THÈSE

UNIVERSITE DE PAU ET DES PAYS DE L'ADOUR
École doctorale Sciences Sociales et Humanités

Présentée et soutenue le 27 Novembre 2019
par Julie **SCHLICK**

pour obtenir le grade de docteur
de l'Université de Pau et des Pays de l'Adour
Spécialité : Sciences Economiques

Mondialisation, Agriculture et Changement Climatique : Quatre essais en Economie Internationale

MEMBRES DU JURY

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• Jean-Marie CARDEBAT	Professeur à l'Université de Bordeaux, Directeur du Laboratoire d'Analyse et de Recherche en Economie et Finance Internationales (Larefi)
• José DE SOUSA	Professeur à l'Université de Paris-Sud, Directeur du Centre de Recherche en Economie et Management (RITM)

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Centre d'Analyse Théorique et de
Traitement des données économiques

Center for the Analysis of Trade
and economic Transitions

Thèse réalisée au Centre d'Analyse Théorique et de Traitement
des données économiques (CATT)
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Financement Bourse du Ministère de l'Enseignement Supérieur et de la Recherche

Globalization, Agriculture and Climate Change: Four essays in International Economics

Abstract

This dissertation studies several determinants of international trade. The first Chapter focuses on prices evolution for French wine export. It explains the recent stability of wine price by an increasing competition faces by French exporters that thwarts the increasing global demand due to the growth of higher income in emerging market (mainly in China). In the second Chapter, we investigate whether water is a determinant of agricultural trade. To estimate this impact, we construct a new indicator that allows to get a better approximation of available water by correcting some local and product specificities. This analysis is completed with simulations about the climate change impact on trade. Simulations highlights a negative impact of climate change on trade but the effect is inequaly distributed among countries. Chapter 3 and 4 analyse the Regional Trade Agreement as determinant of trade for African countries. The third chapter quantifies the impact of several agreements (COMESA, SADC,...) on trade while the fourth chapter is focusing more specifically on the EAC agreement. Main results show an increase of welfare for African countries but with an amplitude of such an increase relatively weak.

Keywords: Trade, Agriculture, Regional Trade Agreement, Water.

Résumé

Cette thèse a pour but d'étudier certains déterminants du commerce international. Le premier chapitre analyse l'évolution des prix des exportations de vin français. L'analyse se base sur le modèle d'Hummels et Lugovskyy (2009) où deux effets de force opposées sont à l'oeuvre. D'une part, l'augmentation du niveau de vie conduit à une augmentation des prix (les consommateurs étant prêt à payer plus cher pour obtenir un bien plus proche de leur variété idéale). D'autre part, une plus grande concurrence, devrait réduire les prix (les profits potentiels attirant plus d'entreprises). Ces fondations théoriques sont confirmées par les résultats des estimations réalisées pour le marché du vin. Le second chapitre cherche à mettre en évidence si l'eau est un déterminant du commerce agricole. Pour estimer cet impact, nous construisons un nouvel indicateur nous permettant d'obtenir une meilleure approximation de l'eau disponible au sein d'un pays corrigé des caractéristiques locales ainsi que de celles liées aux produits. Puis, des simulations sur l'impact du changement climatique sur le commerce ont été réalisé, démontrant un effet négatif de ce dernier sur le commerce mais surtout de grandes inégalités entre les pays. Les chapitres 3 et 4 s'intéressent aux Accords Commerciaux Régionaux (ACR) comme déterminant du commerce pour les pays africains. En utilisant deux méthodologies différentes, nous estimons l'impact des ACR sur le commerce africain, pour lesquels peu d'études ont été réalisées. Le premier des deux chapitres quantifie l'impact de plusieurs accords (COMESA, SADC,...) sur le commerce. Le second poursuit l'analyse en se concentrant uniquement sur l'EAC. Les résultats indiquent qu'il y a bien une augmentation de bien-être pour ces pays mais que celle-ci reste faible.

Mots clés : Commerce, Agriculture, Accord Commerciaux Régionaux, Eau.

Remerciements

Tout d'abord, mes premiers remerciements s'adressent à mon directeur de thèse, Monsieur Fabien Candau, qui m'a encouragé sur la voie de la recherche académique depuis mon premier mémoire de recherche. Je lui suis très reconnaissante d'avoir assez cru en moi pour accepter de diriger cette thèse. Je le remercie pour son suivi, ses conseils, son aide mais également pour sa bonne humeur, son enthousiasme, son rire communicatif ainsi que pour sa patience (car il lui en a fallu). Autant de qualités précieuses qui ont été essentielles pour mener à terme cette thèse.

Je remercie également tous les membres du CATT, les enseignants pour le partage de leurs connaissances ainsi que de leurs expériences que ce soit dans le cadre de la recherche ou dans celui de l'enseignement. Je souhaite également remercier le personnel administratif pour leur aide, leur gentillesse et leur bienveillance face aux nombreuses questions sur le fonctionnement du laboratoire et de l'université.

A présent, je souhaite remercier mes amis et pour certains, collègues également. Tout d'abord, à Geoffroy et Charles, mes plus anciens compagnons dans cette aventure. Je leur suis très reconnaissante pour toute l'aide et les conseils qu'ils m'ont apportés. Je les remercie également pour leur bonne humeur communicative, ils ont été de merveilleux amis et cette thèse n'aurait pas été la même sans eux. Mille mercis à Idrissa, Kildine, Flavien et Ornella, qui savent toujours vous faire rire et vous remonter le moral même lorsque vous rencontrez des difficultés qui vous semblent insurmontables. A tous les autres doctorants, Tchapo, Marie, Camille, Mathilde, Oussama, Yassine, j'en oublie sûrement et je m'en excuse, un grand merci pour leur joie de vivre et leurs rires qui ont rythmé notre salle de documentation et qui donnent envie de venir travailler chaque matin.

A ma famille, mes parents, mes soeurs, Jennifer et Joy et mon frère, Coren-

tin, merci pour votre soutien, vos encouragements et votre compréhension durant toutes ces années. A Elodie, merci d'avoir été présente et de m'avoir soutenu tout au long de la thèse, tout simplement.

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Introduction

"*I see in the Free-trade principle that which shall act on the moral world as the principle of gravitation in the universe [...]. I have speculated, and probably dreamt, in the dim future—ay, a thousand years hence—I have speculated on what the effect of the triumph of this principle may be. I believe that the effect will be to change the face of the world, so as to introduce a system of government entirely distinct from that which now prevails. I believe that the desire and the motive for large and mighty empires; for gigantic armies and great navies [...] will die away; I believe that such things will cease to be necessary, or to be used, when man becomes one family, and freely exchanges the fruits of his labour with his brother man.* " Richard Cobden, Speeches on Questions of Public Policy. Vol.1 Free Trade and Finance, 1848

The emergence of Free Trade principle begun not thousand years as hoped by Richard Cobden, but only one century, with the ratification of General Agreement on Tariffs and Trade (GATT), on 30 October 1947. This agreement had the purpose to remove tariffs and to make trade easier between countries throughtout the World in the hope of preventing a new World War. Seventy two years later, trade liberalization is the "norm" for practically all countries in the World and since then, the GATT has changed considerably, as this agreement became an international institution gathering 160 countries with a regulatory framework in order to facilitate trade negociations. It resulted into an increase of the world trade of several orders of magnitude (from \$2.75 billions in 1947 to \$17 729 billions in 2017) in part supported by a substantial decrease of the average tariffs (15.58% in 1994 to only 5.17% twenty-three years later). Trade did not evolve solely quantitatively but also in the nature of such a trade. On one hand, commercial services grew at a very fast pace over the last forty years from $367 billions in 1980 to $5 280 billions in 2017 and production prcesses have taken an international dimension such that trade in intermediate goods account for an important share of the total trade. On the other hand, the international relationship have been modified with countries trading with more partners and concluding more trade agreements to boost their trade.

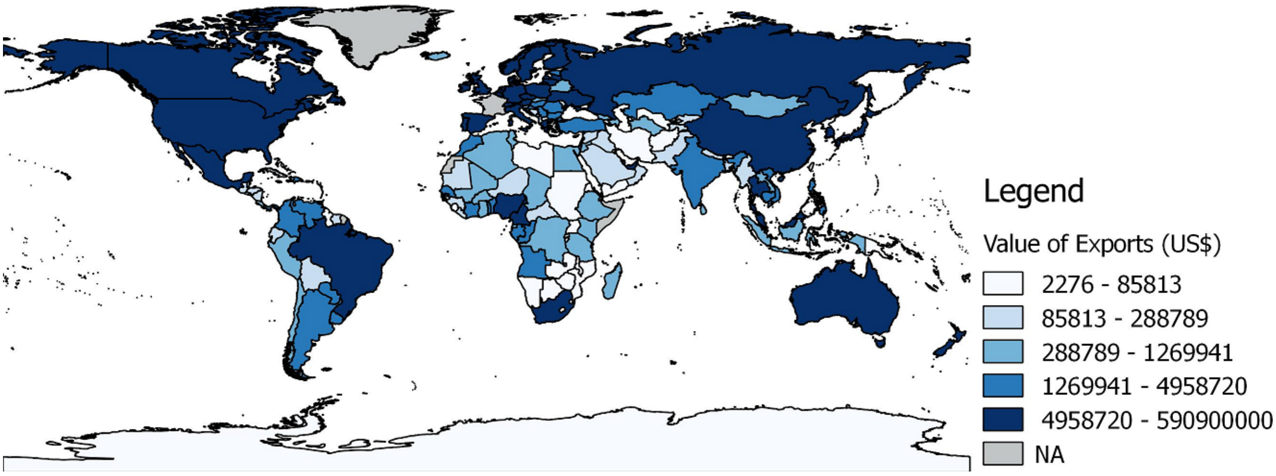
However, it is also clear that despite such efforts and promising evolution of international exchanges, trade barriers did not fully disappeared and the reality of international trade fall short of the speculation stated by Richard Cobden. In one way or another, some strategic sectors are still secluded from the international competition forces and trade wars are still periodically raging in some bilateral relations (e.g United States and China, with an increase of tariffs for some goods for both). In overall, the main stumbling block faced by advocates of a free international trade is that a constant decrease of trade barriers requires to exponentially increase the efforts of the interacting partners (the twenty year negociation between the European Union and the Mercosur to find a common ground and finally reach an agreement in June 2019 is a good exemple of such a challenging endeavor). As a consequence, the utopian perspective of a world being one family is fading away as it is not even close to be a village and increasing the freeness of exchanges may not always represent an optimal solution in term of welfare given the full cost of completely removing all the trade barriers. Yet, deciphering a potential optimal degree of integration is out of reach without a deep understanding of trade mechanisms which correspond to the underlying motivations of this dissertation.

By taking advantage of recent improvements within an extensive body of litterature, this dissertation attempts to get a better understanding of international trade relationship and its effect on welfare. At the core of our researches, lies the concept of international trade frictions with a particular focus on two of its most interesting empirical components. On one hand, a structural estimation of the gravity equation is being performed which allows to account for general equilibrium effects (Anderson (1979)) through the use of importer- and exporter-time fixed effects to capture multilateral resistances (Anderson and Van Wincoop (2003)) and the use of the Pseudo Poisson Maximum Likelihood estimator to account for the zeros flows and heteroskedasticity (which are pervasive issues in international trade data). On the other hand, we apply the New Quantitative Trade Model (NQTM) as used by Arkolakis et al. (2012), Costinot and Rodriguez-Clare (2014), Caliendo and Parro (2015) and (Mayer et al. (2019) to quantify the effects of trade policy on welfare in order to evaluate the effective impact of different counterfactuals. Such a framework provides a theoretical and empirical ground to study more in depth some issues related to international trade but too much often overlooked by the current researches.

In that respect, this thesis has for main goal to study the international trade by analyzing some determinants of the bilateral trade and is decomposed in four chapters. Firstly, we analyse the wine prices for French exports to determine what effect, between competition and income, predominate. Secondly, we examine water as a determinant of agricultural trade and what will be the impact of climate change on this resource and thus for agricultural trade. Finally, we analyze the impact of Regional Trade Agreement for African countries on trade and welfare. This topic is analyzed throught two chapters. A first chapter on several African agreement and a second, where we focus on a unique agreement, East African Community.

Wine Prices Analysis for French Exports

The French wine accounted for some 17 % of the world production and is the first agricultural sector. Exports make around 11 billions of US dollars in 2018 (data from COMTRADE), with a wide variety of partners. The figure (0.0.1) shows wine export destinations coming from France, in average over the period 2001-2011. Main destination markets are developed countries as United States for an amount of approximately 484 millions, Canada with about 155 millions and Australia with about 28 millions US dollars. A large part of exports focuses on the European Union members, among which United-Kingdom, Belgium and Germany are the largest markets with an export value of 590 millions, 337 millions and 268 millions of US dollars, respectively. However, even if these countries are not in the top of the ranking, it is interesting to note some of the destination markets where the France sells the most are emerging countries including three of the BRICS countries (China, Russia and Brazil).



Notes : Mean on the period 2001-2011. Author's calculation based on COMTRADE data.

Figure 0.0.1: French Wine Exports Map

The ranking of French wine's export destinations becomes slightly different when studying them in volume rather than in value. This is true in the case of Russia, this country moves from the position of the sixteenth largest destination market when we take exports in value to the fourth largest destination market with exports in volume over the period considered. These markets are developed countries with a high standard of living level or emerging countries where the standard of living level are increasing. This latter was significantly improved in BRICS countries, with an average annual growth rate of GDP per capita equals to 9.9%, 5.1% and 2.6%, respectively over the same period. These figures further rise for some countries if we remove the crisis period of 2008, to reach 9.9%, 6.4% and 3% over the period. These rates are particularly high in comparison with those of United States, Canada or Australia reaching only 0.8%, 1% and 1,6%, respectively. Some of the biggest markets are also closest neighbors of France such as Italy or Germany as reflected by the Figure (0.0.1). Once more, the average annual growth rate of GDP per capita is relatively low compared to emerging countries' rates with value of 0% and 1,6% for Italy and Germany. On the one hand, the increase in standard of living offers to consumers the opportunity to move closer to a product which is nearer to their ideal product. Then, these consumers are willing to pay more leading to an increase in wine prices by exports firms of this sector. On the other hand, the rise of wine prices will lead to new firms on these markets attracted by these potential gains. Then, the entry of those will influence negatively prices due to a greater competition. The purpose of Chapter 1, is to understand the evolution of wine prices throught prices of French wine exports. Previously, we presented mechanisms that might be at work. Which effects do dominate ? The income or competition effect ? We find that the two opposing effects have approximately the same order of magnitude, the income effect being only slightly higher than the competition effect on the period 2001-2011.

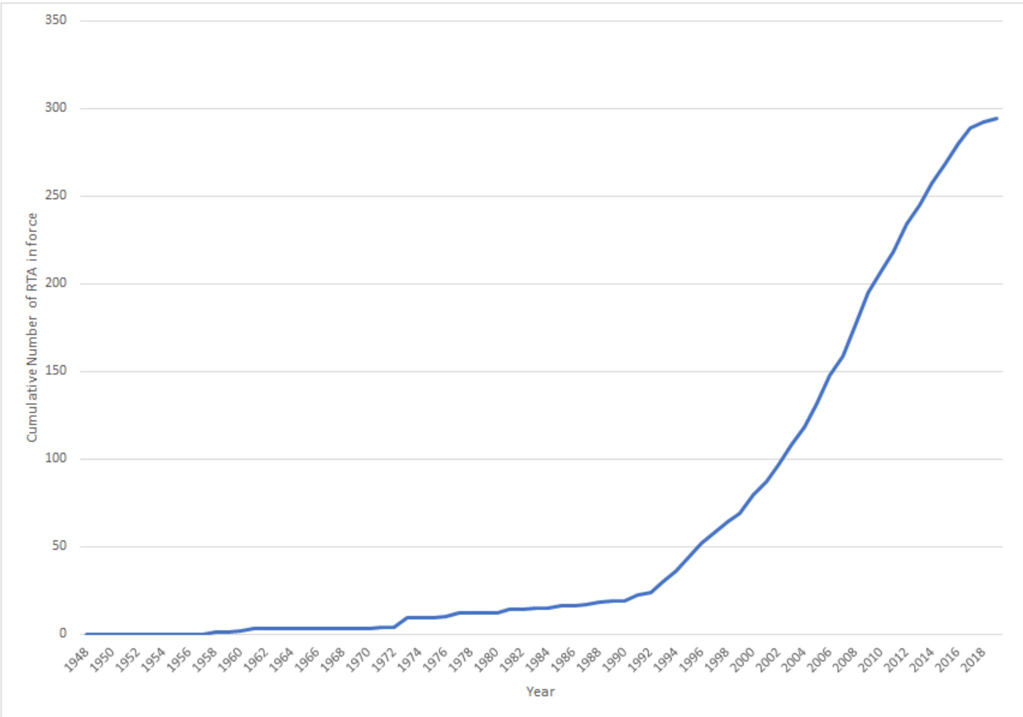
Water in International Agricultural Trade

In 2003, according to a review of the FAO about water resources, the total water ressources in the world is around 43 750 km^3/year which is shared as following across the world : 45% for America, 28% for Asia, 15.5% for Europe and 5% for Africa. Yet, within continent, it exists an important heterogenity between regions. For instance, the total resources is of 787, 6 709 and 12 380 km^3/year for Central America, Northern America and Southern America, respectively. These differences in water endowments should lead to heterogeneous productivities and thus, should shape the pattern of international trade of water intensive goods. Mekonnen and Hoekstra (2011a, 2011b and 2012) measured the contents of water in differents products (crops, biofuels or industrial products) and they also evaluate the water footprint of consumption and production by countries as well as in international flows. It exists a flourishing literature attempting to measure the relationship between water resources abundance and pattern of international trade of water intensive goods, (Debaere, 2014; Delbourg and Dinar, 2016; Fracasso, 2014). But no consensus has been found. The scarcity of water across the globe is already a concern in the present daysand will only increasewith the impact of climate change as highlithed by some World Bank reports. Indeed, according to their estimations the climate change leads to imbalances in meteorological conditions with an increase of climatic phenomenons. Some countries will suffer of these alterations in climate and the scarcity of water for some countries will be more important.

Regarding the second chapter, we focus on the water resources in the international trade of agricultural products. In order to measure the effect of water on trade, we construct a new indicator to measure water endowments in countries in taking into account local specificities rather than used aggregate water resources data. Data on hydrologic conditions have been collected and converted into a resolution of 30 arc-minutes scale which roughly represents a gridded pattern of squares averaging 50 kilometers sideways. Morethan, this indicator takes into account several sources of water (preciciptations, groundwater,...). The water requirements depend on the agricultural product. The product dimension is also integrated through the evapotranspiration for each agricultural product and climatic conditions. Indeed, the abundance of water resources is not sufficent to decide to produce. Other conditions are necessary to allow the production as temperatures, soil quality, the water requirements for the growing of crops. With such variables, our indicator better account for the effective availability of water resources than other indicators calculated so far.Our empirical strategy uses a gravity equation and this water indicator to estimate the impact of water resources on exports for 43 countries and 29 agricultural products. The inclusion of a large number of fixed effects allows to control of all others aspects (bilateral and individual). Whatever the specification, it seems the water endowments have a positive effect on flows for these products. An increase of 1% of the effective availability of the water resources increase the likelihood of exporting water intensive goods by 31.4%. This analysis is completed with the simulations of climate change impact on the trade. For this purpose, we use projections of temperatures, rainfalls, population and evapostranspiration to compute new values of our indicator. Given these values, we recalculate flows thanks to the previous estimations. While developed countries in the northern hemisphere would have a relatively small reduction (averaging the 10% decrease), countries close to the tropics may dramatically suffer from such changes as exportations may fall by approximatively 75% in numbers of these countries (with the Mozambique experiencing the highest decrease at 81.34% followed by Pakistan and Algeria).

African Regional Trade Agreements

Since the establishment of GATT in 1947, more Regional Trade Agreements (RTA) have been signed between countries. The Graph (0.0.2) depicting the cumulative number of RTAs put in place, highlights an explosive growth of RTAs from the 1990's (from a total number of 19 in 1990 to 79 ten years later and finally peak in 2019 at a total number of 294 RTAs signed and active). However, all these agreements are not always equivalent , with some of them focusing on goods or services, while others are including sanitary and phytosanitary rules and the number of members and the scope can drastically vary between agreements. In fact, this graph does not help to distinguish the type of agreements, namely if an agreement is a Free Trade Agreement (FTA) as NAFTA, a customs union as East African Community (EAC) or a common market as MERCOSUR.



Notes : Author's calculation based on data of World Trade Organization.

Figure 0.0.2: Historical Evolution of RTA Number

As early as the 1950's, first concerns about this subject has begun with Viner

(1950) who developed the concept of creation and diversion trade. He brought out that the implementation of customs union between countries should generate a change in trading flows between these countries. However, the effects in terms of welfare are ambiguous. Considering that a new agreement reduces tariffs between members, these countries tend to trade between them because they become more attractive relatively to countries outside of the agreement: there is trade creation between members. On the other hand, there is trade diversion because the trade is diverted from the rest of the World to a member of agreement due to the decrease in tariffs. Without this reduction, the rest of the World will be more attractive offering lower cost. The impact of RTAs on welfare divides the economists as far as the theoritical literature suggesting RTAs can have positive or negative effects, depending on the country (Panagariya (2000)). Numerous works have measured these effects concerning different agreements (free trade area, customs union, common market) or different geographic localisation (Latin America, Asia, North America, Africa and Europe). The analysis of RTAs has often exploited gravity equations in order to estimate if the RTA is a determinant of trade as well as to evaluate the creation and diversion trade effects. A recent part of the literature uses New Quantitative Trade Model (NQTM) to evaluate the impact of trade policies on the welfare as Caliendo et Parro (2015) or Arkolakis et al. (2012). Mayer et al. (2019) used this kind of model to perform a counterfactual on the cost for the European countries do not create the European Union. Other works on the RTAs have been achieved, as Caliendo and Parro (2015) who applied multi-country, multi-sector, intermediate goods and input-output linkages to quantify the NAFTA's impact on members and with the Rest of the World. According to them, the inclusion of intermediate goods is considerable, because a significant part of the trade between United States, Canada and Mexico is trade in intermediate goods.

In the chapter 3, we analyze the trade creation effects for a large panel of African countries.[1] This chapter focuses on African trade, we investigate the African RTAs impact in two steps. Firstly, with a gravity equation and fixed effects, we study the impact of different agreements on trade in terms of trade creation. We consider their evolution with a database covering a large period (1965-2014). During this

[1]COMESA, SADC, EAC, ECOWAS, WAEMU, CEMAC and SACU.

period, several changes occured, some Free Trade Agreements turn into deeper agreements as customs unions, for instance. Morethan, the number of members changed too, with some of them integrating or leaving the agreements. Our study takes into account these changes. The main results of this part shows that there is an increasing trade in African following the implementation of these RTAs (an increase by 95 % on whole period). Then, we perform an estimation distinguishing each African agreements, and find that the effects of creation may vary substantially according to the agreement. In the second step, we apply the Mayer et al. (2019) methodology to quantify the welfare impact on the African countries. The counterfactual exercise consists of a simulation of non creation of these agreements to measure their influence. Focusing on three agreements (ECOWAS, SADC et COMESA), this second step highlights some elements. The existence of these RTAs reduced trade frictions and increased the trade between members in the area. Actually, SADC members recorded a decrease by 69% of trade frictions and some countries as Madagascar increases his imports by 30% thanks to the creation of this agreement. Gains are positive for each countries and each RTAs but two points have to be discussed. Firstly, these gains differ depending on agreements, with higher gains for ECOWAS or SADC. It also appears an important gap between members inside of areas. Within COMESA, Burundi welfare grows by 5% while Malawi welfare increases only by 0.1%.

