer has a positive (negative) effect on the Northern donor's (Southern recipient's) welfare. However, this effect might no be strong enough to compensate for the direct revenue effect of the transfer in the first-period. The empirical test on France-ACP data over a 40 year period shows that only lagged one aid stimulates donor exports, suggesting that habit formation is short-lived; in such a context, the donor needs to make additional transfers to promote its exports.

Directions for Further Research

I can extend my future research into the following directions.

In chapter 1, I find that the free trade to be a corner solution to the maximization problem of the world welfare; this finding is derived from a North-South pure exchange model of trade, which abstracts from the supply-side of the economy. As mentioned by Syropoulos (2002), this model can be viewed as a special case of a $2 \times 2 \times 2$ Heckscher-Ohlin trade model where each sector uses only one factor of production (capital or labour). Therefore, it will be interesting to see under which conditions the results of this research hold in neoclassical trade models such as the Heckscher-Ohlin and specific factors trade models.

The research presented in chapter 2 can be extended to a multilateral setting to take into account the effect of a trade agreement on a third country. This will be bring valuable insight, since the initiation of EPAs with ACP partners is perceived as an instrument of the EU's "raw material diplomacy" in reaction to BRIC competitors. Therefore, an interesting extension is to consider a three-country three-good framework, where the South that experiences supply rigidities for both goods export to the North and to the East that has a higher demand for the South's exports than the

North. Various scenarios can be studies, in particular one where the East and the South sign a trade agreement. Another interesting scenario is the case where South signs a trade agreement with both countries separately.

The empirical research of chapter 2 can be extended in two directions: first, the data set can be extended to include other donors and recipients; second, additional dummies can be added to control for the effects of other FTAs on aid allocation.

In addition, the 2×2 model assumes perfect competition in both markets. It is well known that the commodity markets in which Southern countries have a comparative advantage are not competitive. On the contrary, they are more of a monopsonistic nature. It would be interesting to extend the study by considering, on the one hand, a competitive industry that produces the North's export good and, on the other hand, a monopsonistic industry for the South's export good. In particular, one can see how the South's welfare varies with the number of trading partners. In my opinion, this model will better reflect the reality of Southern countries who trade their raw material for manufactured goods produced in the North.

In chapter 3, I study the effects of habit formation on trade and welfare in a pure exchange model. In that framework, the donor always experiences an intertemporal welfare loss, since the direct revenue loss in the first period dominates the second-period effect of the transfer, even in the presence of strong habits. A promising avenue of research is to consider a growth and trade model with habit formation, since the promotion of donor exports has much chance to be strong when the recipient country is a fast-growing economy. Concerning the empirical test, it would be interesting to see if the empirical result on the short-lived effect of habits is specific to the French case with ACP countries or if it generally holds for several donors and for recipients other than ACP countries.

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