The last chapter focuses on the analysis of the Eastern African Community (EAC). Mayer and Thoenig (2016) has already studied this RTA with the Mayer et al. (2019)'s methodology previously presented and use results of RTA's coefficient and previous work (Martin et al. (2008)) to evaluate the probabilities of civil conflicts between members and with non members. Applying Caliendo and Parro (2015) model, we improve this analysis concerning the effect of the EAC on trade. The model is a multi-country, multi-sector model taking into account the input-output linkages and intermediate goods, then we obtain results at the agregate level and at the sector level. Morethan, this model allows us to integrate explicitly the tariffs changes which are a large part of the RTAs to perform the counterfactual exercise. To the contrary, the methodology of Mayer et al. (2019) used on trade costs estimations of the agreement throught the gravity equations to resolve the model. We used the model to determine the effect of this agreement on the welfare for these African countries. In this purpose, we get applied tariffs data before and after the signature of EAC to simulate the creation of this agreement. We take trade deficit into consideration in the analysis. All results can be decomposed in terms of trade and in volume. Welfare effects for members are low, coming from the terms of trade's deterioration and very large trade diversion effects. Only two countries among the EAC benefit of increase in welfare, Rwanda and Kenya.

Chapter 1

Chapter 1

Income and Crowding Effects on the World Market for French Wines

1.1 Introduction

What is the impact of per capita GDP growth on prices?[1] On one hand, richer agents are more willing to pay high prices, but on the other hand richer markets attract more companies and this new competition can reduce prices. What is the net impact? Do firms generally set higher prices on richer markets?

These questions are both significant and controversial in terms of international economics. In standard models of monopolistic competition with homothetic preferences (e.g. Krugman, 1980), the law of one price is verified ; markups, prices and the elasticity of demand are invariant to competition and income. The price of one type of goods differs between countries because of trade costs or preferences. In models with strategic interactions along a finite product space (e.g. Lancaster, 1979), more firms entering the market causes a "crowding effect", varieties become more substitutable and the price elasticity of demand, although invariant to income, increases with market size (i.e. competition). The empirical interpretation of this result is that the elasticities of the demand would be identical in rich and poor countries once we control for competition. The same result is obtained in

[1]We present here a longer version of our published paper (Candau, Deisting and Schlick, 2017)

models with heterogeneous firms and quasi-linear preferences (e.g. Melitz and Ottaviano, 2008). In contrast, by extending the Lancasterian approach, Hummels and Lugovskyy (2009) propose a model where per capita GDP growth attracts more sellers, leads to more competition and forces firms to set lower prices. This result has been challenged by Simonovska (2015), both by proposing a new model[2] and also by controlling for transport costs in her empirical analysis. The fact of disregarding logistics companies, that apply lower transport costs to both richer and larger markets (according to economies of scale, competition) can bias the result. By working with 245 identical products sold exclusively on the Internet and by taking into account shipping prices, Simonovska (2015) finds that firms set higher prices for identical goods in richer destinations but are not influenced by the market size.

This chapter pursues this line of research with two goals, the former is to use insight from this existing literature to analyse the wine market, the latter is to use the wine market to test competing models of international economics. We use a unique dataset for 2001–2011 that reports bilateral export prices for French producers selling to all importers worldwide. The panel data structure makes it possible to identify price levels that are specific to an importer-product (taste, culture, etc) and price changes that are specific to an exporter-product (quality, etc)[3], relating changes in prices over-time for an importer/exporter-product to changes in importer characteristics. While the Lancasterian approach has been applied in many hedonist studies on wine characteristics[4], its extension by Hummels and

[2]Simonovska (2015) proposes a model with non-homothetic preferences from a hierarchic-choice of consumption (Jackson, 1984). In this model where the marginal utility is bounded (consumers may have zero demand for some varieties, see also Sauré, 2012), the relative price of a variety is higher in relatively richer markets which contradicts Hummels and Lugovskyy's (2009) results.

[3]The current paper is not interested in vertical differentiation i.e. we wish to control for the high price of wine on richer market due to the fact that rich importers demand goods of high quality. See Verhoogen (2008) and Fajgelbaum et al. (2011) for models of international trade focusing on product quality and more particularly Crozet, Head and Mayer (2012) on Champagne wine. See also Di Comite, Thisse and Vandenbussche (2014) for a model of vertical and horizontal differentiation applied to the beer sector.

[4]For instance to quote just a few contributions (see Cardebat, Figuet and Paroissien (2014) for a review), Nerlove (1995) discusses the standard hedonic price equation to study preferences of Swedish wine consumers, Combris, Lecocq and Visser (1997) apply this method to Bordeaux wines to analyze the impact of sensory characteristics (provided by a jury under blind tasting conditions) on prices, and Roma, Di Martino and Perrone (2013) use this method to explain

Lugovskyy (2009) to analyse international wine trade has, to our knowledge, never been carried out. In comparison to the wine economics literature that distinguishes the importance of various characteristics mainly in terms of supply,[5] here we focus on determinants of demand. We confirm Hummels and Lugovskyy's (2009) conclusion[6] by finding that the price elasticity of demand is influenced by GDP per capita as well as importer GDP, contrasting with standard results based on monopolistic competition with homothetic preferences.[7] The market size, approximated by importer GDP, has a negative effect on the price differential as well as on export share revealing a competition effect on external markets for French producers.

While our data does not enable us to control for shipping costs as in Simonovska (2015), we know the means of transport which allows trade flows to be separated and to be analyzed in detail in order to reconcile standard models with the data. We show that a standard gravity equation performs poorly for the wine sector. However, we find that a more precise specification of trade costs helps to improve this performance. Imitating pro-competitive effects, it is possible that shipping prices react to change in market size. This change is due to economies (or diseconomies) of scale in transportation. With endogenous trade costs, an increase in income per-capita has a stronger impact on trade of high quality wines which are exchanged under modes of transport with high economies of scale. We quantify to which degree wines exported by water and land benefit from a smaller income effect than wine exported by air. To our knowledge, such an analysis of export

the price of Sicilian wines.

[5]Ashenfelter (2008) updates its "Bordeaux wines equation" where prices are explained by weather conditions, wine age and expert judgments. See Storchmann (2011) for a survey on Ashenfelter's works and on recent developments in wine economics. Furthermore, by using data on endowments (e.g. soil qualities, weather conditions) as well as data on technology (such as manual operations e.g. picking and selecting grapes, the process of bottling wines, etc), Gergaud and Ginsburgh (2008) succeed in discriminating between determinants of quality (by using instrumental variables) in favor of technology.

[6]Hummels and Lugovskyy (2009, Table 2, p.16) test their predictions for thirty-eight 2-digit industries, including HS-code 22, "beverages, spirits and vinegar", which includes wine.

[7]The most recent work in wine economics with CES preferences and monopolistic competition between heterogeneous firms is Crozet, Head and Mayer (2012). By working on Champagne wine, they rightly justify the CES assumption by emphasizing that (in contrast to other wines studied here), producers blend several years of grapes to reproduce a constant quality over time.

linked to transport has never been studied in wine economics.

This chapter is divided into five parts. Firstly, we provide motivation for this study and we present the Hummels and Lugovskyy (2009) model. Secondly, a brief presentation of our database, thirdly the empirical results applying the Hummels and Lugovskyy (2009) methodology to the wine sector. The fourth part analyses alternative models and investigates the role of (dis)economies of scale in wine transport. Our conclusion is the final part.

1.2 Literature

1.2.1 Motivations

According to Maddison's data, between 1980 and 2008 the ratio of Indian output per head to that of the US has increased from 5 to 10 %, while China's rose from 6 to 22 %. Even if this great convergence is fragile and has been weakened by the financial crisis of 2008, it has lead to the emergence of a middle class in developing countries with consumer behavior similar to the developed countries standard. The consumption of meat and wine has thus increased sharply in Asian countries. This is explained by the fact that these are luxury goods and also by the westernization of consumer behavior patterns. Omura, Sakurai and Ebihara (2013) for instance show how wine consumption has been gaining place in the daily life of the Japanese since the seventies. China would appear to be following the same path according to the surge in wine imports. Income effects by increasing the expenditure on wine seems to be an important determinant. According to Muhammad et al. (2014), French wines are those which benefited the most from this rise in demand.

In addition to this process of convergence between certain nations, the share of total income going to top income groups has risen dramatically in recent decades in many countries (Atkinson, Piketty and Saez, 2011). The top decile share has surged since the 1970s, and the share of an even wealthier group, the top 1 percent, has increased even more. The top 1% in the national distribution of income has for instance benefited from a 30% growth of their revenue in a very short period of time in China (in the period 2001-2003). Earnings of the top 1% in Australia have also increased strongly and even countries like Sweden had an increase of 21%. Such a rise in the concentration of wealth is particularly important for the wine sector as pointed out by Dimson, Rousseau, and Spaenjers (2015) who wrote that "among wealthy individuals, fine wine is a mainstream investment". For instance Barclays (2012) reports that wine represents 2% of the wealth of about one quarter of high-net-worth individuals around the world that owns a wine collection.

French wine has dominated the market, but could encounter a rise in competition to a similar degree as what has been observed in the past in other markets. Indeed, while French (and Italian) wines were leaders at the world level, the 90s was the period when producers in the U.S., in Australia and also in Chile, South Africa, Argentina and New Zealand have increasingly gained market share (see Morrison and Botticelli (2013) for more details).

Given the three elements impacting the wine industry; the increase of the market size due to more demand in emerging markets, the emergence of a growing class of very rich people, the increase in competition, one proposes to use Hummels and Lugoskyy's (2009) model of international trade.

1.2.2 Generalized Model of Ideal Variety (GMIV)

According to Hummels and Lugovskyy (2009) two opposed effects related to income and income per-capita are crucial to analyse trade elasticities.

On the one hand, a rise of income generates more demand and the entry of new varieties, leading to more competition between firms which set lower mark-ups to stay in the market. Ceteris paribus, there are low prices in large markets.

On the other hand, consumers are increasingly finicky regarding the gap between current consumption and the ideal variety when consumption of a typical variety increases. Consequently, when individuals are richer, they value more the consumption of a variety that is close to the ideal. This behavior allows firms to set higher prices. Everything else equal (in particular market size), firms set higher prices when consumers are richer. But in opposition to this effect, rising income per-capita also increases the aggregate income, and thus also generates the market size effect presented previously. In short, while the market size effect generates a pro-competitive effect increasing the price elasticity, the effect of rising income per worker reduces this elasticity. More precisely the conclusion of Hummels and Lugovskyy (2009, Equation 20 and 21 p.11) can be summed up by:

$$\frac{\partial\varepsilon/\varepsilon}{\partial(Y/L)/(Y/L)} = \underbrace{\frac{\partial\varepsilon/\varepsilon}{\partial Y/Y}}_{Competion\,Effect} - \underbrace{\frac{\psi}{\gamma}\frac{\partial\varepsilon/\varepsilon}{\partial Y/Y}}_{Income\,Effect} \tag{1.2.1}$$

where Y represents GDP and L population. As explained above, authors prove that the competition effect (GDP growth) involves an increase in the price elasticity of the demand by demonstrating that:

$$\frac{\partial\varepsilon/\varepsilon}{\partial Y/Y} \in [0,1] \tag{1.2.2}$$

Because the *increase* in the price elasticity of demand leads to a *decrease* in the equilibrium price (see Equation (A.0.1) in Appendix A.1), this means that the competion effect has a negative impact on price. Lastly by using the inequality $\psi/\gamma < 1$ (verified by definition) it is demonstrated by simple inspection of (1.2.1) and (1.2.2) that:

$$\frac{\partial\varepsilon/\varepsilon}{\partial(Y/L)/(Y/L)} \in [0,1]$$

Thus the *total effect* of per capita GDP growth on price elasticity is *positive*. However a look at Equation (1.2.1) indicates that the same variation *conditioned* to market size (competition effect) has a *negative* impact on the elasticity and thus a *positive* impact on price (see again Equation, A.0.1). This is very important for the empirical analysis, because it implies that once we control for GDP, the remaining effect of per capita GDP growth should lead to an *increase* in price.

1.2.3 Empirical analysis of Hummels and Lugovskyy

To test their model, Hummels and Lugovskyy (2009) propose the following equation:

$$\ln \frac{p^k_{ij,t}}{p^k_{ij,t-1}} = a_0 + a_1 \ln \frac{Y_{i,t}}{Y_{i,t-1}} + a_2 \ln \frac{Y_{i,t}/L_{i,t}}{Y_{i,t-1}/L_{i,t-1}} + \epsilon^k_{ij,t}. \tag{1.2.3}$$

As a proxy for prices they use unit values of bilateral export from the Eurostat Database using years 1990 and 2003 (i.e. *t=2003*, *t-1=1990*). They expect three results 1) a negative coefficient $\widehat{a_1}$ to validate that the market size reduces price due to competition effect increasing price elasticity (see 1.2.2); 2) a positive coefficient $\widehat{a_2}$ to validate that, conditioning on market size, a rise in GDP per capita increases price due to the income effect that reduces price elasticity (see 1.2.1); 3) the sum of coefficients $\widehat{a_1}+\widehat{a_2}$ should be negative to verify that the total effect of per capita GDP growth on price elasticity is positive.

Hummels and Lugovskyy (2009) verify result 1 ($\hat{a}_1 < 0$) and 2 ($\hat{a}_2 > 0$) but not result 3 ($\hat{a}_1 + \hat{a}_2 > 0$).

1.3 Data and preliminary results

1.3.1 Data description

Our data set on wine exports comes from the Single Administration Declarations (SAD) concerning the period 2001-2011, collected by the French customs and assembled by INSEE. The monthly database reports wine exports, mode of transport, exporters on each market at the 8-digit Harmonized System. Such a large database of French wine has never been used up to now.[8] This database contains the SIREN number that allows each exporter to be identified (address and economic features of each unit). We match this database with the SIREN register and we only retain firms found under the label "culture" that includes wine producers. The value and volume of each product are reported monthly, we compute the sum

[8]Many articles work on particular wines, e.g. Crozet et al. 2012 on Champagne (and red Burgundy as a robustness check), and do not take into account mode of transportation.

annually, by product, exporter and destination market. This database also contains information concerning the mode of transport. More precisely we know at the individual level and for each destination market if the wine has been exported by plane, boat, road, rail, river, postal services or by private mode.[9] Road was the dominant mode of transport prior to 2009, but while this mode of transport is stable, transport by boat has more than doubled during the period, both in value and in volume, now representing the main mode of transport. This rise can certainly be explained in part by decreasing shipping costs but it can also reflect changes in the destination market. Export by plane has sharply increased, particularly in terms of value. For instance the value of red Bordeaux wines exported by plane has soared to represent 10 times more than in 2001. In contrast the volume of Bordeaux exported by plane has been constant, revealing a striking increase of the unit value of this wine that cannot simply be explained by an increase of quality. Moreover this average increases in the value of wine, masks contrasting price setting in destination markets. Figure (1.3.1) plots exports of red Bordeaux in value with respect to GDP per capita of countries where this wine is sold for two different years. Whatever the year considered, a positive correlation can be observed. The cross-country variation in price seems to be related to GDP per capita. But if we now analyse over-time changes in prices for a particular importer to changes in its GDP per capita, very different results can be observed. The price of wine sold in China has strongly increased between 2001 and 2011, while in Brazil, a country with also a strong growth in term of GDP per capita, the value of Bordeaux wine exported has stagnated. In Argentina, a country that has grown over that period to become the fifth world wine producer, the nominal exportation of Bordeaux has even declined.

[9]Rivers, postal and private modes are marginal.

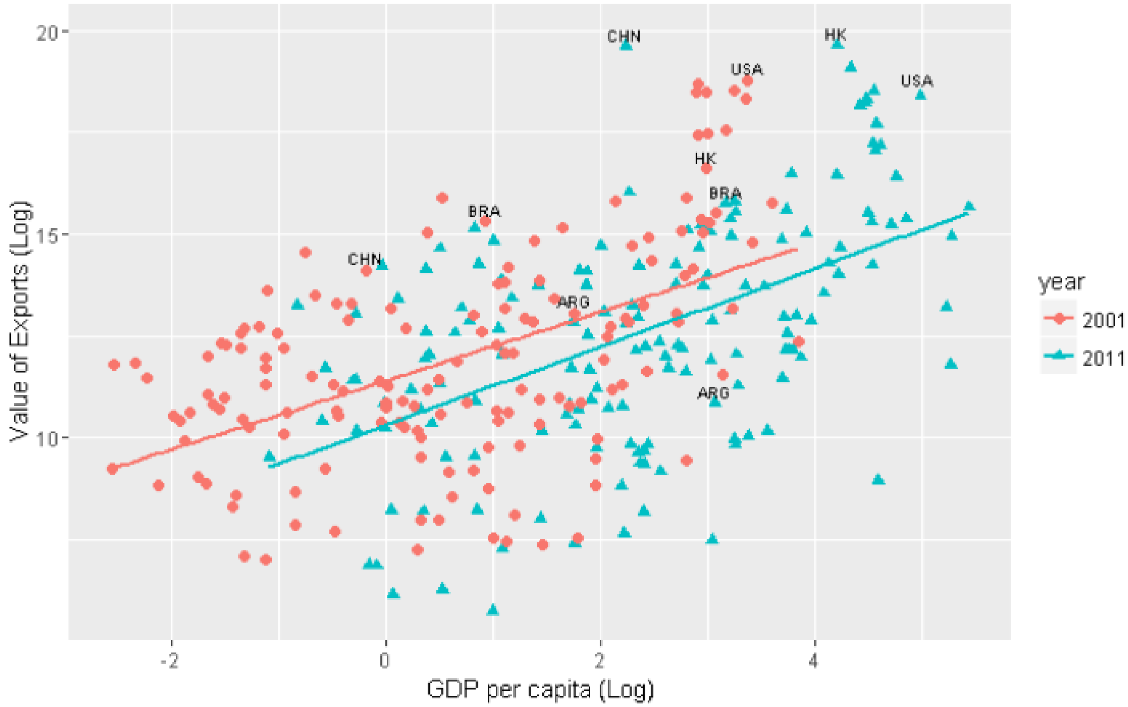


Figure 1.3.1: Bordeaux wine (exported by air) and GDP per capita

1.3.2 Results of Generalized Model of Ideal Variety (GMIV)

The index *Fine Wine 1000* (representing 80% of the world wine market by price) increased two and a half fold between 2001 and 2010 is now stable at around 4 billion dollars (Millar, 2014). Income effect and competition may explain this result. Chevet, Lecocq and Visser (2011) certainly have in mind the former effect when they write that "the sky-high price paid for the 2009 vintage can in large part be attributed to increased wine demand from Asia (China in particular)". However such a claim is not investigated in detail in Chevet et al. (2011) who focuse on the impact of weather conditions on historical price data. In order to analyse these effects, we follow the empirical analysis that Hummels and Lugovskyy (2009) have proposed to test their Generalized Model of Ideal Variety (GMIV).

According to the GMIV model, two opposing effects related to income and income per-capita are crucial to the analysis of trade elasticities. On one hand, a rise of income generates more demand and the entry of new varieties. This leads to more competition between firms which proceed to set lower mark-ups in order to stay in the market. *Ceteris paribus*, there are lower prices in larger markets.

On the other hand, consumers are increasingly "finicky" regarding the gap between current consumption and the ideal variety when consumption of a typical variety increases. Consequently, the richer the consumer, the more they appreciate value of a variety that is close to the ideal. This reaction allows firms to set higher prices. Everything else been equal (in particular market size), firms set higher prices when consumers are richer. While the market size generates a pro-competitive increasing the price elasticity, rising income per worker reduces this elasticity.

To capture these opposed effects in the wine sector we consider that changes in the price set by a French producer j on a product k in the country i at time t depends on destination GDP and GDP per capita:

$$\ln \frac{p^k_{ij,t}}{p^k_{ij,t-1}} = a_0 + a_1 \ln \frac{Y_{i,t}}{Y_{i,t-1}} + a_2 \ln \frac{Y_{i,t}/L_{i,t}}{Y_{i,t-1}/L_{i,t-1}} + f_j + f_k + \epsilon^k_{ij,t}. \quad (1.3.1)$$

where Y_i measures the market size of the partner country i, approximated by GDP, and $L_{i,t}$ the population (GDP and population come from the WDI database). A negative coefficient $\widehat{a_1}$ is expected to confirm that the market size reduces price due to a competition effect that increases price elasticity. In contrast, a positive coefficient $\widehat{a_2}$ confirms that, conditioning on market size, a rise in GDP per capita increases prices due to the income effect (that reduces price elasticity). Fixed effects at the product and firm level are introduced to control for cost and quality variations. We do not introduce destination fixed effects which would control for variations that are specific to importers. These effects can capture the effect of economic growth of partners that we aim to measure. In other words, we exploit cross-importer variation to assess the income and competition effect.

Table (1.1) reports results. Column 1 explains price growth over the whole period by only using extrema of the period, i.e. years 2001 and 2011. Column 2 uses price differential yearly (2011-2010, 2010-2009, and so on). Year fixed effects are introduced for estimations reported in the last Column.

Dep var:	Price differential (using years 2001 and 2011)	Yearly price differential (2001-2011)
Income effect (GDP per capita)	1.13^b	0.55^a
	(0.498)	(0.160)
Competition effect (GDP)	-1.10^b	-0.49^a
	(0.481)	(0.158)
Year fixed effect	No	Yes
Product fixed effect	Yes	Yes
Firm fixed effect	Yes	Yes
R-square	0.587	0.091
Obs	3281	106508

Notes : ^{abc} denote significance at the 1, 5 and 10 percent level respectively.

Estimations performed with OLS estimator with RSE in brackets. All variables are in Log.

We include fixed effects on firms and products in Column 1 and on firms, products and years in Column 2.

Table 1.1: Price regressions of French wines, 2001-2011

Whatever the period considered, Table (1.1) supports the conclusion of the GMIV. Income per capita fosters prices, while market size impacts negatively on the price differential. Using exporters and product fixed effects and exploiting time series variation in importer characteristics, we find that prices fell with importer GDP growth but rose with importer GDP per capita. A 1% increase in GDP per-capita generated an increase in price of 1.13% between 2001 and 2011, while a 1% increase in market size reduced prices by 1.10% over the same period. In Appendix A.2 we show that these results hold at a more disaggregated level (i.e. at the French regional level distinguishing wines by reputation). Many other robustness checks here have been performed, including changes in variables capturing the income and market size effect.[10] The model seems more appropriate for a long term analysis than a short period of time, explaining almost 60% of the average price variations between 2001 and 2011, while only 10% per year on average.

[10]For instance, following Simonovska (2015) we have also used population instead of GDP. While this variable is not significant in her analysis we find a coefficient of -0.743 significant at 1%.

1.4 Competing theories

The previous result illustrates that the main predictions of the GMIV models are verified for the wine sector. Here we go beyond this first step to discriminate between this model and more standard models of international trade. To illustrate this we consider the gravity equation proposed by Markusen (2010) (see also Frankel, Stein and Wei, 1998):

$$x_{ij}^k = (Y_j Y_i)^\alpha \left(\frac{Y_j}{L_j}\frac{Y_i}{L_i}\right)^\beta \frac{\tau_{ij}^{1-\sigma}}{P_i P_j}. \tag{1.4.1}$$

Where Y_i and Y_j are incomes (GDPs), L_i and L_j are the populations in i and j, P_i and P_j are price indices, τ_{ij} represents bilateral trade costs and σ is the elasticity of substitution between two varieties. With $\alpha = 1$ and $\beta = 0$ the gravity equation is similar to the one obtained in Anderson and van Wincoop (2003) and Krugman (1980), there is no income effect. In contrast with $\beta \neq 0$, luxury and inferior goods can be analysed.

To discriminate between this general equation and the prediction of the GMIV, we simply have to use this formula to compute imports of the rest of the world from j, i.e. x_{rj}^k:

$$x_{rj}^k = (Y_j Y_r)^\alpha \left(\frac{Y_j}{L_j}\frac{Y_r}{L_r}\right)^\beta \frac{\tau_{rj}^{1-\sigma}}{P_r P_j}$$

and we use this expression to consider the share of i's import from j on import of the rest of the world, r from country j, taking the logarithm of this share finally gives after rearrangement:

$$\ln s_{ij}^k \equiv \ln \frac{x_{ij}^k}{x_{rj}^k} = (1-\sigma)\ln \tau_{ij} + \ln \frac{Y_i^{\alpha+\beta}}{P_i L_i^\beta} + \ln \frac{P_r L_r^\beta}{Y_r^{\alpha+\beta}} \tau_{rj}^{\sigma-1} \tag{1.4.2}$$

The interesting fact of this computation is that all the variables specific to French producers have been eliminated. Moreover, by using partner-product fixed effects, denoted by f_i^k, we can capture specific characteristics of importers (GDP per capita, price index, etc). In short, taking the logarithm of (1.4.2) using (1.4.1) allows the following equation to be estimated:

$$\ln(s_{ij}^k) = (1 - \sigma)\ln(\tau_{ij}) + f_i^k + \epsilon_{ij}^k \quad (1.4.3)$$

The only variables that explain s_{ij}^k are trade costs τ_{ij} approximated by bilateral distance d_{ij}. This result contrasts with the GMIV model, where the distance to the market depends on the number of competitors, which itself varies according to GDP and GDP per-capita. Thus, by introducing distance in interaction with other variables, Hummels and Lugovskyy (2009) obtain what they call "a test of the CES null hypothesis":

$$\ln s_{ij,t}^k = a_0 + a_1 \ln d_{ij} + a_2 \ln d_{ij} \ln(Y_{i,t}) + a_3 \ln d_{ij} \ln(Y_{i,t}/L_{i,t}) + f_i^k + \epsilon_{ij,t}^k. \quad (1.4.4)$$

To validate the CES model (and also other models where GDP per-capita enters in a multiplicative form as we have shown), only the coefficient of distance should be significant (with $a_2 = a_3 = 0$ Equation (1.4.2) is reduced to Equation (1.4.3) obtained from the general gravity equation).

They find that $\widehat{a_2} < 0$ and $\widehat{a_3} > 0$ are statistically significant, which validates their model. We use this methodology on our database. Geographical distance between countries is taken from the CEPII database. Table (1.2) illustrates results. Column 1 is the benchmark with similar independent variables to those used in the previous section (GDP and GDP per capita) in interaction with distance.

To validate the CES model, distance must be the only significant coefficient, which is clearly not the case here. These results disqualify the CES assumption used with a simple model of monopolistic competition.[11] Interactions between distance, market size and GDP per capita are essential in order to explain the share of wine exported as predicted by the GMIV model.

As a robustness check we have also used alternative measures of GDP per capita taking into account the income effect (Column 2 and 3). We have chosen in particular the top income shares (top 10% and top 1%) from the World Top Incomes Database[12], to identify how exportations evolved in richer markets. This variable

[11] This does not disqualify CES preferences used with more sophisticated models of monopolistic competition, in particular those using heterogeneous firms.

[12] Alvaredo, Facundo, Anthony B. Atkinson, Thomas Piketty and Emmanuel Saez, The World

Dep var:	Share of trade				
Distance	-1.004[a]	-1.115[a]	-0.938[a]	-1.580[a]	-0.054[a]
	(0.011)	(0.026)	(0.019)	(0.135)	(0.015)
GDP*Distance	0.032[a]	0.037[a]	0.031[a]		
	(0.000)	(0.001)	(0.001)		
GDP per capita*Distance	0.010[a]				0.020[a]
	(0.001)				(0.001)
Income share of top 10%*Distance		0.797[a]		0.474[a]	
		(0.069)		(0.037)	
Income share of top 1%*Distance			0.710[a]		
			(0.019)		
Production*Distance				-0.018[a]	-0.002[a]
				(0.002)	(0.000)
R-square	0.368	0.386	0.388	0.572	0.328
Obs	203 375	111 383	113 383	8 751	67 489

Notes :[a b c] denote significance at the 1, 5 and 10 percent level respectively. Estimations performed with OLS estimator (RSE in brackets) including year, firms and product-fixed effects.

Table 1.2: Share of trade and wealth

seems more appropriate than GDP per capita for countries like China where consumption and investment[13] in wine are concentrated at the top of the distribution. Results obtained with top income shares in Column 2 and 3 of Table (1.2) confirm results obtained with GDP per capita and thus provide additional evidence supporting the GMIV model predictions. Using other variables (based incomes instead of shares) we obtained similar results.[14] Lastly Column 4 and 5 use the production of wine in the destination market to test the robustness of our result regarding the competition effect. One more time, the interaction with distance is significative.

Top Incomes Database, http://topincomes.g-mond.parisschoolofeconomics.eu/

[13]Dimson, Rousseau, and Spaenjers (2015) for instance wrote that “among wealthy individuals, fine wine is a mainstream investment” and Barclays (2012) reports that wine represents 2% of the wealth of about one quarter of high-net-worth individuals around the world that owns a wine collection.

[14]One can observe that measure of income inequalities are related to the GMIV model, for instance Bekkers, Francois and Manchin (2012) generalize even more the Lancaster model by considering that the compensation function does not depend only on the consumption of the variety (as Hummels and Lugovskyy, 2009) but on total consumption. Then they demonstrate that the elasticity of trade decreases with an Atkinson index of income inequality.

1.5 Non-homothetic preferences and trade costs

Surprisingly the GMIV has a better predictive power than alternative models based on the widely-used standard/powerful gravity equation (1.4.1). Consequently we return to this equation and after rearrangement and by taking the log of (1.4.1) we obtain the following expression:

$$\ln\left(x_{ij}^{k}\right) = (\alpha+\beta)\ln\left(Y_j Y_i\right) - \beta\ln\left(L_j L_i\right) + (1-\sigma)\ln\left(\tau_{ij}\right) + \ln\left(P_i P_j\right). \quad (1.5.1)$$

From this we estimate the following equation by separating wines exported by air, water and land:

$$\ln\left(x_{ij,t}^{k}\right) = a_1\ln\left(Y_{j,t}Y_{i,t}\right) + a_2\ln\left(L_{j,t}L_{i,t}\right) + a_3\ln\left(\tau_{ijt}\right) + a_4\ln\left(P_{it}P_{jt}\right) + \epsilon_{ijt}^{k} \quad (1.5.2)$$

We expect to obtain support for non-homothetic preferences with a positive impact of GDP per capita for wine exported by air. These wines may be of better quality than wine exported via other transport systems and consequently may be more sensitive to GDP per capita. The crucial coefficient is that of population; indeed with a negative sign, $\widehat{a_2} < 0$ we verify that $\beta > 0$ and thus the gravity equation (1.4.1) with GDP per capita influencing positively export.

To control for price index, we refer to a wide range of literature using consumer price indices (e.g. Bergstrand 1989, Baldwin and Taglioni 2014). We carried many robustness checks concerning this last variable.[15]

[15] Anderson and van Wincoop (2003) as well as Baldwin and Taglioni (2007) recommended the setting of partner fixed effects to control for price index and to obtain an unbiased coefficient of *distance* (and border effects). These fixed effects have been used here and provide similar results to consumer price index. However, because our main interest lies in GDP and population (and not in dyadic variables such as distance) it seems logical to take out these fixed effects. This is also the empirical strategy adopted by Baldwin and Taglioni (2014) who write: 'If the econometrician is only interested in estimating the impact of a pair-specific variable – such as distance or tariffs – the standard solution is to put in time-varying country-specific fixed effects. [...] Plainly we cannot use this approach to investigate the impact of using GDPs as the economic mass proxies'. We have also conducted estimations with different functional forms such as: 1) all variables concerning France (including price index) reported on the right hand side of the gravity equation (a trade adjusted measure)

Furthermore, estimating the gravity equation by type of transport allows us to partially treat heterogeneity in terms of both products and destination markets. A selection effect linked to distance and to product quality certainly leads to the choice of one mode of transportation over another. We have considered a standard form for trade costs:

$$\tau_{ijt} = dist_{ij}e^{b_{ij}}$$

where b_{ij} includes dummies representing common language, $lang_{ij}$, and past colonial links, col_{ij}, such as $b_{ij} = dist_{ij}col_{ij}$. Common language and colonial history appear crucial in explaining bilateral trade but direct measures are riddled with measurement errors. By using a constructed 0-1 index we limit these errors. In wine economics the importance of past colonial links has been studied for instance by Melonni and Swinnen (2014) who detail the rise and fall of Algeria as the largest wine-exporter, worldwide during the French colonization.

We use the OLS estimator, as well as the PPML and Gamma estimators.[16] Using Monte Carlo simulations, Santos Silva and Tenreyro (2006) recommend the Poisson pseudo-MLE that performs better than the traditional linear-in-logs OLS. Head and Mayer (2013) recommend the use of OLS, Poisson and Gamma PML, they state that if the sample is large enough then Poisson and Gamma PML should give approximately the same result.

2) fixed effects and only population variables are introduced on the left hand side to analyse whether the sign of population changes when multicollinearities between variables are reduced to the minimum 3) introduction of unit value of wines instead of price index. Whatever the specification, results reported in the text table are still valid.

[16] As recommended for instance by Head and Mayer (2013) who write "if all three estimates are similar, then we can relax because the model appears to be well specified [...] Therefore the OLS results are the maximum likelihood estimates".

Dep var:	French Wine Exportation (adjusted by french GDP per-capita)				
Mode:	Air-plane			Water-ship	Land-road & rail
Estimator:	OLS	PPML	Gamma	OLS	OLS
GDPs	-0.007[b]	-0.012	-0.034	0.290[a]	0.385[a]
	(0.036)	(0.028)	(0.029)	(0.007)	(0.018)
POPs	0.083[b]	0.116[a]	0.075[b]	-0.063[a]	-0.115[a]
	(0.039)	(0.027)	(0.030)	(0.009)	(0.017)
Distance	-0.105	-0.001	-0.143[b]	0.108[a]	-0.180[a]
	(0.075)	(0.064)	(0.063)	(0.009)	(0.013)
CPIs	-1.792	-3.764[a]	-2.573[a]	-1.941[a]	1.570[b]
	(1.779)	(1.207)	(1.474)	(0.385)	(0.724)
Colony	-0.411[a]	-0.799[a]	-0.620[a]	0.348[a]	-0.047
	(0.102)	(0.083)	(0.081)	(0.015)	(0.044)
Common Language	-0.661[a]	-0.192	-0.448[a]	0.155[a]	0.332[a]
	(0.134)	(0.118)	(0.110)	(0.019)	(0.025)
R^2/Pseudo R^2	0.762	0.672	0.086	0.401	0.389
Obs	3971	3971	3971	69079	39619

Notes : [a b c] denote significance at the 1, 5 and 10 percent level respectively.
Estimations realized with year, firm and product fixed effects.

Table 1.3: Gravity equation

Columns 1, 2 and 3 give results for wine exported by plane using the three different estimators. Distance and price index have the expected sign, but GDP and population contradict the theory. Indeed a positive sign is obtained for population rejecting the idea that wines exported with this mode of transport are luxury goods. On the contrary, the theory is validated for wines exported by ship and road reported in Table (1.3) in column 4 and 5 using OLS.[17] This validation of non-homothetic preferences is surprising since wines exported by road can be considered as typical goods not characterized by a strong income effect. After various robustness checks providing similar results, we conclude that these initial results are correct and that the theoretical model needs to be revisited. To reconcile our data with theory we decided to introduce economies of scale in transport. Depending on export-value, obviously firms pay different transport costs. There is a wide range of literature on this topic. For instance Skiba (2007) considering economies of scale in transport finds that a 10% increase in the volume of trade

[17]We carried out estimations with Poisson and Gamma PML with similar results

brings about a 2.5% reduction in trade costs. Clark et al. (2004) find that transport costs are lower when trade volumes are high. In Kleinert and Spies (2011) total export figures determine the mode of transport. Transport costs of course vary with investment in more efficient technology. By using price data from UPS, they find that a 10% increase in exports decreases transport prices by 0.8%. Hummels, Lugovskyy and Skiba (2009) show that shipping costs decrease according to the number of competitors, with low tariffs and product prices and with high demand elasticities.[18] Lastly Rudolph (2009) demonstrates how a standard gravity equation can be biased if economies of scale in transport are not introduced.

By referring to this literature, we assume that transport costs take the following form:

$$\tau_{ij} = \left(x_{ij,t}^k\right)^\eta d_{ij} e^{b_{ij}}$$

where $x_{ij,t}^k$ represents the wine exports in value and η density (dis)economies. There are economies of scale with η negative, and diseconomies in the opposite case. Inserting this function in the gravity equation and resolving for $x_{ij,t}^k$ to eliminate the endogeneity bias gives:

$$\begin{aligned} \ln\left(x_{ij,t}^k\right) &= \frac{\alpha+\beta}{1-(1-\sigma)\eta}\ln\left(Y_{j,t}Y_{i,t}\right) + \frac{\beta}{1-(1-\sigma)\eta}\ln\left(L_{j,t}L_{i,t}\right) \\ &\quad + \frac{(1-\sigma)\eta}{1-(1-\sigma)\eta}\ln\left(d_{ij}e^{b_{ij}}\right) + \frac{1}{1-(1-\sigma)\eta}\ln\left(P_{it}P_{jt}\right). \end{aligned}$$

This last gravity equation is helpful in revisiting the previous results. In particular in comparison with Equation (1.5.2) the coefficient of distance now consists of the following parameters:

$$\widehat{a_3} = \frac{(1-\sigma)\eta}{1-(1-\sigma)\eta} \tag{1.5.3}$$

For air transport according to the estimation using the Gamma PML estimator

[18] There also are interesting theoretical papers, for instance Duranton and Storper (2008) propose a model whereby the decrease in transport costs can generate an increase in trade costs. In their model with vertical differentiation where the quality of input is not contractible, they show that a decrease in transport costs leads to exchange higher quality of goods for which trade costs increase. Lastly the assumption of endogenous transport costs with respect to trade is not innocuous in terms of specialization and location choice (see Matsuyama, 2007 and Behrens, Gaigné and Thisse, 2009, Behrens and Picard, 2011)

we have $\widehat{a_3} = -0.143$, thus assuming an elasticity of substitution equal to 5 (which is a realistic value of σ according to estimations of Broda and Weinstein, 2004), we obtain $\eta = -1.988$. From such a result we can now deduce β, we have:

$$\widehat{a_2} = \frac{\beta}{1-(1-\sigma)\eta} \tag{1.5.4}$$

and from Table (1.3, Gamma PML) the coefficient of population gives $\widehat{a_2} = 0.075$ thus using η and σ we get $\beta = -0.524$. This result confirms the income effect that was previously rejected. Lastly by using the coefficient of GDPs from:

$$\widehat{a_1} = \frac{\alpha+\beta}{1-(1-\sigma)\eta} \tag{1.5.5}$$

with $\widehat{a_1} = -0.034$ we get $\alpha = 0.762$ which is relatively close to the unit elasticity of GDP obtained in many trade gravity equations. We note that our calculation of α and β does not depend on our assumption regarding σ. In other words these parameters only depend on our estimations in table (1.3). Resolving the system (1.5.3,1.5.4,1.5.5) gives expressions of (η,β,α) where η depends on σ but where α and β only depend on estimates:

$$\eta = \frac{\widehat{a_3}}{(1+\widehat{a_3})(1-\sigma)}, \quad \beta = \frac{\widehat{a_2}}{1+\widehat{a_3}}, \quad \alpha = \frac{\widehat{a_1}-\widehat{a_2}}{1+\widehat{a_3}}$$

Table (1.4) summarizes the numerical expressions derived from estimations and also reports results for wine exported by road and ship since we expect a zero value for β that was not obvious until now.

Mode:	Air-plane	Water-ship	Land-road & rail
Transp econ scale (η)	-1.988	-0.024	0.054
Income per cap (β)	-0.524	-0.056	-0.140
GDPs (α)	0.762	0.318	0.609

Calculation for η done with $\sigma = 5$

Table 1.4: Economies of scale in transportation

Expected results are obtained. Wine exported by ship and road benefits from a smaller income effect than wine exported by air. The coefficient of β is not strictly equal to zero but is however, closer to this value, in particular for wine transported by ship. Interestingly economies of scale are observed for transportation by plane and boat ($\eta < 0$) but not for road. A 10% increase in the value of wine exported by road leads to a rise in transportation costs of 0.5%. Obviously, such a result could to be considered as a simple exercise. The previous empirical analysis indicates that direct introduction of transport costs can facilitate the analysis of international wine-trade.

1.6 Conclusion

Hummels and Lugovskyy (2009) proposed a model generalizing the ideal variety approach of Lancaster (1979, 1984). By applying this model to the wine sector, we have confirmed the majority of its conclusion. A 1% increase in GDP per capita generates on average, an increase in price differential of between 0.55% and 1.13%. Trade-share is strongly influenced by all variables approximating wealth concentration such as income earned at the top of the distribution. Lastly a gravity-trade equation supports the view that income effects play an important role in explaining wine exports but also raise questions about transport costs. Depending on economies of scale and market structure in this sector, changes in price and volume exported may partly be explained by transport costs interacting with rising global demand.

Chapter 2

Chapter 2

The Impact of Water Resources on the International Trade of Agricultural Products in a Non-Frictionless World

Since water resources are not evenly distributed between countries and is essential for virtually all human activities, it can be conjectured that such disparities across the globe lead to heterogeneous productivity and thus, should shape the pattern of international trade of water intensive goods such as the agricultural ones from water-abundant to water-scarce countries, inducing efficiencies at a global scale (Allan, 1997 and Chapagain and Hoekstra, 2011)[1]. The theoretical framework of such a conjecture is based upon the well-known Hecksher-Holin-Vanek Theory which defines a clear relationship between the relative abundance of a production factor in a country and the factor content of its exchange with the rest of the world such that a country well endowed in a given resource should be specialized in producing goods that are intensive in this very same resource and export it toward countries relatively less endowed. Therefore, countries with a relative abundance of water resources should be specialized in agricultural products and export them to other countries relatively scarce in water resources which implies that these export-

[1]This chapter is a work under progress (Régnacq and Schlick, 2019).

ing countries are particularly sensitive to any change of the climate conditions that will reshape the natural endowment in water between regions and countries. In that respect, the relationship between water endowments and international trade of water intensive goods can be one of the main channels by which the disruptive effects of climate changes may induce dramatic economic changes and thus, having a clear understanding of such a relationship may help in mitigating all of these future changes. Yet, despite a flourishing literature attempting to measure the relationship between water resources abundance and pattern of international trade of water intensive goods over the past decade, no definitive proof of such a conjecture has been found (Debaere, 2014; Delbourg and Dinar, 2016; Fracasso, 2014; Kumar and Singh, 2015; Seekell et al., 2011 and Yang and Zehnder, 2007). In this article, we argue that such inconclusive results can be traced back to the simplifying assumption of a frictionless world made in the lion share of the existing literature which do not reflect well the reality of possible water allocation and use within countries as well as possible trade of water intensive goods between countries. Therefore, this article is mostly intended to raise awareness about these simplifying assumptions and to provide a method to handle such issues rather than to find a definitive answer to the question of proving this conjecture which should be address in future researches. However, to get some meaningful results, we simulate the impact of climate changes upon the international trade of agricultural goods when the strong assumptions of the frictionless world often made in the previous studies are relaxed and add to the existing literature on that point.

Indeed, the predictive power of the theoretical framework on which are based most of the studies in this topic heavily relies upon the absence of frictions between transacting parties that would otherwise distorts the behavior of these very same transacting parties away from the optimal use of their available resources (Griffin, 1991). Therefore, studying the relationship between the relative abundance of water in a given country and its trade pattern of water intensive goods with the rest of the world implies to first control for the possible frictions that may exists within the complete chain of interactions that draw the path of actions from the initial access of a water resource in this country to the water content of its export toward other countries. With the existence of frictions, each transaction along such a path represents an opportunity to deviate from the optimal action when transactions are frictionless, leading to very different outcome than the one predicted by the theory. In this article, two main types of frictions are accounted: the ones between countries that distorts the international trade flows and the ones within countries that limit the effective use of the available water resources and thus, its allocation between productions.

The frictions affecting the international transactions are very well studied and have led to an enormous strand of theoretical as well as empirical literature through the use of gravity equations with several applications to the specific case of international trade of agricultural goods (Reimer and Li, 2010; Jayasinghe, Beghin, and Moschini, 2010; Cardamone, 2011 and Chevassus-Lozza and Latouche, 2012). These different studies showed that agricultural trade between countries experiences significant level of trade costs which not only reduce the potential income of farmers but also distorts the flow of trade. In that respect, it can be argue that international trade in agricultural goods is not the sole result of the relative endowment of resources used in the production process such as land and obviously water as conjectured in the initial hypothesis of Allen (2003) but also depends upon the trade policy of foreign countries which may apply some trade barriers. Therefore, it is very likely that some of the studies intended to estimate the relevance of water endowments into the water intensiveness of exported products that do not account for the international frictions such as the ones of Debaere (2014) or Afkhami et al. (2018) suffer from important biases. However, some recent studies tackled this issue by estimating the relationship between the relative abundance of water in a country and its level of export of water intensive goods within the empirical framework of the gravity equation. Fracasso (2014) has been among the first to do such analysis but used only a naive approach to the econometric model without any fixed effects to control for the unobserved heterogeneity between countries. Delbourg and Dinar (2016) have then provided interesting evidence of the water endowment effect on agricultural trade through a more appropriate gravity equation combining exporter-product and importer-product fixed effects with the relative water endowment of trading countries. In overall, recent studies seem to point out that with the adequate controls for the international frictions, the water endowment may have an impact into the composition of exports. In that respect, this article follow this recent literature by estimating the impact of water resources through a gravity equation based upon the seminal work of Eaton and Kortum (2002). However, it is worth noting that the use in these two studies of traditional bilateral variables such as distance, languages and regional trade agreements instead of pair-fixed effects may have induced biased estimates of the water endowments effect since these traditional variables cannot capture all the frictions arising in international relationships. Therefore, we improve the control of bilateral unobserved heterogeneity through the use of pair fixed effects as well as importer-product and exporter fixed effects (our variable of interest will be on the exporter-product dimension). In addition to these improvements, we refined the indicator variable intended to capture the water endowment of a country such that it can account for the heterogeneity of conditions within the country. This last point represents our major contribution to the existing literature as previous studies do not take in consideration the frictions in water allocation within the countries as they solely approximate water endowment through aggregate values at the country level which does not allow to differentiate between the quantity of water in a given country and the amount of water that can be effectively used for certain type of productions.

Indeed, exactly like unequal distribution of water resources between countries exists, regions within countries also experience disparities in their water availability and unlike other types of production factors such as the labor or capital, these water resources cannot be moved easily from a water-abundant region to a water-scarce one. Therefore, since water is not the sole input in agricultural production but has to be combined with other fixed factors such as land and a favorable range of temperatures, the sole water endowment aggregated at the country level may be misleading as some regions may have sufficient water resources but not the temperatures or soil quality required. In that case, part of the total water endowment of the country cannot be used to produce certain types of water intensive goods as in other regions or countries with more favorable conditions leading to overestimate the water that can be effectively used if the sole indicator is the country water endowment. Solely accounting the aggregate value of water endowment implies to make the implausible assumption that either production is always possible where water is available or conversely that water resources can be freely moved to the place of production which cannot withstand a close examination of the water resources characteristics and its use by the different sectors. In other words, one cannot expect to have a good approximation of the opportunity cost of water use from the sole country level data since such a cost can widely vary within the country due to the strong immobility of this factor. For the sake of generality, such a relative immobility is termed in this article as friction in the geographical allocation of water resources to make water conceptually similar to any other type of production factors and also, while it is true that moving water is a very challenging task, it is not impossible but at a very high transportation and transaction costs. This article deals with this problem by using agronomic, climatic and socioeconomic variables at the highly disaggregated scale of a 30 arc-minute worldwide grid (or approximately 55 kilometers) to estimate an agricultural potential accounting for the different constraints for producing agricultural goods. This agricultural potential includes indicators on temperatures, soil and land use suitability for different crops in combination with the local water availability which has been distinguished between green water (precipitations) and blue water (river's runoffs and groundwater). In that respect, the easiness by which a locality can access enough water to fulfill the requirements for growing certain crops, given that the other conditions are satisfied, may represent a comparative advantage of this locality to produce these specific types of crop.

The reminder of this chapter is as follow. A first part will develop the theoretical framework based upon the model of Eaton and Kortum (2002). Such a framework will lead to the empirical part where the prevalence of water resources in the pattern of international trade of agricultural products between countries is being estimated through a gravity equation devised in the first part. A third part will present the results and a fourth part will use the estimated coefficients to perform simulation on how climate changes may affect the patterns of international trade in agricultural products. Finally, the last part will conclude with some avenue for future researches.

2.1 Theoretical Framework

In this theoretical framework, we adapt the model developed by Eaton and Kortum (2002) to account for local water resources availability into the determination of international trade of agricultural product. The key element is to consider local water resources as a way to improve the productivity of land parcels given that the constraints about temperature and soil are satisfied. In that respect, the higher will be the local water resources available to produce an agricultural good, the lower will be the opportunity cost of producing this good as well as the price for selling this good on the international market. The set up of the model is as follow.

2.1.1 Supply

Any country across the world can be an exporter $i \in I$ or an importer $j \in J$ of agricultural products classified according to a two-tiered hierarchy with the first one being a finite number of goods $k \in K$ made up by a continuum of variety $\omega \in \Omega$ (and $\omega \in [0;1]$). The constant marginal cost for producing a good k in a country i to be delivered in a country j is driven by a productivity factor $z_i^k(\omega)$ and can be written as:

$$c_{ij}^k(\omega) = \frac{r_i \tau_{ij}}{z_i^k(\omega)}$$

Where τ_{ij} is the classical "iceberg" trade cost to export from i toward j and is assumed to be identical across products k. While this is an obvious simplification of the reality since agricultural products are often subject to important tariffs depending on the country that trading them, accounting for such a dimension will lead to an important computational hurdle. We are thus following the literature on that aspect by considering trades costs to vary only on the country dimensions and not on the product one. The variable r_i corresponds to the unit cost of production in a country i which is also identical across all products k. In the case of agricultural products, this unit cost may correspond to the rent of land where the more surfaces are being available for agricultural production, the less expensive will be the parcels of land. Finally, the $z_i^k(\omega)$ variable is, as defined by Eaton and Kortum (2002) a random variable distributed according to the Fréchet distribution and is the sole cost component that depends on the type of product k:

$$F_i^k(z) = \exp\left\{-T_i^k z^{-\theta}\right\} \tag{2.1.1}$$

Where the θ parameter measures the heterogeneity of varieties such that a higher value of this parameter implies a lower dispersion of differences among varieties within the specific crop of type k and T_i^k defines the global productivity factor that stem from the availability of water resources for all varieties of a product k in a country i, given that soil texture and other climatic constraints such as growing temperature are being satisfied. The higher is this value, the lower is the opportunity cost of using local water resources to produce a product k and thus, the more productive is this locality to produce this good. In other words, this global productivity factor reflects the absolute advantage of countries to produce a particular product k and therefore, induces a potential source of comparative advantage driving the pattern of international trade of agricultural products. The variable T_i^k will thus be the interest variable in the empirical work as it represents the impact of water effectively available to produce and trade certain types of agricultural products and the empirical section will further elaborate on the approximation of such a variable and more specifically on the method used to aggregate at the country level the agronomic data collected at a much higher resolution.

2.1.2 Demand

Each importer country $j \in J$ has a representative agent who maximizes a nested Spence-Dixit-Stiglitz utility function over all varieties ω of all products k such that, on the first level, the total expenditure for a product k is:

$$E_j^k = E_j \left(\frac{p_j^k}{P_j} \right)^{1-\sigma}$$

Where $\sigma > 1$ is the constant elasticity of substitution between products k, P_j is the price index and E_j is the total income of j. In this case, the price index P_j is:

$$P_j = \left(\sum_k \left(p_j^k \right)^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$$

And, on the second level, the expenditure on a variety ω of a product k in this country j is:

$$X_j^k (\omega) = E_j^k \left(\frac{p_j^k (\omega)}{P_j^k} \right)^{1-\sigma^k}$$

In this last demand level, $\sigma^k > 1$ is the constant elasticity of substitution between variety ω and P_j^k is the price index of a product k, such that:

$$P_j^k = \left(\int_0^1 p_j^k (\omega)^{1-\sigma^k} \, d\omega \right)^{\frac{1}{1-\sigma^k}}$$

2.1.3 Market Price

As in the model of Eaton and Kortum (2002), international markets are assumed to be in perfect competition such that the price of a variety ω for an agricultural product k between a country i and j is as follows:

$$p_{ij}^k (\omega) = c_{ij}^k (\omega) = \frac{r_i \tau_{ij}}{z_i^k (\omega)} \tag{2.1.2}$$

The country j will import the agricultural product k from a country i if the latter can offer the lowest price among all possible exporter I. Thus, the probability that the country i offers a price lower than p to the country j can be expressed as follow:

$$G_{ij}^k(p) = \Pr\left\{p_{ij}^k\left(\omega\right) \leq p\right\}$$

Substituting $p_{ij}^k\left(\omega\right)$ by its function in equation (2.1.2) and rearranging, we get:

$$G_{ij}^k(p) = 1 - \Pr\left\{\frac{r_i \tau_{ij}}{p} > z_i^k\left(\omega\right)\right\}$$

Then, using the Fréchet distribution from equation (2.1.1):

$$G_{ij}^k(p) = 1 - \exp\left\{-T_i^k\left(\frac{r_i \tau_{ij}}{p}\right)^{-\theta}\right\} \tag{2.1.3}$$

Now, lets take a look at the probability that the country j will pay a price inferior to p for the product k from a country i:

$$G_j^k\left(p\right) = 1 - \Pr\left\{\min_i p_{ij}^k\left(\omega\right) > p\right\}$$

Again, with some rearrangement and from equation (2.1.3), the probability becomes:

$$\begin{aligned} G_j^k\left(p\right) = & \quad 1 - \textstyle\prod_i \left(1 - G_{ij}^k(p)\right) \\ \Leftrightarrow G_j^k\left(p\right) = & \quad 1 - \exp\left\{-p^\theta \textstyle\sum_i T_i^k\left(r_i \tau_{ij}\right)^{-\theta}\right\} \end{aligned}$$

Finally, it is possible to compute the price index of the country j for the product k:

$$P_j^k = \alpha\left[\sum_i T_i^k\left(r_i \tau_{ij}\right)^{-\theta}\right]^{-\frac{1}{\theta}} \tag{2.1.4}$$

Where $\alpha = \Gamma\left(1 - \frac{\sigma^k - 1}{\theta}\right)^{\frac{1}{1-\sigma^k}}$ with $\Gamma(\cdot)$, the gamma function.

2.1.4 Trade

Determining if the country i will actually export a product k to a country j, implies to define the probability that i has the lowest cost possible toward j:

$$\pi_{ij}^k = \Pr\left\{p_{ij}^k(\omega) \leq \min_{i'} p_{i'j}^k(\omega)\right\}$$

$$\Leftrightarrow \pi_{ij}^k = \int_0^\infty \Pr\left\{p \leq \min_{i'} p_{i'j}^k(\omega)\right\} dG_{ij}^k(p)$$

Using equation (2.1.3) and rearranging leads to:

$$\pi_{ij}^k = \int_0^\infty \prod_{i'}\left(\exp\left\{-T_{i'}^k\left(\frac{r_{i'}\tau_{i'j}}{p}\right)^{-\theta}\right\}\right)\left(\frac{\theta T_i^k}{p}\exp\left\{-T_i^k\left(\frac{r_i\tau_{ij}}{p}\right)^{-\theta}\right\}\right)$$

$$\Leftrightarrow \pi_{ij}^k = \frac{T_i^k}{(r_i\tau_{ij})^{-\theta}}\int_0^\infty \theta p^\theta \exp\left\{-p^\theta \sum_i T_i^k (r_i\tau_{ij})^{-\theta}\right\}$$

Then, solving the above expression gives the probability that a country i will export a product k to a country j:

$$\pi_{ij}^k = \frac{T_i^k (r_i\tau_{ij})^{-\theta}}{\sum_i T_i^k (r_i\tau_{ij})^{-\theta}} \tag{2.1.5}$$

Knowing that the trade $X_{ij}^k = \pi_{ij}^k E_j^k$, its expression is simply the following:

$$X_{ij}^k = \frac{T_i^k (r_i\tau_{ij})^{-\theta}}{\sum_i T_i^k (r_i\tau_{ij})^{-\theta}} E_j^k$$

Finally, rearranging the price index P_j^k from equation (2.1.4) and plugging into the trade equation gives:

$$X_{ij}^k = T_i^k \tau_{ij}^{-\theta} \left(\frac{P_j^k}{\alpha r_i} \right)^\theta E_j^k \tag{2.1.6}$$

Equation (2.1.6) gives the classical gravity equation that will be used in the next section to estimate the impact of water resources T_i^k into the trade of an agricultural product k.

2.2 Data and Empirical Strategy

This section will now present the overall methodology used in this article to estimate the gravity equation derived from equation (2.1.6) in the previous section and infers the impact of the water availability on the international trade of agricultural products. A first subsection will describe the trade data set used in this framework as well as the calculation of our measure of water productivity from various agronomic datasets. A second section will present the specific econometric model used to measure the variable T_i^k.

2.2.1 Data and Water Availability Indicators

As previously noted, two types of data sources are required to investigate comparative advantage of water on international agricultural flows: international trade and infra-national agronomic data. While the former is relatively common in the existing literature and will have thus a short presentation, the latter requires a deeper explanation as well as an accurate depiction of its use in calculation of water availability indicator and its aggregation at country level.

2.2.1.1 International Trade Data

To complete successfully the investigation about water comparative advantage, we use trade data of BACI database developed by CEPII (Gaulier and Zignago (2010)). It contains annual bilateral flows on the period 1990-2005 highly disaggregated (6 digit HS) for an important number of countries. It covers more than 5000 products and 200 countries. This dataset is appealing for the estimation of gravity equation because authors have been employed an approach to reconcile the original data (COMTRADE database of the United Nations Statistics Division) where the information between imports and exports for a same flow can be different. This procedure allows to correct some errors and to obtain reliable data.[2] For computational reasons, our database for estimations is reduced in 4-Digit HS and focus on agricultural products and has estimated on whole period. The panel gathers 43 countries and 29 products together[3]. Then, each flow can be identified by exporter i, importer j, product k and year t.

2.2.1.2 Water Availability Indicator from Infra-national Agronomic data

Since we attempt to uncover the impact of water resources on the decision to grow specific types of crop, approximating the water availability for agricultural use cannot be done by pulling observations depending on current agricultural production such as irrigation data due to the obvious endogenous issues. Similarly, the data of water footprint computed by Mekonnen and Hoekstra (2011) and often used in previous studies cannot be used either for similar reasons. Therefore, a measure of agricultural production potential, only relying upon physical exogenous conditions has to be computed to be able to isolate the impact of water availability on the decision to grow certain types of agricultural products. For that, we follow basic features of agronomic models as developed by the FAO and use several datasets from the project Global Agro-Ecological Zone (GAEZ) developed by the International Institute for Applied Systems Analysis (IIASA) to isolate any effects that

[2]For more details about the methodology of construction, see Gaulier and Zignago (2010).

[3]For a complete list of product and countries include in database employed for regressions, see Appendix B.1 and B.2.

water availability may have upon agricultural production and thus to approximate an opportunity cost of water resources use in the agricultural sector.

Furthermore, to accurately account for the local specificity of such a water opportunity cost within countries, it seems more appropriate to use spatially disaggregated data of water supply and demand which allows to better identify the local scarcity of the resources than with the country level analysis. Therefore, data on hydrologic conditions have been collected or converted at a resolution of 30 arc-minutes scale which roughly represents a gridded pattern of squares averaging 50 kilometers sideways. As such a gridded pattern of squares corresponds to the smallest spatial unit of analysis in our empirical work, we assume the features that characterize each of those squares as homogeneous and define them as localities l. The main advantage of such approach is to be able to account for local constraints other than the one of water that may reduce the effective use of this resource in some localities. Such set of constraints is comprising of features independent of the product dimension k and noted C_l such as land use for urban development, land subjected to permanent frost, terrain slope and soil mixture unsuitable for agricultural production taken from GAEZ as well as features varying on the product dimensions l and k and noted C_l^k such as the temperature requirements for growing a specific crop k taken from various academic sources. These two variables are ranging from zero to one with the unit value implying a locality l without any constraints (conversely, a value equals to zero implies no production is possible in locality l). However, since the international trade data previously described are only available at the country level, it is not possible to directly use any infra-national agronomic data at such a higher resolution. An indicator has thus to be first calculated for each locality l that will approximate the local availability of water for growing the agricultural product k in a locality l given that the other constraints C_l and $C_l^k$are being satisfied to be then aggregated at the country level i through a simple sum. This aggregation will thus give the total amount of available water of a country i that can be effectively used to produce a specific product k.

Computing this local water availability indicator in localities l requires to combine the local supplies of water in l as well as the water requirement for producing any specific agricultural product k in l. This crop specific water requirement can be approximated by the crop specific evapotranspiration ET_l^k which has to be computed from the reference evapotranspiration ET_l^0 given by GAEZ (only varying on the l dimension), multiplied by a crop coefficient from (varying on the product dimension k and l). As for local supplies, they comprise of precipitations that fall in l taken by GAEZ (noted P_l) and surface as well as ground water resources (respectively noted SW_l and GW_l) that can be used by l to supplement the water supply from precipitations. Ground water data comes from the Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) which provides localization and natural recharge of main groundwater basins and surface water data has been approximated from the Water Resource Institute (WRI) which computes cumulative runoffs from upstream to downstream hydrographic basins for an average year. However, such a surface water measure requires the calculation of a sharing mechanism between the surrounding localities from a given river stream to accommodate for the rivalry nature of this resource. To define such a mechanism, we first delineate corridors along each river stream that discriminate between a subset of localities being able to subtract a certain amount of the cumulative runoff in the river stream and the other localities outside of this corridor not having access to such a surface water. This cumulative runoff is thus shared between localities within the corridor in proportion to their agricultural water needs (measured by the reference evapotranspiration taken from GAEZ) given that part of this cumulative runoff is first being appropriated by the total municipal and industrial use within the corridor. These municipal and industrial uses are calculated by multiplying the population of a locality provided by the Socio-Economic Data and Application Center (SEDAC) with the municipal and industrial water use per capita of the country in which is located the locality taken from the FAO. Finally, we also take into account in this sharing mechanism that some localities, while being inside the corridor cannot have agricultural production due to the set of constraints C_l[4], implying that these localities are not appropriating water resources from the river stream, thus freeing such resource for other localities.

The local water availability indicator in a locality l to produce a specific product

[4]To keep the calculation of such a sharing mechanism of SW_l on the sole spatial dimension l and not on the product dimension k, we do not implement the temperature requirements constraint C_l^k in this calculation. The goal is thus not to compute the real amount of water subtracted by a locality l but rather the potential that this locality may want to subtract.

k, noted W_l^k can thus be calculated as follow:

$$W_l^k = \frac{P_l + b_l^k\left(SW_l + GW_l\right)}{ET_l^k\left(1+\sigma_l\right)}$$

With b_l^k, a binary variable that takes the value one if precipitation is inferior to the crop specific evapotranspiration for k in l and zero otherwise and σ_l, an inter annual variability coefficient taken from the WRI intended to correct for potential variation of climate between years and thus to account for unreliability of water supplies in some localities. The underlying reason for accounting for inter annual variability is that all values of precipitation, surface and ground water and evapotranspiration are averages over the years which means that important variability of water supply in some regions are smoothen and may thus mask the real unreliability of using for production in those regions.

Computing a water availability indicator at the country level, is done by taking the weighted sum of the local water availability indicators W_l^k over l, accounting for the set of constraints C_l and C_l^k and assuming that the share of land of a locality l dedicated to an agricultural good k is proportional to its local water availability indicator W_l^k given the constraints C_l and C_l^k and the area of the locality l (combined in a multiplicative form with $A_l^k = area_l \times C_l \times C_l^k$) such that, the water availability indicator at the country level, noted LW_i^k is:

$$LW_i^k = \frac{1}{L_i^k}\sum_{l\in i}\frac{A_l^k W_l^k}{\sum_k A_l^k W_l^k} \times area_l \qquad (2.2.1)$$

Where L_i^k corresponds to the land availability irrespective of the water availability which is integretated into our global indicator to suppress the effect that land endowment may have on the trade of agricultural production and solely focus on the water aspects. It is calculated as follow:

$$L_i^k = \sum_{l\in i}\frac{A_l^k}{\sum_k A_l^k} \times area_l$$

2.2.2 Empirical Strategy

To investigate the importance of the effective water availability upon the international trade of agricultural products, we make use of the equation (2.1.6) where the variable T_i^k is a function of our water availability indicator LW_i^k from equation (2.2.1) such that the measure of T_i^k can take the following form:

$$\log\left(T_{it}^k\right) = \delta_{it} + \lambda \log\left(LW_i^k\right)$$

Where δ_i is fixed effects intended to capture heterogeneity on the exporter dimension while the parameter λ is effect of the water availability upon the fundamental productivity T_i^k[5]. Substituting this last equation in the log-transformation of equation (2.1.6) gives the model that will be estimated:

$$\log\left(X_{ijt}^k\right) = \delta_{ij} + \delta_{jt}^k + \delta_{it} + \lambda \log\left(LW_i^k\right) + \varepsilon_{ijt}^k$$

Where δ_{ij} is a bilateral fixed effects intended to account for any transaction costs that may impede the trade flow between the exporter i and the importer j, approximating the log of the variable τ_{ij}^θ in the model and δ_{jt}^k is an importer-product fixed effects approximating the variable $E_{jt}^k \left(P_{jt}^k\right)^\theta$.

This estimation is computed with PPML estimator (see Santos Silva and Tenreyro (2006)). This estimator has been largely used in empirical analysis about trade because it allows the taking in consideration two problems present in the trade databases. Firstly, some pair of countries don't trade. This no trade is translated by zeros, their presence in regression with OLS, for instance, leads to remove these observations, and to remove in the same time, information about these partners incurring a selection bias. Secondly, Santos Silva and Tenreyro has shown PPML estimator able to deal with the heteroskedasticity. Given that benefits described previously and the presence of zeros in the trade database employed, we use the PPML estimator in our empirical strategy. These estimations need

[5]Note that in the case of the robustness check we also add the land availability indicator L_i^k such that $\log\left(T_{it}^k\right) = \delta_{it} + \lambda \log\left(LW_i^k\right) + \psi \log\left(L_i^k\right)$

substantial fixed-effects (bilateral and importer-product), the PPML command in Stata leads to estimations which are very long. To overcome this problem, we use a recent Stata module to implement Pseudo Poisson Maximum Likelihood including multiple high-dimensional fixed-effects, called ppmlhdfe developed by Correia, Guimares and Zylkin (2019). The speed of estimations can be explain by two elements. Firstly, the using of iterative reweighted least square algorithm allows to reduce the dimensionality problem. Secondly, this command use the advantage of reghdfe command allowing to reduce some computations which are performed once and so it is not necessary to perform these computations for each iteration.

2.3 Results

In this section, we present the results (Table (2.1)) of the estimation of the econometric model developed above with different specifications. The first variable is the one of interest, LW_i^k which represent an inverse measure of opportunity cost of using water in producing the crop of type k in the country i such that the higher is this variable, the higher is the absolute advantage in term of water availability of this country in this type of crop. In the two first columns, we perform an estimation without bilateral fixed effects and thus, with the more traditional bilateral variables. All these standard variables are a set of bilateral variables taken from CEPII database (Mayer and Zignago, 2011) with the distance between exporter and importer being the sole continuous variables while all other dyadic variables are dummies. These dummies indicate if the importer and exporter are contiguous, share the same official language, has had a colonial link, if they are or were part of the same country. While this approach is relatively naive in comparison to the recent studies of French (2017) and Donaldson, Costinot and Komunjer (2012), this shows that the most important bilateral variables such as distances and contiguity have the expected sign and are significant at 0.1%. Furthermore, this first results in columns 1 and 2 are interesting in comparison to the other estimates (columns 3 to 6) where these dyadic variables as well as the distance have been substituted by bilateral fixed-effects. Therefore, the four other columns implement bilateral fixed effects with the difference that the columns 3 and 4 do not account for the combined effects of the importer-product dimension while the last two columns correspond to the econometric model described above. Finally, the columns 2, 4 and 6 is mostly intended for robustness as it implement the supplemental variable L_i^k which account for the land availability irrespective of the water availability.

The main result is that for any kind of specification, our water availability indicator LW_i^k stays positive and is strongly significant at 0.1% level even with the implementation of the L_i^k variable (the negative coefficient of this latter is due to multicolinearity since this land availability is already accounted into our water availability indicator LW_i^k). Interestingly enough, controlling for the international frictions through pair fixed effects does not change the level of the coefficient which stays at 0.189 but improves the pseudo R^2 implying that while some heterogeneity have not been captured by the more traditional variables, this may not affect the impact of water endowment upon international trade. However, the two-dimension fixed effects on the importer-product have important impact on the coefficient (from 0.189 to 0.223). From the econometric model, it can thus be said that an increase of 1% of the effective availability of the water resources increase the likelihood of exporting water intensive goods by 31.4%.

	(1)	(2)	(3)	(4)	(5)	(6)
LW_i^k	0.189^a	0.156^a	0.189^a	0.156^a	0.273^a	0.220^a
	(0.044)	(0.045)	(0.044)	(0.045)	(0.051)	(0.051)
L_i^k		-1.448^a		-1.448^a		-1.372^a
		(0.188)		(0.188)		(0.160)
$Distance_{ij}$	-0.747^a	-0.747^a				
	(0.030)	(0.030)				
$Contiguity$	0.798^a	0.798^a				
	(0.083)	(0.083)				
$Language$	-0.338^a	-0.338^a				
	(0.099)	(0.099)				
$Colony$	-0.207^b	-0.207^b				
	(0.352)	(0.352)				
$Smctry$	0.231^c	0.231^c				
	(0.135)	(0.135)				
Fixed Effect :						
Pair	No	No	Yes	Yes	Yes	Yes
Importer-product -time	No	No	No	No	Yes	Yes
Importer-time	Yes	Yes	Yes	Yes	No	No
Exporter-time	Yes	Yes	Yes	Yes	Yes	Yes
Product	Yes	Yes	Yes	Yes	No	No
Exporter	No	No	No	No	No	No
Importer	No	No	No	No	No	No
Cluster :						
Importer-Exporter-time	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R-square	0.5866	0.5886	0.6695	0.6715	0.7925	0.7939
Log Pseudo likelihood	-1182916.96	-1177171.44	-909321.56	-903576.03	-549423.94	-545929.71
Nb of Obs.	713 284	713 284	586 641	586 641	489 488	489 488

Notes: $^{a\,b\,c}$ denote significance at the 0.1, 1 and 5 percent level respectively. Estimations have been done with the PPML estimator. Robust standard errors are reported under each coefficient. Estimations are performed with a corridor of 200 km. The results are obtained for 43 countries and all years (1990-2005).

Table 2.1: Baseline estimations

To evaluate the liability of the previous estimations, we perform additional estimations in tables (2.2) and (2.3) with different set of countries and different disaggregation level of products based upon the estimation in columns 5 and 6 of the table (2.1). This allows to demonstrate that our water availability indicator stay positive and significant at 0.1% while coefficients vary with the number of countries in our sample. In that respect, with only 25 countries, the coefficient is almost twice as large as the coefficient with 43 countries (such a difference is due to the fact that these 25 countries are the largest exporters of agricultural products). Similarly, considering an HS-6 level of disaggregation does not add more information as many products do not substantially vary between two classes of such disaggregation.

	25 Countries	25 Countries	33 Countries
LW_i^k	0.443^a	0.406^a	0.288^a
	(0.067)	(0.067)	(0.058)
L_i^k		-1.005^a	
		(0.171)	
Pair FE	*Yes*	*Yes*	*Yes*
Importer-product-time FE	*Yes*	*Yes*	*Yes*
Importer-time FE	*Yes*	*Yes*	*Yes*
Exporter-time FE	*Yes*	*Yes*	*Yes*
Product FE	*No*	*No*	*No*
Exporter FE	*No*	*No*	*No*
Importer FE	*No*	*No*	*No*
Cluster by Importer-Exporter-time	*Yes*	*Yes*	*Yes*
Pseudo R-square	0.8107	0.8111	0.7954
Log Pseudo likelihood	-307751.7359	-307129.2813	-454508.7187
Nb of Obs.	176 831	176 831	297 560

Notes: ^{abc} denote significance at the 1, 5 and 10 percent level respectively.

Estimations have been done with the PPML estimator.

Robust standard errors are reported under each coefficient.

Table 2.2: Additional estimations with extended countries and years

From these results, we can go further in the analysis by simulating the impacts that the climate may have upon the international trade pattern of agricultural products from the sole variation of this water availability indicator.

	33 Countries	HS-6	HS-6
LW_i^k	0.202^a	0.305^a	0.232^a
	(0.058)	(0.050)	(0.049)
L_i^k	-2.223^a		-1.716^a
	(0.189)		(0.177)
Pair FE	*Yes*	*Yes*	*Yes*
Importer-product-time FE	*Yes*	*Yes*	*Yes*
Importer-time FE	*Yes*	*No*	*No*
Exporter-time FE	*Yes*	*Yes*	*Yes*
Product FE	*No*	*No*	*No*
Exporter FE	*No*	*No*	*No*
Importer FE	*No*	*No*	*No*
Cluster by Importer-Exporter-time	*Yes*	*Yes*	*Yes*
Pseudo R-square	0.7986	0.7866	0.7885
Log Pseudo likelihood	-447276.713	-711186.677	-704719.3809
Nb of Obs.	297 560	1 097 124	1 097 124

Notes: ^{abc} denote significance at the 1, 5 and 10 percent level respectively.

Estimations have been done with the PPML estimator.

Robust standard errors are reported under each coefficient.

Table 2.3: Additional estimations with extended countries and years (Continued)

2.4 Simulations

2.4.1 Methodology of the Simulations

The climate change has became an important concern and many international organizations perform reports and projections about the impact of these changes on the world. Currently, the climate change has consequences on many aspects : human, social, environmental and economics. The greenhouse gazes has to consequences an alteration of meteorological conditions, leading to an increase of frequency, duration and severity of climatic phenomenons as droughts, storms or sea-level rise. These effects already affect the agriculture and FAO performs some studies to evaluate this impact, and tries to determine the consequences on food risk and water resources in the world. The growing temperatures and scarcity of rainfalls reduces agricultural productivity of lands and can lead to the impossibility to produce some products. The reduction of agricultural production in the world can be emphasized by other factors coming from climate changes too. World Bank estimates than around 143 millions of individuals have to move in order to run away climate imbalance effects in 2050. These effects will hit strongly some parts of the world. Three continents will be especially concern : Africa, Latin America and Asia. As shown is several reports of United Nations and FAO, each of these continents have different profiles but the origin of the problem and consequences are identical. For instance, subsaharian Africa could count around 86 millions of climate migrants from now until 2050, 17 millions for the Latin America and 40 millions for the South Asia. These intern movements of population will impact the water resources.

In this section, we simulate the impact on trade from a change in temperatures, evapotranspiration of crops and precipitations and also from expected migration that will change the opportunity costs of using water resources for agriculture. These alterations can be take into account with the water indicator built in the previous section as these variables are integrated in the calculation. In order to make simulations which are as closely as possible to reality, we are based on reports of different international organizations as United Nations, IOM (International Organization for Migration) and FAO. In the case of temperature and precipitations, we used data from the research program on Climate Change, Agriculture and Food Security (CCAFS) which supplied geo-data predictions for 2050 across the world. According scenarios, the temperature would increase between 1.8°C to 4°C (with a possible pic of 6.4°C), evapostranspiration data are not available, so we use a conversion coefficient based on Yates and Strzepek (1994) who estimates with different methods of evapotranspiration computation. In the simulations, an increase of 3°C will lead to an increase of 7% in the evapostranspiration. We use the estimations based on United States to translate these increases of temperature on the evapotranspiration crops. Regarding to climate migration, we use the data coming from the SEDAC which supplied a large number of maps. These maps allow us to obtain the geo-data about the number of individual across the world.

In that respect, we perform several simulations with different types of conditions but we present the results for combined changes only in the core of this article (the other results by each changes are in Appendix B.3 and B.4) and the method we adopt is relatively simple as we calculate the new trade flow $\hat{X}_{ij}^k$ from the equation estimated above with a new water availability indicator, noted $L\hat{W}_i^k$ which account for the climate and population changes.

$$L\hat{W}_i^k = \frac{1}{\hat{L}_i^k} \sum_{l \in i} \frac{\hat{A}_l^k \hat{W}_l^k}{\sum_k \hat{A}_l^k \hat{W}_l^k} \times area_l$$

Where $\hat{W}_l^k = \frac{\hat{P}_l + b_l^k \left(S\hat{W}_i + GW_l\right)}{E\hat{T}_l^k (1+\sigma_l)}$ and $\hat{A}_l^k = area_l \times C_l \times \hat{C}_l^k$ are respectively the new ratio between water supply and water demand (from a change in the precipitation $\hat{P}_l$, evapotranspiration $\hat{ET}_l^k$ and surface water availability $S\hat{W}_i$) and the new set of constraints.

The following figure depicts the change of such indicator in log scale.

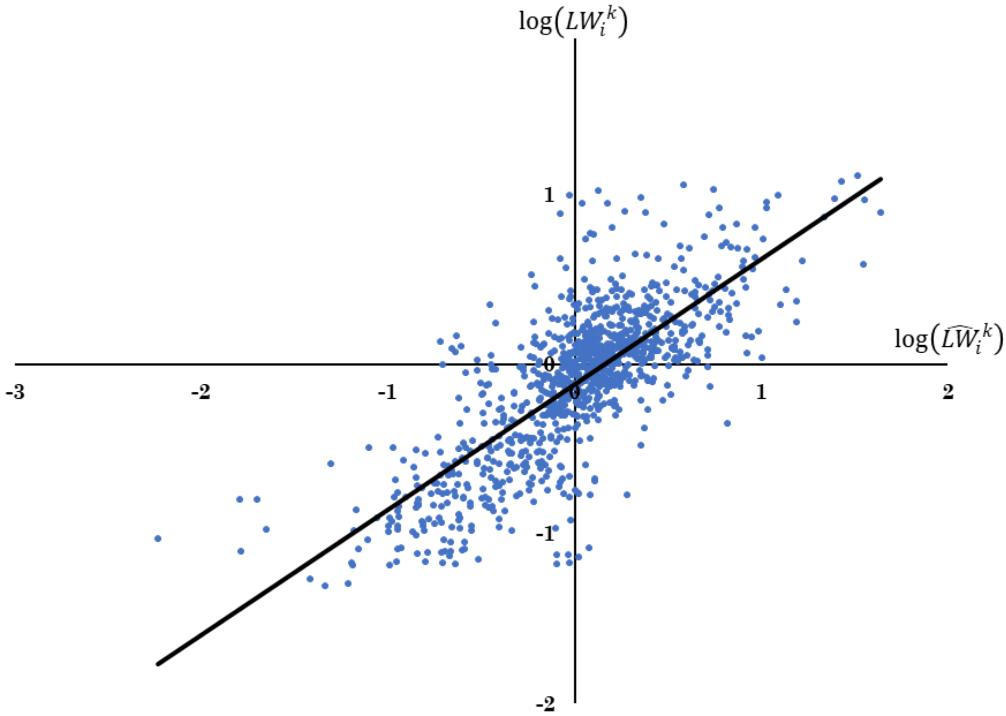


Figure 2.4.1: Correlation between the initial (LW_i^k) and the new ($L\hat{W}_i^k$) water availability indicator

As one may expect, such change are roughly proportional to the initial values such that countries with low indicator for a certain type of product stay relatively low after the change.

From that we can recalculate the expected trade for the year 2050 by (since their is only one year, we supress the subscript t):

$$\log\left(\hat{X}_{ij}^{k}\right) = \delta_{ij} + \delta_{j}^{k} + \delta_{i} + \lambda \log\left(L\hat{W}_{i}^{k}\right)$$

It is important to note that such a calculation is not accounting for any general equilibrium effects that would arise from any change of the productivity. Therefore this new value cannot be considered as the real effect of climate change but rather a partial effect that will locate the places of major changes.

2.4.2 Results of the Simulations

The Figure () is depicting the average change of our water availability indicator from the combined changes of climatic conditions and population settlement.

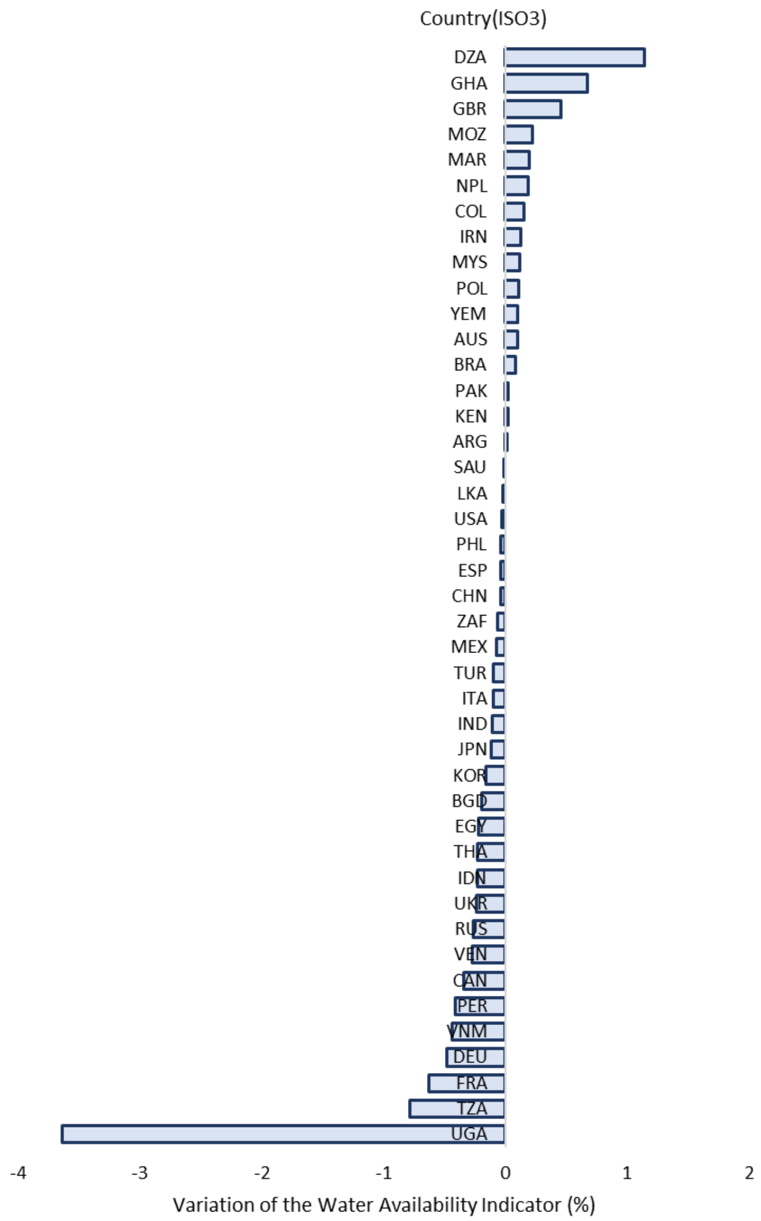


Figure 2.4.2: Variation of the Water Availibility Indicator by country

Most of the changes would be relatively small with variations ranging from -1% to +1% with Uganda being the outlier and the most affected with reduction of approximatively 3.5% of its average water availability. On the other end, Algeria may have the major increase at 1.14%. While this results may appear counterintuitive in light of other researches, it is important to note that these values are averages which mask some important variations.

The following graph (Figure(2.4.3)) depicts the average variation of trade in percentage following the variation in the water availability indicator and present some results quite different from the sole average variation of the indicator. In such a partial analysis, all countries would experience an average reduction of their trade in agricultural products. Yet, while developed countries in the northern hemishpere would have a relatively small reduction (averaging the 10% decrease), countries close to the tropics may dramatically suffer from such changes as exportations may fall by approximatively 75% in numbers of these countries (with the Mozambique experiencing the highest decrease at 81.34% followed by Pakistan and Algeria).

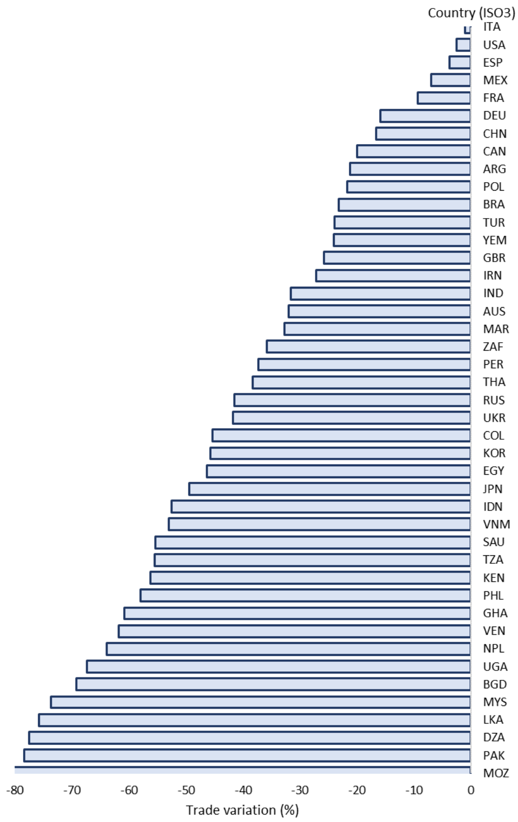


Figure 2.4.3: Trade Variation by country

As depicted in the Figure (2.4.4), we can also see that, at the product level, all agricultural products present in our analysis would experience a fall in their trade. The most notable fall would come from the Oil seeds (HS code 1207) and the Starches (HS code 1008) with a deacrease of more than 50% for this both products while the vegetables (HS code 709) and the Coffee (HS code 901) would be the least exposed by such changes with an approximate variation of less than 10% (note that vegetables would only vary by 3.83% while the coffee would vary by 10.59%). In overall, such changes in the climate conditions may impacts all countries with a varying degree of severity depending upon the type of specialization in which those countries are. Since the present analysis is only a partial effect of the climate change and not embedded into a general equilibrium, we do not compute welefare impacts as such value would be meaningless.

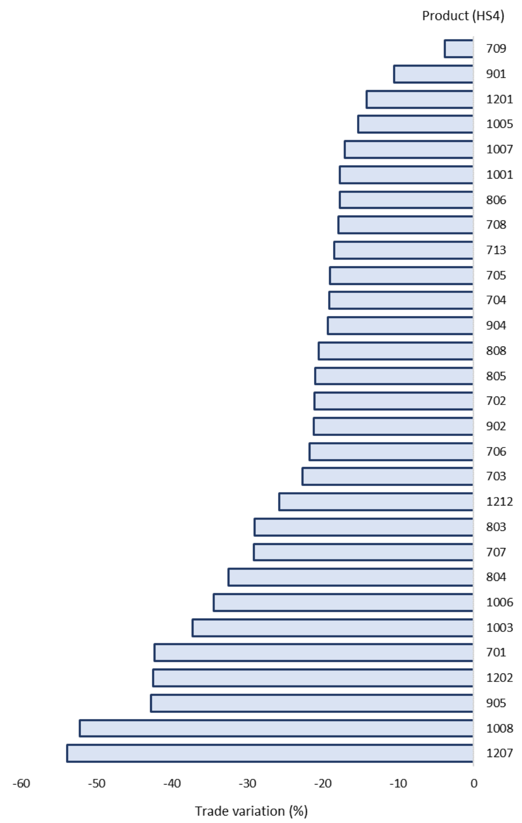


Figure 2.4.4: Trade Variation by Product

However, our indicator comming from highly disaggregated data can be used to determine places within countries that would be the most affected by this climate changes and correlate that to international specialization to focus upon localities that would likely face the main economic impact. For exemple, the next figure (Figure 2.4.5) depicts such effects for Brazil regarding their exportation of coffee.

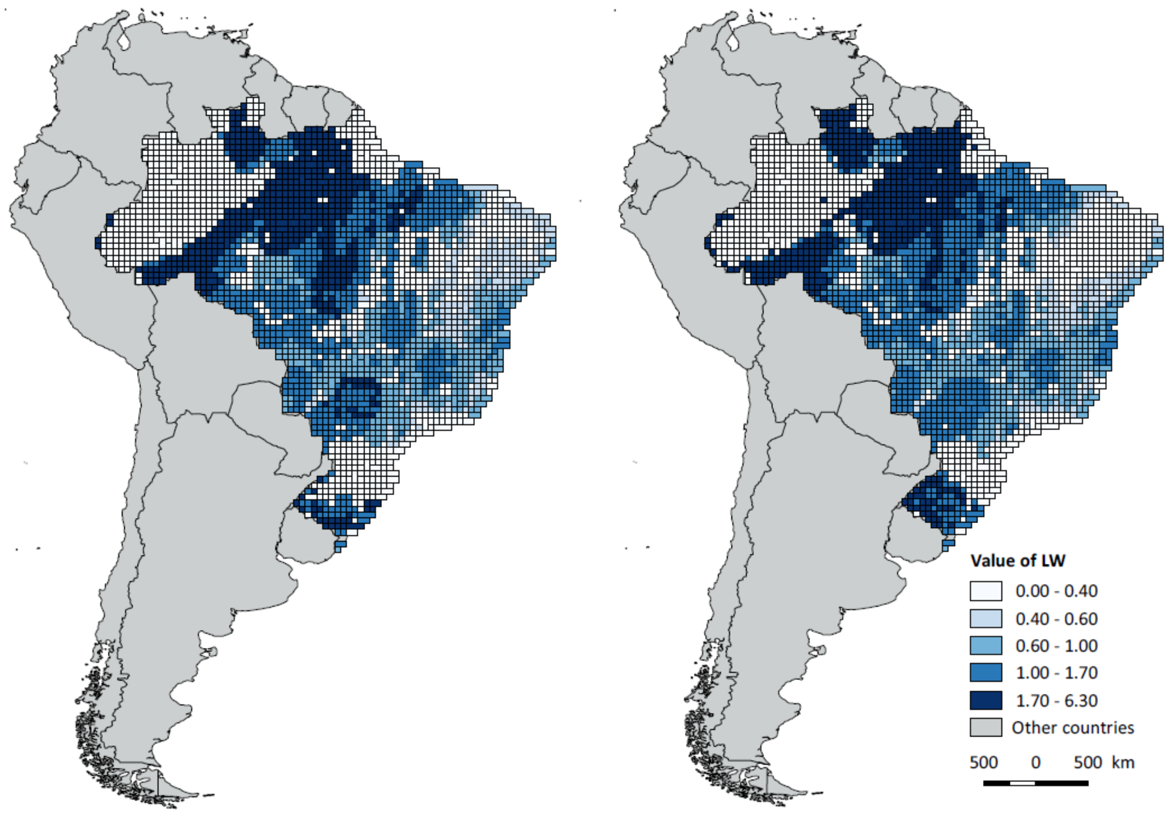


Figure 2.4.5: Water Indicator before and after taking into account the climate change for the coffee in Brazil

The reduction of available water affects the entire country but some areas are more impacted than other as the north and the center of the Brazil while some other areas in the south seem to increase their availability of water. Given the simulations including all changes (evapotranspiration, temperatures, rainfalls and population), we can note that the exports should collapse due to the climate change. In 2005, the coffee's exports represented around 1.9 millions of dollars and fall to 0.6 millions of dollar, so that's a reduction of around 64%. Given our simulations, we can conclude that the little reduction in the available water may lead to an important reduction in trade for this product and this country with varying impact within it.

2.5 Conclusion

In this article, we develop a new methodology to account for some of the different frictions that may arise along the chain of interactions from the water extraction to the trade at the international level of goods intensive in water, namely the agricultural ones. In that respect, it becomes possible to better identify the relationship between the effective water endowment of a country that can be used to produce a certain type of good and the international trade of that very same good and is thus a major innovation from the existing literature. Indeed, the latter solely examines the water availability at the country level such that the water resources in localities where conditions do not allow the production of certain type of good would have been accounted as resource available for use. However, by not accounting for the frictions that do exist in moving water from a locality of abundant supply to another locality of important demand is overestimating the water that can be effectively used in a given country. Therefore, the water availability indicator calculated in this article from highly disaggregated data allow to better measure the water endowment of a country by accounting more accurately for the relative geographic immobility of such a resource which can be conceptually defined as frictions in water reallocation within countries. Implementating this water availability indicator into a classical gravity equation model allows then to estimate the impact of such effective water endowment given the existence of frictions between countries.

The empirical analysis found a positive and significant coeficient for our water availability indicator with an important stability from the reobustness checks. This implies not only that such an indicator is a relevant measure of the water endowment of a country but also that such a water availability is a significant determinant of the trade in water intensive goods, confirming the results of some previous studies. This article is thus encouraging for further research in this direction and more specificaly to tackle the two main limits of the present article.

A first limit can be found in the calculation of the water availability indicator which is accounting in a very simple manner the political and hydrological dynamics of the localities within countries. A better implementation of the local institutions upon which rely most of the water allocation can be particularly helpfull in devising a more accurate indicator of water availability. A second limit can be found in the estimation of partial effects only and not to grasp the multiples links between water endowment and international trade through a general equilibrium model. In that respect, this article is a first step toward a deeper analysis into the relationship between the effective water endowment and the international trade.

Chapter 3

Chapter 3

The Benefits of Regional Trade Agreements in Africa

3.1 Introduction

For more than forty years, African countries have enforced many different Regional Trade Agreements (RTAs) that differ in their degree of integration, going from free trade areas,[1] to common markets[2], to customs unions[3] and finally to monetary unions[4][5].

What have been the effects of these agreements on trade? In the meta-analysis on RTAs undertaken by Cipollina and Salvatici (2010) and by Head and Mayer (2014), it is striking to observe that the bulk of the literature has been interested mainly in the EU, NAFTA, MERCOSUR or by RTAs in general, but not by RTAs in Africa[6]. Starting from the fact that trade between African countries only represents 15 percent of their exchange with the world (which is a small percentage

[1]The Southern African Development Community (SADC)

[2]The Common Market for Eastern and Southern Africa (COMESA) and the East African Community (EAC)

[3]The Economic Community of West African States (ECOWAS)

[4]The West African Economic and Monetary Union (WAEMU) and the Economic and Monetary Community of Central Africa (CEMAC)

[5]This chapter comes from Candau, Guepie and Schlick (2018).

[6]Focusing on African trade, the review of De Melo and Tsikata (2015) and Hoekman and Njinkeu (2017) document the lack of analysis of RTAs in Africa.

in comparison with other continents[7]) the conventional wisdom seems to be that many of the RTAs enforced have been inefficient. However, there is a long list of individual and bilateral variables that can explain the weak continental integration (specialization patterns, regional or civil conflicts, preferential agreements with developed countries, etc) that must be controlled before concluding on the usefulness of RTAs.

Using the historical data on trade compiled by Fouquin and Hugot (2016), we use dummies of RTAs that vary over time enabling us to control for the various variables explaining trade by using country pair, importer-year, and exporter-year fixed effects. All the aforementioned RTAs in Africa enforced between 1965 and 2014 are analyzed.

We find that RTAs have provided significant trade creation without trade diversion. We find that ECOWAS, SADC and COMESA have successfully fostered trade, only the WAEMU and to a lesser extent the CEMAC have been disappointing by bringing trade diversion without creation. We also assess the impact of past agreements, and find that the current RTAs have a most significant impact on trade than previous ones. For instance, only the current version of ECOWAS is clearly beneficial to trade.

Regarding the literature, only a handful of studies have been undertaken with the aim to better control for bilateral and individual-time unobserved characteristics in Africa. Carrère (2004), De Sousa and Lochard (2005)[8], Magee (2008), Mayer and Thoenig (2016), Candau, Guepie and Schlick (2019) are noticeable exceptions. However these studies work with shorter period of time, with smaller sample of countries or analyzed only one African RTA.

Lastly, in comparison with the literature, we lead different counterfactual analysis removing the COMESA, the SADC and the ECOWAS with a simple quantitative trade model (Arkolakis, Costinot and Rodriguez-Clare, 2012) which has the great advantage of transparency based on a tight connection between theory,

[7]Internal trade between North American countries represents almost 50 percent of their total trade. Similar numbers can be found for Asia, while internal trade in 'Fortress Europe' with 27 countries reaches 70 percent. Finally intra-trade between South American countries is around 30 percent.

[8]These authors don't analyze RTAs in Africa but currency barriers for two monetary unions in West and Central Africa.

data and estimations of key parameters. This kind of model has been increasingly used to quantify the gains from trade in Europe (Mayer et al., 2019; Dhingra et al., 2017), in North America (Caliendo and Parro, 2015), in the East African Community (Guepie and Schlick, 2019) but has never been used to quantify trade integration in 18 African countries, covering more than 12 RTAs in Africa.

The experiment which consists to turn off dummies of RTAs in order to calculate the counterfactual trade flows for all pair, shows that the COMESA, the SADC and the ECOWAS have created a substantial volume of trade by reducing trade costs and multilateral resistances of trade. This fillip on trade flows has however brought small welfare gains (few countries have gained more than 1%). Because the initial African flows were small, even a strong increase of trade flows has a weak impact on real income. As a robustness check, we also estimate the conditional and the full general equilibrium responses of removing RTAs using the Anderson and Yotov (2016) procedure. All the results are verified showing in addition that both buyers and sellers have benefited of the enforcement of RTAs.

The chapter is organized as follows. In Section II, the data and the empirical strategy is presented. Section III discusses the main results regarding trade creation. Section IV presents the counterfactual analysis and the final section outlines the study's conclusion.

3.2 Trade and Regional Trade Agreements in Africa

3.2.1 Empirical strategy

From neoclassical models of trade with perfect competition to new trade theories with increasing returns to scale, many different models display a gravity equation that takes the following form:

$$X_{od} = \phi_{od} \frac{Y_o}{\Pi_o^{1-\sigma}} \frac{Y_d}{P_d^{1-\sigma}} \tag{3.2.1}$$

where σ is the elasticity of substitution between varieties ($\sigma > 1$), ϕ_{od} an inversed measure of trade costs τ_{od} ($\phi_{od} = \tau_{od}^{1-\sigma}$i.e an indicator of trade openness) between

o and d, Y_d and Y_o the aggregated expenditures/incomes at the destination of exports d and at origin o. $\Pi_o^{1-\sigma}$ represents the market potential in o. This term is sometimes considered as an indicator of the market access from o and/or called outward multilateral resistance because it represents a GDP share weighted measure of trade cost resistance that exporters in o face when shipping their goods to consumers on their own and outward markets. Concerning African RTAs, this term may matter since the recent History of Africa (e.g. slavery, colonialism, preferential trade agreements[9]) has affected bilateral trade costs between African countries *relatively* to trade costs with distant countries. The term $P_d^{1-\sigma}$ in this gravity equation (3.2.1) is the accessibility-weighted sum of exporters-o capabilities also called inward multilateral resistance since it is a reversed measure of the openness of a nation to import from the world. Anderson and Yotov (2010) also consider this term as the buyers' incidence because it represents the weighted sum of trade costs paid by buyers.

This gravity equation is estimated using the pseudo-maximum likelihood (PML) estimator as follows:

$$X_{odt} = \exp\left(\alpha + f_{ot} + f_{dt} + \phi_{odt} + \epsilon_{odt}\right) \tag{3.2.2}$$

where f_{ot} and f_{dt} are time-varying countries-specific effects approximating exporting and importing capacity, $Y_{o,s}/\Pi_{o,s}^{1-\sigma_s}$ and $E_{d,s}/P_{d,s}^{1-\sigma_s}$ in Equation (3.2.1) at time t, α is a constant.

Subscripts o and d represent all countries in the world, and the dummy variable RTA_{odt} takes 1 at the year t when a regional agreement between these countries enters into force and zero otherwise.

To control for other bilateral relationships, binary bilateral variables are used i.e. dummies for colonial links, borders, common language and physical distance. Since this strategy raises doubts regarding the possibility of omitted variables, we compare results with estimations including bilateral fixed effects f_{od} to control

[9]The first Generalized System of Preferences were non-reciprocal schemes implemented by the European Economic Community and Japan in 1971 and by the USA in 1976, i.e. only a few decades after the wave of independances, to facilitate LDCs access to markets of rich countries. See Candau and Jean (2009) for a detailed analysis on the utilisation of these trade preferences in Africa.

for all unobserved time-unvarying bilateral determinants of exports (Baier and Bergstrand, 2007; Magee, 2008).

Consequently trade costs in (3.2.2) take the following form:

$$\phi_{odt} = \psi RTA_{odt} + \lambda RTA_{odt} AFR_{od} + f_{od} \quad (3.2.3)$$

where the dummy AFR_{od} taking value 1 for African pairs, in interaction with the dummy of RTAs (RTA_{odt}), captures the trade creation effect of African RTAs. In addition to individual-time fixed effects (see, 3.2.2) that control for several individual variables varying over time (such as change in internal infrastructures or internal conflicts) here we consider bilateral fixed effects that aim to take into account bilateral relationships that are constant over time.

3.2.2 Data and estimators

While regional trade agreements have strongly boosted regional trade in Europe or in North America, intra-African trade remains very low despite several agreements, here we consider six of them: the Economic Community of West African States (ECOWAS) within which eight countries have a deeper integration with the West African Economic and Monetary Union (WAEMU). The Economic and Monetary Community of Central Africa (known as CEMAC from its name in French) which is the other monetary union of our sample. The Common Market for Eastern and Southern Africa (COMESA) which is the largest regional agreement in Africa with a free trade area and a customs union since 2009. We also analyze the Southern African Development Community (SADC) and lastly the East African Community (EAC). Appendix C.1 provides a figure representing each country in the agreements signed. We compute a dummy taking one when these agreements enter in enforcement and zero otherwise.

We lead our analysis of trade flows on the bilateral TRADe HISTorical series, TRADHIST, a database from the CEPII (see Fouquin and Hugot, 2016). This database is to our knowledge the sole to compile bilateral flows at the aggregate level with an historical perspective allowing to analyze the effects of RTA over the period 1965-2014. This period of time enables to consider a dummy of RTA that varies over time, with the entry (and sometimes the exit) of members. Furthermore, even on recent periods (e.g. the 90's), TRADHIST is more complete. Other databases coming exclusively from COMTRADE (e.g. BACI) have many missing data of trade between African countries before 1994 which is very problematic since many significant RTAs have been signed on that period. These databases however have the advantage to provide data at a more desegregated level. The dummy of regional trade agreements, RTA_{odt}, comes from Jeffrey Bergstrand's homepage[10] and all dummies concerning specific agreements (e.g. "COMESA before 1994") are also built from these data.

To control for bilateral relationship we used bilateral fixed effects or a vector of dummies coming from the database GEODIST of the CEPII, i.e. dummies variables taking one when countries are contiguous ($contig_{od}$), when one country was the colonizer of the other ($colony_{od}$), when the two countries were part of the same country ($smctry_{od}$)[11], and when at least 9% of the population in both countries speak the same language ($lang_{od}$).

Equation (3.2.2) is estimated with Poisson Pseudo-Maximum-Likelihood (PPML) which is the most appropriated estimator of the trade gravity equation.[12]

3.3 Trade creation

All the results reported in Table (3.1) show that RTAs have significantly promoted trade. Column 1 depicts results of a standard gravity equation with individual fixed effects.

The effect of RTAs in general is high, in particular in Column 1 which presents the results of a standard gravity equation, indicating that this traditional specification with individual fixed effects over-estimates trade creation. The same

[10]https://www3.nd.edu/~jbergstr/ 2017

[11]Here, we define same country differently from Anderson and Yotov (2010) where their variable is equal to 1 when the flow is international and 0 when is internal.

[12]see Santos Silva and Tenreyro (2006) for detailed explanations and more recently Fally (2015, Proposition 1) which demonstrates that the estimated fixed effects with PPML are perfectly consistent with the multilateral resistances of the theoretical model

conclusion comes from individual-time fixed effects, the coefficient may be biased upward due to the lack of control. The most demanding specification (Column 3), where both individual-time fixed effects and bilateral fixed effects are taken into account leads to a strong reduction of the coefficient of RTAs in the general case (divided by 5). The coefficient of the interaction between RTAs and the African dummy is also smaller but to a lesser extent. The trade creation of RTA in Africa is thus strong and even stronger than the average effect of RTAs, boosting trade by around 95% ($e^{0.668} - 1$) between 1965 and 2012. Concerning the traditional variables of the trade gravity equation, standard results are obtained. The average distance elasticity is closed to -0.5 which is smaller than the one reported by studies using log-linear estimation with the OLS estimator[13] but in line with estimates using the PPML estimator.[14] The GDP elasticities as well as contiguity, a common language and a common colonizer have the usual sign and size.

[13]According to the meta-analyzis of Disdier and Head (2008) the mean coefficient is -0.9.

[14]Santos Silva and Tenreyro (2006) find an elasticity around -0.7 with PPML and an elasticity twice as large with OLS.

Period	1965-2012		
dep = X_{odt}	(1)	(2)	(3)
RTA_{odt}	0.505 ^{a}	0.514 ^{a}	0.102^{a}
	(0.055)	(0.019)	(0.026)
$RTA_{odt}AFR_{od}$	0.785^{a}	0.802 ^{a}	0.668 ^{a}
	(0.151)	(0.051)	(0.101)
$log(dist_{od})$	-0.559^{a}	-0.563^{a}	
	(0.028)	(0.008)	
$log(GDP_{ot})$	0.744 ^{a}		
	(0.041)		
$log(GDP_{dt})$	0.736^{a}		
	(0.039)		
$colony_{od}$	0.267^{a}	0.259^{a}	
	(0.086)	(0.018)	
$contig_{od}$	0.507^{a}	0.492 ^{a}	
	(0.080)	(0.021)	
$lang_{od}$	0.111	0.120 ^{a}	
	(0.071)	(0.018)	
$comcol_{od}$	0.295^{b}	0.291 ^{a}	
	(0.150)	(0.042)	
$smctry_{od}$	0.168	0.169^{a}	
	(0.181)	(0.046)	
Obs	874163	918852	835315
Pseudo R^2	0.85	0.87	0.99
Log likelihood	-2.852e+13	-2.552e+13	-4.605e+12

Notes: ^{abc} denote significance at the 1, 5 and 10 percent level respectively. Estimations have been done with the PPML estimator. Robust clustered standard errors are reported under each coefficient. Concerning fixed effects: Column 1: f_o , f_d ,f_t , Column 2: f_{ot} , f_{dt} and Column 3 f_{ot} , f_{dt} , f_{od} .

Table 3.1: Trade Creation

Table (3.2) analyzes different trade agreements in Africa with individual-time fixed effects and bilateral fixed effects. This analysis aims to measure the different enlargements of the different RTAs, we then consider a dummy for the current WAEMU, a dummy that takes one for countries that enforced this agreement in 1993 and another dummy for 1974 (Appendix C.1 provides a brief history of these different agreements). Similar dummies are computed for ECOWAS, CEMAC, SADC, COMESA and EAC. The second aim is to identify agreements that have made a difference when countries have enforced different RTAs. For instance eight countries belong to the WAEMU and to ECOWAS and the spaghetti bowl is even bigger for COMESA, SADC and EAC. Column 1 considers exclusively the WAEMU, the CEMAC, the SADC and their ancestors. Among the current agreements only the CEMAC is not significant. Regression 2 controls for the fact that the positive effect of the WAEMU (SADC) may be driven by the ECOWAS (respectively COMESA). This is indeed the case for WAEMU which is no longer significant after this introduction. At the opposite of this unsignificant effect, trade creation obtained thanks to ECOWAS has been strong, increasing trade by a coefficient of 0.9. In Column 3, all the dummies of RTAs are introduced, which shows that three agreements have been particularly efficient to stimulate trade: ECOWAS, SADC and COMESA. It is also noteworthy that some agreements that precede the current RTAs have been usefull to stimulate trade (SADC before 1993) while other not. For instance, only the current version of ECOWAS is clearly beneficial to trade.

	(1)	(2)	(3)
$WAEMU$	0.885^a	0.149	0.149
	(0.287)	(0.276)	(0.276)
$WAEMU\,(before\,1974)$	-0.086	-0.050	-0.050
	(0.469)	(0.521)	(0.522)
$WAEMU\,(before\,1993)$	0.238	0.350	0.351
	(0.311)	(0.267)	(0.267)
$ECOWAS$		0.906^a	0.907^a
		(0.295)	(0.295)
$ECOWAS\,(before\,1993)$		-0.171	-0.172
		(0.286)	(0.286)
$CEMAC$	0.091	0.076	0.076
	(0.593)	(0.594)	(0.594)
$CEMAC\,(before\,1994)$	-0.181	-0.189	-0.189
	(0.523)	(0.524)	(0.524)
$SADC$	1.177^a	1.180^a	1.178^a
	(0.192)	(0.190)	(0.190)
$SADC\,(before\,1993)$	0.068	0.798^b	0.734^b
	(0.341)	(0.337)	(0.331)
$COMESA$		0.648^b	0.674^a
		(0.250)	(0.258)
$COMESA\,(before\,1994)$		-0.471^c	-0.359
		(0.271)	(0.254)
EAC			0.337
			(0.342)
$EAC\,(before\,2000)$			0.052
			(0.228)
$Other\ RTA$	0.260^a	0.258^a	0.259^a
	(0.035)	(0.035)	(0.035)
Obs	835315	835315	835315
Pseudo R^2	0.9901	0.9901	0.9901
Log likelihood	-4.581e+12	-4.575e+12	-4.59e+12

Notes: ^{abc} denote significance at the 1, 5 and 10 percent level respectively. Estimations have been done with PPML. Robust clustered standard errors are reported under each coefficient. Individual and bilateral fixed effects (f_{ot} , f_{dt} , f_{od}) have been introduced in all regressions.

Table 3.2: Individual Trade Creation

We now need to go beyond this gravity equation and to analyze the effects of RTA with a theoretical framework, in particular to take into account trade diversion. Indeed, RTAs by impacting on the relative prices of goods and on multilateral resistances, leads to a reallocation of the demand, diverting trade from outside; but importer-year and exporter-year effects typically capture these diversion effects in our gravity equation. In other words, the coefficient of the RTAs presented here is conditioned to trade diversion, it only represents the *pure* trade creation effect (in Appendix C.2 for an empirical analysis of trade diversion). On the contrary, resolving a theoretical model leads to take into account multilateral resistances and thus the trade diversion that are included in these terms.

3.4 General Equilibrium Analysis

To assess the impact of past RTAs in Africa, we use the theoretical model of Arkolakis, Costinot and Rodriguez-Clare (2012) where the real market potential of exporters in the structural gravity equation (3.2.1) is defined by:

$$\Pi_o^{1-\sigma} \equiv \sum_{d=1}^{n} \left(\tau_{od}/P_d\right)^{1-\sigma} Y_d \tag{3.4.1}$$

while the price index of the consumption basket in the destination country is given by:

$$P_d^{1-\sigma} \equiv \sum_{o=1}^{n} \left(\tau_{od}/\Pi_o\right)^{1-\sigma} Y_o \tag{3.4.2}$$

Considering a Log-differenciation of the gravity equation (3.2.1) we present, hereafter and step by step, the impact of a change in trade costs due to RTAs.

By focusing our analysis on a change of trade costs ϕ_{od} in the numerator of (3.2.1), from ϕ_{od} to ϕ_{od}^c then we obtain the direct effect of trade costs. The upperscript c is used to characterize the counterfactual experiment. Assuming the part of trade costs related to RTAs is a linear function of $\ln \phi$ with a coefficient ψ, we can write the *direct* effect of the enforcement of RTA on bilateral trade flows in a very simple form:

$$Direct_{od} \equiv \dot{\phi}_{od} = \frac{\phi^c_{od}}{\phi_{od}} = \exp\left[\psi\left(RTA(1)_{od} - RTA(0)_{od}\right)\right], \tag{3.4.3}$$

where $RTA(0)$ means no RTA and $RTA(1)$ enforcement. The "dot" is used in this paper to represent the proportional change in a variable between its initial value and the counterfactual scenario.[15] As shown in this equation (3.4.3), the direct effect does not take into account price indices.

Now adding in this analysis how multilateral resistances vary after regional trade liberalization gives the *Price Index Effect* of RTAs[16]:

$$PIE_{od} \equiv \frac{\Pi_o P_d}{\Pi^c_o P^c_d} \exp\left[\psi\left(RTA(1)_{od} - RTA(0)_{od}\right)\right]. \tag{3.4.4}$$

To compute this, we first use the estimate of ψ obtained from Equation (3.2.3). See Table (3.2) for a discussion on this coefficient. Then we use the result of the gravity regression to measure trade costs ϕ_{od} , i.e. $\phi_{od} \equiv \exp[\widehat{\psi} RTA_{odt} + \widehat{\lambda} RTA_{odt} AFR_{od}]$. Using this measure of ϕ_{od} with expenditures Y_o and Y_d in Equation (3.4.1) and (3.4.2) with the contraction mapping of Head and Mayer (2014) gives the multilateral resistances Π_o and P_d. Then using the previous measure of ϕ_{od}, we get from Equation (3.4.3) the counterfactual trade costs ϕ^c_{od}, i.e. $\phi^c_{od} \equiv \phi_{od} \exp\left[\widehat{\psi}\left(RTA(1)_{od} - RTA(0)_{od}\right)\right]$. Using again the contraction mapping with ϕ^c_{od} and with the same expenditures Y_o and Y_d provides the counterfactual multilateral resistances Π^c_o and P^c_d. All these findings give the *PIE* of RTAs presented in Equation (3.4.4).

This Equation (3.4.4) of the price index effect revisits the Viner analysis of RTAs: any change between a pair of countries gives counterfactual changes in trade flows for all country pairs. Then trade diversion, which is a reduction of trade flows from outside the block after an RTAs are taken into account. The computation of the PIE is based on the assumption that RTAs do not affect incomes. This is a strong but useful assumption to decompose the force at work and to focus on change in prices after the implementation of RTAs.

[15] The literature usually work with a "hat", a notation here preserved to notify the predicted value of coefficients.

[16] Head and Mayer (2014) call this effect the Modular Trade Impact in reference to Anderson (2011). We prefer the term Price Index Effect which may be more telling.

Column 1 in Tables (3.3), (3.4) and (3.5) report the PIE considering successively the counterfactual removal of the COMESA, the ECOWAS and the SADC (using the coefficients obtained in the first part (column 3, Table (3.2))), which are the three African RTAs that have significantly promoted bilateral trade according to our previous analysis. The direct impact of these RTAs is a strong reduction of the delivered price of goods exported. For instance, trade frictions under the SADC are 0.30 time smaller than under the counterfactual, implying that without the SADC the value of trade frictions would be 69% higher. The direct impact of the COMESA and the ECOWAS is smaller but however high ($\dot{\phi}$ is respectively equals 0.509 and 0.403). To the extent that a significant RTA reduces the average trade barriers faced by an importer and an exporter (multilateral resistances), it dampens the direct impact of this RTA on bilateral trade flows (Anderson and van Wincoop, 2003). As a result the price index effect of RTAs is positive, indeed by reducing the delivered price, a reduction of tariffs leads to a reduction of price indices, increasing the purchasing power of consummers and then the demand of new goods and finally bilateral exchanges. The PIE seems to have been particularly strong and homogeneous for countries of the ECOWAS. In constrast the COMESA and the SADC have brought unequal indirect gains, for instance South Africa is one of the country that gets the most significant reduction in multilateral resistances thanks to the SADC, the PIE is equal to 6.3, which may be compared with the ratio of Lesotho which is the smallest in this sample (equal to 2.1). The reduction of bilateral barriers relative to average trade barriers that these two countries face with all their trading partner has been certainly stronger for South Africa than for a small and isolated country like Lesotho.

Country	PIE	GETI	Welfare	Inward Multi	Outward Multi	Factory Price	Real GDP
Angola	2.121%	8.965%	0.040%	-0.198%	-0.198%	0.159%	0.359%
Burundi	5.389%	28.886%	5.378%	-0.218%	-0.209%	0.167%	0.387%
Djibouti	5.463%	8.793%	0.029%	-0.215%	-0.206%	0.165%	0.382%
Egypt	5.526%	8.897%	0.061%	-0.189%	-0.185%	0.148%	0.338%
Ethiopia	5.754%	1.968%	1.223%	-0.214%	-0.206%	0.165%	0.381%
Kenya	5.455%	8.588%	0.028%	-0.209%	-0.200%	0.160%	0.370%
Libya	5.385%	8.766%	0.013%	-0.190%	-0.195%	0.156%	0.348%
Lesotho	1.992%	8.549%	0.060%	-0.163%	-0.158%	0.127%	0.290%
Madagascar	2.009%	15.453%	0.765%	-0.217%	-0.210%	0.168%	0.386%
Mozambique	2.116%	2.286%	0.775%	-0.161%	-0.157%	0.126%	0.288%
Mauritius	3.864%	8.819%	0.032%	-0.149%	-0.138%	0.111%	0.261%
Malawi	3.001%	8.120%	0.100%	-0.196%	-0.186%	0.149%	0.347%
Rwanda	5.382%	8.805%	0.031%	-0.218%	-0.209%	0.167%	0.387%
Somalia	5.389%	8.718%	0.017%	-0.210%	-0.206%	0.165%	0.377%
Swaziland	3.654%	8.395%	0.074%	-0.170%	-0.160%	0.128%	0.300%
Uganda	5.608%	8.739%	0.056%	-0.193%	-0.183%	0.147%	0.342%
Zambia	2.024%	8.553%	0.194%	-0.217%	-0.208%	0.166%	0.385%
Zimbabwe	2.030%	2.803%	0.137%	-0.216%	-0.208%	0.166%	0.384%

Notes : The benchmark year is 2006. The direct impact of the COMESA is 0.509. Some member's countries of COMESA are not present in our results because of a lack in data (Seychelles, Democratic Republic of Congo, Comoros, Eritrea and Sudan). PIE and GETI are the country's mean facing all others countries.

Table 3.3: General Equilibrium effects of COMESA

Country	PIE	GETI	Welfare	Inward Multi	Outward Multi	Factory Price	Real GDP
Benin	7.365%	11.434%	0.037%	-0.115%	-0.109%	0.089%	0.205%
Burkina Faso	7.361%	11.542%	0.035%	-0.117%	-0.109%	0.089%	0.207%
Côte d'Ivoire	7.467%	11.558%	0.025%	-0.110%	-0.102%	0.083%	0.194%
Cap Verde	7.374%	12.523%	0.140%	-0.110%	-0.103%	0.084%	0.195%
Ghana	7.750%	11.429%	0.043%	-0.096%	-0.087%	0.071%	0.168%
Guinee	7.740%	11.595%	0.002%	-0.091%	-0.083%	0.068%	0.159%
Gambia	7.378%	11.511%	0.038%	-0.116%	-0.110%	0.090%	0.206%
Liberia	7.478%	11.571%	0.061%	-0.106%	-0.098%	0.080%	0.188%
Mali	7.371%	11.133%	0.115%	-0.117%	-0.109%	0.089%	0.207%
Niger	7.792%	11.299%	0.021%	-0.090%	-0.082%	0.067%	0.159%
Nigeria	7.393%	11.528%	0.007%	-0.102%	-0.107%	0.087%	0.190%
Senegal	7.377%	11.294%	0.033%	-0.116%	-0.108%	0.088%	0.205%
Sierra Leone	8.624%	10.545%	0.100%	-0.117%	-0.110%	0.089%	0.207%
Togo	7.436%	11.202%	0.076%	-0.113%	-0.105%	0.086%	0.199%

Notes : The benchmark year is 2006. The direct effect of ECOWAS is 0.403. Guinee-Bissau not present in our results because of a lack in data. PIE and GETI are the country's mean facing all others countries.

Table 3.4: General Equilibrium Effects of ECOWAS

Country	PIE	GETI	Welfare	Inward Multi	Outward Multi	Factory Price	Real GDP
Angola	2.352%	-10.146%	0.522%	-0.197%	-0.197%	0.158%	0.356%
Botswana	5.736%	30.162%	4.219%	-0.213%	-0.205%	0.164%	0.379%
Lesotho	2.159%	13.251%	0.078%	-0.216%	-0.206%	0.165%	0.383%
Madagscar	2.185%	30.386%	1.748%	-0.208%	-0.205%	0.164%	0.374%
Malawi	3.663%	13.065%	0.109%	-0.186%	-0.182%	0.146%	0.333%
Mauritius	4.887%	13.951%	0.042%	-0.139%	-0.134%	0.107%	0.247%
Mozambique	2.347%	5.503%	1.664%	-0.212%	-0.205%	0.164%	0.378%
South Africa	6.308%	10.741%	0.228%	-0.156%	-0.153%	0.123%	0.280%
Swaziland	4.625%	12.914%	0.075%	-0.160%	-0.156%	0.125%	0.286%
Tanzania	6.607%	13.446%	0.040%	-0.207%	-0.204%	0.164%	0.372%
Zambia	2.207%	21.577%	1.168%	-0.210%	-0.204%	0.163%	0.375%
Zimbabwe	2.217%	8.922%	0.832%	-0.210%	-0.203%	0.163%	0.374%

Notes : The benchmark year is 2006. Seychelles doesn't appear in this table because it was not member of SADC at our benchmark year. The direct effect of SADC is 0.307. Some member's countries of SADC are not present in our results because of a lack in data (Seychelles, Democratic Republic of Congo and Namibia). PIE and GETI are the country's mean facing all others countries.

Table 3.5: General Equilibrium Effects of SADC

This analysis thus shows that the trade creation effect has been stronger that the trade diversion after the enforcement of the COMESA, the ECOWAS and the SADC.

However one important aspect of trade liberalization has been neglected: the impact of RTAs on wages/incomes. Taking into account this change, the General Equilibrium Trade Effect (GETI), is defined as follows:

$$GETI_{od} = \frac{Y_o' X_d'}{Y_o X_d} \frac{\Pi_o P_d}{\Pi_o^c P_d^c} \exp\left[\psi \left(RTA(1)_{od} - RTA(0)_{od}\right)\right]$$

Where Y_o' and X_d' denote respectively the production in origin country and the expenditures in destination country after trade costs changes.

Considering the production side with labour as the sole factor of production in each country $i = (o, d)$, $Y_i = w_i L_i$, and by considering change in the labour force as constant, then changes in incomes are determined by changes in wages $\dot{w} = \dot{Y}$). Since trade deficit are constant, change in expenditures equals change in incomes (indeed with$X_d = w_d L_d (1 + d_d)$) where d_d is the deficit of country d, gives $\dot{X}_d = \dot{w}_d = \dot{Y}_d$). To determine the equilibrium change in income we use the share of expenditure of consummers in o spent on goods produced in d, $\pi_{od} = X_{od}/X_o$. Finally, the change in expenditure due to a trade shock is given by:

$$\dot{\pi}_{od} = \frac{\dot{\phi}_{od} \dot{Y}_o^{1-\sigma}}{\sum_l \pi_{ld} \dot{\phi}_{ld} \dot{Y}_l^{1-\sigma}}. \tag{3.4.5}$$

Inserting this expression in the market clearing enables to solve the system and to get the income change due to the enforcement of a RTA:

$$\dot{Y}_d = \frac{1}{Y_d} \sum_{o=1}^{n} \frac{\pi_{od} \dot{\phi}_{od} \dot{Y}_o^{1-\sigma}}{\sum_l \pi_{ld} \dot{\phi}_{ld} \dot{Y}_l^{1-\sigma}} \dot{Y}_o X_o. \tag{3.4.6}$$

Using the direct effects calculated earlier, with Y_o approximated by GDPs, and the trade share π_{od} of each country o, gives from (3.4.6) a system of equations defining $\dot{Y}_o$, which once inserting in the trade share expenditure (3.4.5)[17], gives the General Trade Equilibrium Impact (GETI) of trade shock: $\dot{\pi}_{od} \dot{Y}_d$. We also compute the welfare gains of RTAs under this quantitative exercise, given by $\dot{\pi}_{dd}^{1/(1-\sigma)}$, since welfare depends only on changes in the trade to GDP ratio.

To assess the removal impact of African RTAs, it is essential to have internal flows to measure domestic expenditures in order to re-calculate multilateral resistances and GDPs after a change in trade costs. As a consequence, we use the Input-Output Tables coming from EORA Database. This database contains the Input-Output tables for 195 countries. We choose the 2006's table as benchmark year and the Uruguay as a reference since this country shares characteristics with some African countries in terms of size and in terms of trade agreements. Readers have to keep in mind that with a General Equilibrium model, the solution should be independent of the normalization by reference country. Then to avoid any doubt about that, we have checked that changing reference country does not modify our results. With Perou, Paraguay and Vietnam which are more close to Subsaharian Africa in terms of GDP per capita, findings are still the same. In

[17]To resolve the system we need an estimate of the constant elasticity of substitution between variety, we use $\sigma = 4.03$ which is the number obtained in the meta-analysis of Head and Mayer (2014).

Appendix C.3 we also propose different results where we change our benchmark year (2010 and 2000). Results are almost unaffected.

Table (3.3), (3.4) and (3.5) witness the impact of RTAs detailling the GETI and the welfare gains at the country level for each agreements.

Concerning the GETI, the most striking result is that RTAs have impacted on the income of all countries with particular strong impact on the exportations of some of them such as Madagascar where exports soar to 30% in comparison with a situation without the SADC. Results are quite similars between members of ECOWAS (varying around an increase of eleven percents), while the trade effects of the COMESA and even more of the SADC are quite heterogeneous with different GETIs between members. For instance, Zambia has an increase of trade flows around 21 percent while Mozambique only an increase of 5.5 percent. Finally, the SADC records the most important value of GETI (around 30%) for two countries (Botswana and Madagascar).

In comparison, effects on welfare are small, for instance the highest gain under the ECOWAS is an increase of 0.1% of the monetary well-being in Mali. In comparison, the COMESA and the SADC have been much more welfare improving, increasing real GDPs by approximately 0.7% to 1% for many countries. In computing the mean of welfare for each agreement analyzed in this paper, the SADC provides the biggest gains (0.89%) while the smallest gains come from the ECOWAS (0.05%).

This relative small impact of RTAs on welfare must be balanced with other findings. Calculating the "cost of Non-Europe", Mayer et al (2019) for instance find that the Single market has increased trade between EU members by 109% on average with an associated welfare gains around 4.4% for the average European countries. Because the initial African flows were smaller than the European initial trade, it is not surprising that even a strong increase of trade will result in very tiny changes in the share of expenditure that is spent locally in Africa and as a result involves a small welfare gains.

We supplement these results with the analysis of Anderson and Yotov (2016) and Anderson, Larch and Yotov (2018) as a robustness check.[18] These authors also depart from the gravity equation (3.2.1) but use the model differently to

[18]Stata code for this analysis and the previous one are provided online.

get another insight of the impact of trade costs. While the previous analysis was based on observed data of trade flows, here the incidence of trade costs are based on predicted trade flows. More precisely we estimate Equation (3.2.2) twice, first with $\phi_{odt} = \psi RTA_{odt} + f_{od}$ and then with $\phi^c_{odt} = \beta\bar{\psi} RTA^c_{odt} + \bar{f}_{od}$ where RTA^c_{odt} takes one for all RTAs enforced in the world excepted the African RTAs studied (e.g. COMESA) and zero otherwise. As previously, the upper-script c is used to characterize the counterfactual experiment and the "bar" the coefficient estimated in the first estimation, i.e. the second estimation is a constrained version of the first one. Based on the work of Fally (2015), time-varying countries-specific effects f_{ot} and f_{dt} estimated from Equation (3.2.2) with $\phi_{odt} = \psi RTA_{odt} + f_{od}$ are considered as an exact measure of price indices and then used to construct the outward multilateral resistances:

$$\widehat{\Pi}^{1-\sigma}_{ot} \equiv \frac{Y_{o,t}}{\exp(\widehat{f}_{ot})} N_{UY,t}, \tag{3.4.7}$$

where $N_{UY,t}$ represents aggregate expenditure of the dropped country in the initial estimation which is used as the numeraire, i.e. all other effects are interpreted with respect to that one. Here we choose the Uruguay (denoted UY) as in the previous methodology. This normalization is done without loss of generality, the solution we get is independent of the normalization. Similarly, the inward resistance is given by:

$$\widehat{P}^{1-\sigma}_{dt} \equiv \frac{Y_{d,t}}{\exp(\widehat{f_{dt}})} \frac{1}{N_{UY,t}} \tag{3.4.8}$$

This analysis is in the spirit of the empirical literature in economic geography that used the predicted value of individual fixed effects to compute the market and the supplier market access to explain the cross-country variation in per capita income (Redding and Venables, 2004), the location choices of multinational firms (Candau and Dienesch, 2017), and the concentration of activities in nations's largest metropolis (Candau and Gbandi, 2019).

These multilateral resistances are also computed by using the estimates of time-varying countries-specific effects obtained from the estimation of the constrained Equation (3.2.2), i.e. with $\phi^c_{odt} = \beta\bar{\psi} RTA^c_{odt} + \bar{f}_{od}$. We also used these estimations to determine the change in the factory-gate price defined by:

$$Factory_{od} \equiv \dot{p}_{od} = \frac{p^c_{ot}}{p_{ot}} = \left(\frac{\exp(\widehat{f^c_{ot}})/N^c_{UY,t}}{\exp(\widehat{f_{ot}})/N_{UY,t}} \right)^{1/(1-\sigma)} \tag{3.4.9}$$

Using this factory price in incomes (e.g. $Y^c_{ot} = Y_{ot}p^c_{ot}/p_{ot}$) and then in the theoretical equation (3.2.1) finally leads to new trade flows in the counterfactual exercises:

$$\dot{X}_{odt} = \dot{\Phi}_{odt}\dot{Y}_{ot}\dot{Y}_{dt}\dot{\Pi}_{ot}\dot{P}_{dt} \tag{3.4.10}$$

where $\dot{\Phi}_{odt}$ is given by:

$$\dot{\Phi}_{odt} = \frac{\exp(\bar{\psi}RTA^c_{odt} + \bar{f}_{od})}{\exp(\psi RTA_{odt} + f_{od})} \tag{3.4.11}$$

Table (3.3), (3.4) and (3.5) report the results of these variables for the different agreements. In each case, RTAs have led to a reduction of buyers and sellers' incidence. They are however interesting difference accross countries that confirms the previous analysis. Madagascar for instance is one of the country with the highest change in the buyers and sellers's incidence. Among all agreements, the SADC has been the most beneficial for both sellers and buyers. Countries like Botswana, who are not heavily specialized on agricultural goods, are also in this exercise among the biggest winners of RTAs with a significant decrease in the outward and inward multilateral resistances. The effects of RTAs are however modest in term of changes in factory prices (increase by only 0.15% for many sellers) and in term of welfare confirming the previous analysis[19].

[19] There are also some differences between the two analysis. An interesting one is that the dispersion of change in GDP is smaller here, e.g. we do not find the strong increase in welfare for countries like Burundi (4%). Another difference with the GETI results is that some 'remote' countries, such as Lesotho, are those that benefit the most of RTAs. These differences are however minors and may be simply understood by the fact that the second methodology is more an estimation of the general equilibrium effects than a computation of these effects.

3.5 Concluding remarks

The marginalization of Africa in the world trade system is still a reality.[20] Africa's share of world exports has declined from about 6 percent in 1974 to 1.6 percent in 1995, and even if this number has since more than doubled it only reached 3.2 percent in 2014.[21]Despite this poor performance, the current study shows that RTAs cannot be accused of pointlessness. Some agreements have failed to deliver the expected trade gains, this is particularly true for the WAEMU since its early design, but overall RTAs have fostered trade in Africa. Results are even comparable with those obtained elsewhere in the world, for instance the COMESA and the ECOWAS provide similar effects than the NAFTA in term of trade flows [22]. As shown in our counterfactual analysis, these RTAs have contribuated to reduce trade frictions and multilateral trade resistances in Africa. Their effects on welfare are obviously still small, but with the increasing integration of African countries in the world trade system, one can expect that the future generation of RTAs in Africa will have more substantial effects.

[20]Sachs and Warner (1997) and Subramanian and Tamirisa (2001) consider the marginalization of Africa as a consequence of a lack of trade integration while Foroutan and Pritchett (1993) and Rodrik (1998) view this marginalization as a consequence of their low income levels.

[21]Authors' calculation from Comtrade.

[22]Cipollina and Salvatici (2010) find in their meta-analyzis that the mean coefficient for NAFTA is equal to 0.90.

Chapter 4

Chapter 4

Gains and Losses in a Trade Bloc : The Case of the East African Community

4.1 Introduction

For more than forty years, African countries have enforced many different Regional Trade Agreements (RTAs) but empirical analysis of the effects of these agreements on trade and welfare are still scarce[1]. The current paper analyzes the East African Community (EAC). Founded in 1967 by the three countries of Kenya, Tanzania and Uganda, the first EAC collapsed in 1977 on the grounds that Kenya was taking the lion's share of the benefits of the EAC. The new EAC enforced in 2000 by Kenya, Tanzania and Uganda and then by Rwanda and Burundi in 2007, which became a fully-fledged Customs Union in 2009, adopts a more optimistic point of view by considering this regional integration as mutually beneficial. To our knowledge these successively negative and positive opinions have never been analyzed until now, at least not in the way we proceed.

Using fifty years of trade data over the period 1964-2014, we undertake a within identification strategy with dummies of the EAC that varies over time enabling

[1]This chapter is based on Guepie and Schlick (2019)

us to control for the various variables explaining trade by using importer-year, exporter-year and country pair fixed effects. We find that the former EAC (1967-1977) has not been significant to foster trade while the recent EAC has strongly increased bilateral exports over the period 2000-2012. Beyond this statistical analysis, we use a multi-country and multi-sector Ricardian model to quantify and to decompose the gains/losses of the current EAC between countries and across sectors. The model is based on Caliendo and Parro (2015) and takes into account the international trade of intermediate goods and the impact of input-output linkages on trade. It is a well known fact that countries exchange intermediate goods along the global supply chain, however since African countries are highly specialized and often viewed as marginalized to the world trade network, counterfactual analysis with such a model has never been done for RTAs in Africa. Still, at the beginning of the EAC in 2000, trade in intermediate goods represented half of the total importation of the members of this agreement.[2] Then, it seems crucial to take into account these data to assess the impact of the EAC.

Regarding the literature on gravity equations, only a handful of studies has been undertaken with the aim to better control for bilateral and individual-time unobserved characteristics in Africa. Carrère (2004) provides convincing evidence of the positive effect of RTAs on African trade using a panel specification with random bilateral effects. In comparison we use here bilateral fixed effects, and country-year effects to control for institutional and cultural determinants of trade that vary over the period analyzed. This analysis is in the vein of the seminal paper of Magee (2008) and follows in particular Mayer and Thoenig (2016) who analyze how trade has pacified Eastern Africa.

Regarding the counterfactual analysis, many Computable General Equilibrium models (CGE) have been used to analyzed the EAC (Willenbockel, 2012; Balistreri et al., 2016), and have concluded that this agreement has successfully promoted growth and reduced poverty in the trade bloc. Mayer and Thoenig (2016) and Candau, Guepie and Schlick (2019) use a middle size model without intermediate trade (Arkolakis et al. 2012) to study RTAs and find that these agreements has

[2]Based on the Comtrade database, the import share of intermediate goods in Kenya was equal to 56%, 55% in Burundi, 41% in Rwanda, 54% in Tanzania, 50% in Uganda. Intermediate goods refer to UNCTAD-SoP2 and UNCTAD-SoP4 HS6 groups

been beneficial to promote trade. Here, using a richer model than the Arkolakis et al. (2012) model, but however more transparent than classical CGE, our conclusion is less positive. We find strong trade diversion in many countries (in particular in Rwanda) and a deterioration of the term of trade in all members (with the exception of Kenya). Considering the overall impact, including trade creation, we find that the EAC has been beneficial but gains remains small, i.e. close to zero for Burundi, Uganda and Tanzania and close to 1% for Kenya and Rwanda. Our analysis also shows that not taking trade in intermediate goods into account leads to the overestimation of the effect of the EAC.

The chapter is organized as follows. In Section II, the data and the empirical strategy are presented. Section III discusses the main results regarding trade creation. Section IV presents the counterfactual analysis and the final section outlines the study's conclusion.

4.2 Preliminary results

4.2.1 The model

Our analysis is based on Caliendo and Parro (2015) who propose a multi-country and multi-sector Ricardian model (i.e. an extension of Eaton and Kortum, 2002). There are N countries and J sectors. Subscripts k and j are used for sectors, o and d for countries. Labour and intermediate goods are the inputs of production. Labour is paid w_d and is mobile between sectors but not between countries. This economy is composed of L representative households that maximize a Cobb-Douglas utility function of final goods denoted C_d^j, with α_d^j the preference parameter for these goods. A continuum of intermediate goods ω^j, also called materials, is produced in each sector. Producers of intermediate goods differ in their efficiency to produce by a factor $z_d^j(\omega^j)$ drawn from a Fréchet distribution with a location parameter λ_d^j that varies by country and sector, and a shape parameter θ^j that varies by sector j. The production function takes the form of Cobb-Douglas function with γ_d^{kj} the share of materials from sector k used in the production of intermediate good j, and γ_d^j the share of labour in this production function. Intermediate goods are produced under constant return to scale and firms evolve under perfect competition and set the price at the unit cost $c_d^j/z_d^j(\omega^j)$ with c_d^j the cost of an input given by:

$$c_d^j = A_d^j w_d^{\gamma_d^j} \prod_{k=1}^{J} (P_d^k)^{\gamma_d^{k,j}} \tag{4.2.1}$$

with

$$P_d^k = \left[\int p_d^k(\omega^k)^{1-\sigma^k} d\omega^k \right]^{1/(1-\sigma^k)} \tag{4.2.2}$$

where $p_d^k(\omega^k)$ is the lowest price of intermediate good ω^k across all location d, σ^k is the elasticity of substitution between intermediate goods within sector j, A_d^j is a constant and P_d^k the price index of intermediate goods. This equation clearly describes the sectoral linkages, where change in a price of one intermediate goods affects the costs of other products.

Producers in sector j in country d supply a composite intermediate good by purchasing intermediate goods ω^j from the lowest cost suppliers across countries. The production function of the composite goods takes the classical form proposed by Ethier (1982). These composite goods are used for the production of intermediate and final goods. The consumption price index is given by:

$$P_d = \prod_{k=1}^{J} (P_d^k/\alpha_d^k)^{\alpha_d^k} \tag{4.2.3}$$

Trade costs, κ, are iceberg costs and depend on tariffs and distance:

$$\kappa_{do}^j = \tilde{\tau}_{do}^j d_{do}^j \tag{4.2.4}$$

with $\tilde{\tau}_{do}^j = (1 + \tau_{do}^j)$ where τ_{do}^j is the ad-valorem tariff and d_{do} the distance between o and d.

Using the properties of the Fréchet distribution, the expenditure shares, denoted π_{do}^j, takes the following form:

$$\pi_{do}^{j} = \frac{\lambda_o^j [c_o^j \kappa_{do}^j]^{-\theta^j}}{\sum_{h=1}^{N} \lambda_h^j [c_h^j \kappa_{dh}^j]^{-\theta^j}} \tag{4.2.5}$$

This share is thus just a function of prices, technologies and trade costs. Total expenditure on goods j, X_d^j, is the sum of the expenditures such as:

$$X_d^j = \sum_{k=1}^{j} \gamma_d^{j,k} \sum_{o=1}^{N} X_i^k \frac{\pi_{od}^k}{1+\tau_{od}^k} + Y_d \alpha_d^j \tag{4.2.6}$$

where the income I_d depends on wages w_d, tariff revenues R_d, and trade deficit D_d:

$$I_d = w_d L_d + R_d + D_d$$

4.2.2 The gravity equation

From the previous subsection, the total expenditure of country d on goods from o is given by:

$$X_{od}^j = \pi_{do}^j X_d^j$$

which observing (4.2.5), (4.2.6), adding time t and summing on sectors j takes the form of a general gravity equation:

$$X_{odt} = \frac{f_{ot} f_{dt}}{d_{odt}} \tag{4.2.7}$$

where f_{ot} and f_{dt} represent the comparative advantage of countries (productivity, costs) and the purchasing power of consumers (prices indices and incomes). f_{ot} is often considered as an indicator of the market access from o and/or called outward multilateral resistance because it represents a GDP share weighted measure of trade cost resistance that exporters in o face when shipping their goods to consumers on their own and outward markets. Concerning African RTAs, this term matter since different significant historical events (e.g. slavery, colonialism, preferential trade agreements[3]) have affected bilateral trade costs between African

[3] The first Generalized System of Preferences were non-reciprocal schemes implemented by the European Economic Community and Japan in 1971 and by the USA in 1976, i.e. only a few decades after the wave of Independence, to facilitate LDCs access to markets of rich countries. See Candau and Jean (2009) for a detailed analysis on the utilisation of these

countries *relatively* to trade costs with distant countries. The term f_{dt} in this gravity equation is the accessibility-weighted sum of exporters-o capabilities also called inward multilateral resistance since it is a reversed measure of the openness of a nation to import from the world.

This gravity equation is estimated using the Poisson Pseudo-Maximum Likelihood (PPML) estimator[4] as follows:

$$X_{odt} = \exp\left(\alpha + f_{ot} + f_{dt} + f_{od} + \psi_1 EAC_{odt} + \psi_2 RTA_{odt} + \epsilon_{odt}\right) \tag{4.2.8}$$

where f_{ot} and f_{dt} are time-varying countries-specific effects approximating exporting and importing capacity at time t, α is a constant. Trade flows X_{odt} come from the bilateral TRADe HISTorical series, TRADHIST, a database from the CEPII (see Fouquin and Hugot, 2016) over the period 1965-2012. Respectively the dummy EAC_{odt} (RTA_{odt}) takes one at year t when the EAC (another RTA) enters into force and zero otherwise. These dummies come from Jeffrey Bergstrand's homepage[5].

To control for bilateral determinant of trade, f_{od}, we use a vector of dummies coming from the database GEODIST of the CEPII. These binary variables take one when countries are contiguous (called *Contiguity*), when a country was the colonizer of its trade partner (called *Colony*), when two countries had the same colonizer (called *Common Colony*), when the two countries were part of the same country (*Same Country*), when at least 9% of the population in both countries speak the same language (*Official Language*) and when two countries share a least one ethnic language (*Ethnic Language*). Since this strategy to add arbitrarily variables may raise doubt regarding the possibility of endogenous bias due to omitted variables, we compare with estimations including bilateral fixed effects f_{od} to control for all unobserved time-unvarying bilateral determinants of export

trade preferences in Africa.

[4]To take into account that many countries do not trade bilaterally (leading to consider an estimator dealing with zeroes and heteroskedasticity), the trade literature has adopted the PPML approach proposed by Santos Silva and Tenreyro (2006). See Head and Mayer (2014) for a discussion and a comparison with the generalized Tobit proposed by Eaton and Kortum (2001).

[5]https://www3.nd.edu/~jbergstr/ 2017

(Baier and Bergstrand, 2007; Magee, 2008).

As explained in the introduction, the first EAC agreement entered into force between 1967 and 1977 and the second one started in 2000. In order to quantify the distinct effect of these two waves of regionalization, we consider a binary variable, called 'EAC (1967-77)', taking one for members during the period 1967-1977 and zero otherwise, and another dummy, called 'EAC (2000-12)', taking 1 between 2000 and 2012.

Table ((4.1), Column 1) presents a standard gravity equation with GDPs, distance and bilateral controls (dummies for contiguity, past colonial links, common language, common history such as the fact that countries have belong to the same country in the past). This specification is typically the one used in past studies and leads to conclude that the EAC (1967-77) has fostered trade while the most recent agreement has not been significant. However, from a theoretical point of view, this estimation is not reliable since many omitted terms that are country specifics (e.g. price indices) are correlated with trade cost terms (e.g. distance and RTAs). Then in Table (1, Column 2), fixed effects by exporter and importer are introduced. Fally (2015) demonstrates that estimating a gravity equations using the PPML estimator with these fixed effects is equivalent to introduce the 'multilateral resistance' presented in theoretical models (*à la* Anderson and Van Wincoop, 2004). According to this estimation, the EAC promotes trade but in too strong way to be credible ($(e^{2.99} - 1) * 100 = 1800\%$). The introduction of time-varying individual effects in Column 4 does not resolve this problem of overestimation of the RTAs' coefficient. The set of binary dummies (such as common language, colonial ties, etc) *imperfectly* control for all the bilateral links between countries that explain trade flows. Countries that have enforced the EAC are certainly also characterized by other unobserved bilateral factors and thus the endogenous bias of omitted variables is still problematic to consider seriously the coefficient of RTAs in this specification. The last Column 4 is thus our preferred estimation since bilateral fixed effects are introduced resolving all the aforementioned problems. The conclusion of this last regression is exactly the reverse of the naïve estimation done in Column 1, the current EAC (2000-12) has been a significant factor of trade growth, whereas the historical EAC (1967-77) was inefficient. The impact of the new EAC (2000-12) that increase trade by 75% ($e^{0.564} - 1$) is very close to the estimation of the trade effect obtained in Europe (68%) and smaller than the coefficient obtained for the NAFTA (145%) according to the meta-analysis of Cipollina and Salvatici (2010).

	(1)	(2)	(3)	(4)
$EAC(1967-77)$	1.348[a]	3.286[a]	1.767[a]	0.045
	(0.469)	(0.348)	(0.499)	(0.175)
$EAC(2000-12)$	-0.250	2.710[a]	2.998[a]	0.564[b]
	(0.466)	(0.388)	(0.403)	(0.256)
$Other\,RTA$	0.062	0.523[a]	0.521[a]	0.107[a]
	(0.077)	(0.056)	(0.059)	(0.026)
$Exporters\,GDP$	0.773[a]	0.603[a]		
	(0.015)	(0.034)		
$Importers\,GDP$	0.788[a]	0.560[a]		
	(0.019)	(0.034)		
$Distance$	-0.519[a]	-0.550[a]	-0.558[a]	
	(0.038)	(0.027)	(0.028)	
$Contiguity$	0.513[a]	0.469[a]	0.446[a]	
	(0.100)	(0.074)	(0.076)	
$Official\,language$	-0.081	-0.149	-0.158	
	(0.158)	(0.111)	(0.111)	
$Ethnic\,language$	0.420[a]	0.330[a]	0.355[a]	
	(0.141)	(0.112)	(0.112)	
$Colony$	-0.034	0.264[a]	0.246[a]	
	(0.113)	(0.087)	(0.086)	
$Comon\,Colony$	0.531[b]	0.333[b]	0.326[b]	
	(0.266)	(0.149)	(0.149)	
$Same\,country$	0.807[a]	0.163	0.168	
	0.314	(0.174)	(0.179)	
Observations	874 163	874 163	918 852	835 315
Pseudo R-square	0.88	0.93	0.94	0.99
Pseudolikelihood	-5.27455e+13	-2.88938e+13	-2.52816e+13	-4.610e+12
Importers FE	No	Yes	No	No
Exporters FE	No	Yes	No	No
Importer-time FE	No	No	yes	Yes
Exporters-time FE	No	No	yes	Yes
Pairs FE	No	No	No	Yes

Notes: robust dyad Clustered Standard errors are reported in parentheses with [a], [b] and [c] respectively denoting significance at the 1%, 5% and 10% levels. Estimations have been done with PPML estimator.

Table 4.1: Gravity results

To paraphrase Allen, Arkolakis and Takahashi (2019) many trade models lead to the "universal gravity" described by Equation (4.2.7), which makes the results of this section particularly general. However to run a credible counterfactual analysis, we need to scratch beneath the surface of this gravity equation and to come back on the theoretical model. In particular in order to assess trade diversion. Indeed, the EAC by impacting on the relative prices of goods and on multilateral resistances, leads to a reallocation of the demand, diverting trade from outside; but importer-year and exporter-year effects typically capture these diversion effects in our gravity equation. In other words, the coefficient of the EAC presented here is conditioned to trade diversion, it only represents the *pure* trade creation effect. On the contrary, resolving the model leads to take into account multilateral resistances and thus trade diversion.

4.3 Quantitative analysis

4.3.1 How to resolve the model

Following a long tradition in international trade, the model is solved for changes in prices and wages after a discrete change in tariff from τ to τ'. All the variables that are affected by this new tariff are analyzed in relative change and denoted with a "hat" (i.e. $\hat{x} = x'/x$). Then the equilibrium is get from the following equations with the cost of the input:

$$\hat{c}_d^j = \hat{w}_d^{\gamma_d^j} \prod_{k=1}^{J} (P_d^k)^{\gamma_d^{k,j}}, \tag{4.3.1}$$

the price index:

$$\hat{P}_d^j = \left[\sum_{o=1}^{N} \pi_{do}^j [\hat{\kappa}_{do}^j \hat{c}_0^j]^{-\theta^j} \right]^{\frac{-1}{\theta^j}} \tag{4.3.2}$$

the trade share:

$$\hat{\pi}_{do}^j = \left[\frac{\hat{\kappa}_{do}^j \hat{c}_0^j}{\hat{P}_d^j} \right]^{-\theta^j} \tag{4.3.3}$$

These equations (with the total expenditures and the trade balance equation) give the equilibrium in relative changes. As it well known now, the great advantage of this system is that it can be resolved with few data and estimations. Only tariffs, trade shares, value added and their share and the sectoral dispersion of productivity are necessary. The trade elasticities are here directly determined by the dispersion of productivity θ^j which are the only parameters that need to be estimated for the quantitative trade policy evaluation of the EAC.

4.3.2 Taking the Model to the Data

4.3.2.1 Elasticities

Evaluation of trade policy welfare gains depend crucially on trade elasticities. With a high θ^j, the productivity is concentrated and goods are not substitute. As a result a change in tariff will not have a strong effect on the share of traded goods because producers of the composite aggregate are less likely to change their suppliers. This means that our results depend on the values of these elasticities. Following Mejean and Imbs (2017) we propose to use two different estimates of θ^j:

First, we use the sectoral elasticities of Caliendo and Parro (2015). These authors use the expenditure share (4.2.5) and a triple differentiation to estimate only from tariffs these elasticities, reported in Table (4.2).

Secondly, we estimate these elasticities from the method of Feenstra (1994), Broda and Weinstein (2006) and Soderbery (2018).

Formally, following Feenstra (1994), demand and supply trade elasticities are estimated from a single equation that takes the following form:

$$(\triangle^i lnP_{dkt})^2 = \alpha_k(\triangle^i lnS_{dkt})^2 + \beta_k(\triangle^i lnS_{dkt})(\triangle^i lnP_{dkt}) + \varepsilon_{dkt} \qquad (4.3.4)$$

where S_{dkt} and P_{dkt} are respectively country d trade share and price of product k at time t. In order to eliminate time specific effect, all variables are first differentiating ($\triangle$). We estimate this equation with the Limited Information Maximum Likelihood (LIML) hybrid estimator proposed by Soderbery (2018). This estimator corrects for small sample bias and outliers observations effects. Its constrained non linear routine corrects grid search inefficiencies introduced by Broda and Weinstein (2006). The estimation of this equation gives trade price elasticity relative to a reference country i (here Zambia). The coefficient of interest here is the elasticity of the trade share α_k.

Table (4.2) presents these trade elasticities, the range is from 1.32 to 22.63 showing strong heterogeneity across sectors. Since these two methods provide different results, they represent a interesting way to lead sensitivity analysis of the model and to test the robustness of our findings.

Eora sectors	Feenstra	Caliendo & Parro
Agriculture	3.584	9.11
Fishing	2.037	9.11
Mining and Quarrying	2.832	13.53
Food & Beverages,	3.268	2.62
Textiles and Wearing Apparel	3.844	8.1
Wood and Paper	6.742	14.846
Petroleum, Chemical, Non-Metallic Mineral Prod	4.944	18.015
Metal Products	22.638	5.135
Electrical and Machinery	3.991	7.994
Transport Equipment	1.324	1.115
Other Manufacturing	3.271	1.98

Notes: Caliendo and Parro ISIC Rev 3 are converted in EORA classification through the classification proposed by Lenzen et al (2013).

Table 4.2: Sectoral trade elasticities

4.3.2.2 Data

Value added (V_d^j) and gross production (Y_d^j) come from the EORA global supply chain database. This database consists of a multi-region input-output time series (1990-2015) for 26 sectors and 190 countries. Bilateral trade flows come from United Nation statistical division Commodity Trade (COMTRADE) database using The Harmonized Commodity Description and Coding System (HS) 1996 at 6 digit level of aggregation. In order to maintain a single classification, trade flows are converted to EORA classification. This is done in two steps. First, by using the World Integrated Trade Solutions (WITS) correspondence table, we move from the HS nomenclature to the 4-digit ISIC Rev 3 nomenclature. Then, the transition from ISIC to EORA classification is made through the classification proposed by

Lenzen et al (2013). Bilateral tariff data at the sectoral level come from United Nation Conference on Trade And Development Trade Analysis Information System (UNCTAD-TRAINS) for the year 1999 and 2009. Our counterfactual exercise covers 11 tradable sectors as well as 48 countries[6], including an aggregated rest of the world. These countries and sectors are the same as those used to estimate trade elasticities. Finally concerning trade data we used the BACI database provided by CEPII.

4.3.3 Tariff, real wage and welfare

To understand the result of the quantitative model, it is useful to decompose the effect of tariffs on real wage and welfare.

Using the cost function (4.3.1) with trade share (4.3.3), the counterfactual change in real wages is solved in each sector j as a function of the share of expenditure on domestic goods and sectoral prices. Using this expression in the consumption expenditure shares, gives the following expression:

$$ln\,\frac{\hat{w}_d}{\hat{P}_d} = -\sum_{j=1}^{J}\frac{\alpha_d^j}{\theta^j}ln\,\hat{\pi}_{dd}^j - \sum_{j=1}^{J}\frac{\alpha_d^j}{\theta^j}\frac{1-\gamma_d^j}{\gamma_d^j}ln\,\hat{\pi}_{dd}^j - \sum_{j=1}^{J}\frac{\alpha_d^j}{\gamma_d^j}ln\,\prod_{k=1}^{J}\left(\hat{P}_d^k/\hat{P}_d^j\right)^{\gamma_d^{k,j}} \quad (4.3.5)$$

Changes in real wages depend on three components. The economic conditions in the final sector, $-\sum_{j=1}^{J}\frac{\alpha_d^j}{\theta^j}ln\,\hat{\pi}_{dd}^j$, and in the intermediate good, $-\sum_{j=1}^{J}\frac{\alpha_d^j}{\theta^j}\frac{1-\gamma_d^j}{\gamma_d^j}ln\,\hat{\pi}_{dd}^j$ and finally of changes in sectoral and consumer prices, $-\sum_{j=1}^{J}\frac{\alpha_d^j}{\gamma_d^j}ln\,\prod_{k=1}^{J}\left(\hat{P}_d^k/\hat{P}_d^j\right)^{\gamma_d^{k,j}}$. Then, changes in wages depends on sectoral elasticities and on the share of the final demand. The higher the ratio between sectoral elasticities and the share of final demand growth, the greater the effects on real wages, even if there are small variations in domestic spending. In a similar way, the share of value added of intermediate goods in the production matters. The higher this parameter increases, the less significant the impact on real wages is. In the model without intermediate goods (we make this assumption in the last part of the paper), the aggregate effect of tariff reduction on producers of these goods does not play any role on the welfare. Indeed, there are no reduction in the price of intermediate goods and so

[6]Appendix D.1, gives the list of countries used in this study.

the gain coming from the decrease in the cost of production is simply not taken into account. Lastly, sectoral linkages are impacted by the ratio between the share spent on final goods and the share of value added in production. As this ratio increases, the effect of sectoral linkages on real wages increases.

Totally differentiating the welfare function of the representative consumer in country d yields:

$$d\,ln\,W_d = \frac{1}{I_d}\sum_{j=1}^{J}\sum_{o=1}^{N}\left(E_{do}^{j} d\,ln\,c_d^j - M_{do}^j d\,ln\,c_o^j\right) + \frac{1}{I_d}\sum_{j=1}^{J}\sum_{o=1}^{N}\tau_{do}^j M_{do}^j\left(d\,ln\,M_{do}^j - d\,ln\,c_o^j\right) \tag{4.3.6}$$

This expression enables to decompose the welfare impact of tariffs into terms of trade and volume of trade effects across countries and sectors. The terms of trade given by the first part of equation (4.3.6) measure the gains of an increase in exporter prices relative to a change in importer prices from tariff reduction. This component impacts the welfare through the sectoral deficit and sectoral prices. The second part represents the volume of trade and measures the gain of an increase in the volumes of trade from tariff reduction.

At the national level, the change in bilateral Terms of Trade (hereafter denoted ToT_{do}) and the change in the bilateral Volume of Trade (VoT_{do}) are respectively given by:

$$ToT_{do} \equiv \sum_{j=1}^{J}\left(E_{do}^j \triangle\, ln\,c_d^j - M_{do}^j \triangle\, ln\,c_o^j\right), \tag{4.3.7}$$

$$VoT_{do} \equiv \sum_{j=1}^{J}\tau_{do}^j M_{do}^j\left(\triangle ln\,M_{do}^j - \triangle ln\,c_o^j\right). \tag{4.3.8}$$

The change in the sectoral terms of trade and volume of trade are similarly given by:

$$ToT_d^j \equiv \sum_{i=1}^{N}\left(E_{do}^j \triangle\, ln\,c_d^j - M_{do}^j \triangle\, ln\,c_o^j\right), \tag{4.3.9}$$

$$VoT_d^j \equiv \sum_{i=1}^{N}\tau_{do}^j M_{do}^j\left(\triangle ln\,M_{do}^j - \triangle ln\,c_o^j\right). \tag{4.3.10}$$

Then the welfare change takes the following form:

$$\triangle\, ln\, W_d = \frac{1}{I_d} \sum_{j=1}^{J} \left(VoT_d^j + ToT_d^j \right) \tag{4.3.11}$$

Using data from I-O tables, trade flows (M_{do}^j), value added (V_d^j) and gross production (Y_d^j) we get π_{do}^j, γ_d^j, $\gamma_d^{j,k}$ and α_d^j, and with the estimates of sectoral productivity dispersion θ^j, we can solve the model for tariff changes in order to study how real wages (4.3.5) and welfare (4.3.6, 4.3.7, 4.3.8, 4.3.9, 4.3.10) have been affected by the EAC and by trade liberalization in general.

4.4 Main results

With the model, data and estimations in hand, we now turn to simulations of the EAC trade integration. We also propose additional results by modifying important assumptions (number of sectors, sectoral linkages, trade deficit).

4.4.1 Ceteris Paribus: the EAC

4.4.1.1 Country analysis

To compute the effect of the EAC, we make two different shocks and our analysis of the EAC is based on the difference between these shocks. This methodology is typically the one proposed by Caliendo and Parro (2015) to study the impact of the NAFTA given world tariff changes or by Mayer et al. (2019) to revisit the cost of Non-Europe. In each cases we calibrate the model on the year 1999 when the EAC has been signed, i.e. before its implementation, and we take into account trade deficits. In the first shock, we introduce the observed change in world tariff structure from 1999 to the year 2009 including changes due to the EAC. In the second shock, we still consider the observed change in world tariff structure from 1999 to the year 2009 but holding EAC tariffs fixed. The difference between these two simulations allows to isolate the effect of the EAC from other changes in the world.

In all tables, we present the simulations done with the elasticities of θ^j obtained from the two methodologies presented previously.

Counterfactuals based on elasticities computed from Caliendo and Parro's Methodology				
	Welfare			
Country	Total	Term of Trade	Volume of Trade	Real Wage
Burundi	0.10%	-0.35%	0.45%	-1.30%
Kenya	0.89%	0.59%	0.30%	2.40%
Rwanda	1.10%	-0.30%	1.40%	-1.20%
Tanzania	0.31%	-0.09%	0.40%	-0.28%
Uganda	0.03%	-0.39%	0.42%	-1.70%

Counterfactuals based on elasticities computed from Feenstra's Methodology				
	Welfare			
Country	Total	Term of Trade	Volume of Trade	Real Wage
Burundi	-0.42%	-0.76%	0.22%	-3.40%
Kenya	1.10%	0.83%	0.22%	3.20%
Rwanda	0.43%	-0.48%	0.92%	-3.20%
Tanzania	0.08%	-0.18%	0.26%	-0.93%
Uganda	-0.30%	-0.51%	0.21%	-2.50%

Table 4.3: Welfare Effects of EAC's tariff reductions

In Table ((4.3), Column 1), we provide results concerning welfare change (Equation 4.3.6) and in Column 2 and 3 we decompose the effect of the EAC by analyzing changes in the terms of trade and in the volume of trade (Equations 4.3.7, 4.3.8). Finally Column 4 provides the impact of the EAC on real wages (Equation 4.3.5). The main result of this analysis is that the EAC increases the welfare of individuals in the five countries of the trade bloc. These gains are however small for some countries. Kenya and Rwanda benefits of an increase of well-being of approximately 1% but gains in Tanzania, Burundi and Uganda are negligible. For the latter two countries, the counterfactual done with the Feenstra's elasticities (at the bottom of Table (4.3)), shows that the impact of the EAC is even detrimental. In fact for these two countries, and to a lesser extent for Tanzania, this customs union has fostered the volume of trade but has also generated an equivalent deterioration of the terms of trade. In other words, while we can be confident about the welfare improvement in Kenya and Rwanda, the consequence of the EAC for Tanzania, Burundi and Uganda is less clear. The case of Kenya is particularly interesting since this country is the sole to improve its term of trade thanks to the EAC. To understand this result, first note that the material prices decrease between 0.07% and 2.51% in all countries excepted in Kenya where these prices increase by 2.58%. Furthermore, wage increases by 6.26% in Kenya while in all other members this variable decreases strongly (a reduction between 2,50% and 13.02%). As a result, because export prices increase when change in wages is higher than the change in material prices, Kenya benefits of an appreciation of its terms of trade. The fact that the EAC leads to strong decrease in wages and to a small decrease in prices in Rwanda, Tanzania, Burundi and Uganda also explains the negative impact of the EAC on real wages in these countries (Column 4).

Counterfactuals based on elasticities computed from Caliendo and Parro's Methodology				
	Terms of Trade		Volume of Trade	
Country	EAC	Rest of the World	EAC	Rest of the World
Burundi	0.00%	-0.35%	1.10%	-0.64%
Kenya	0.05%	0.55%	0.06%	0.24%
Rwanda	-0.03%	-0.27%	3.20%	-1.80%
Tanzania	-0.02%	-0.08%	0.76%	-0.36%
Uganda	-0.07%	-0.32%	0.90%	-0.48%

Counterfactuals based on elasticities computed from Feenstra's Methodology				
	Terms of Trade		Volume of Trade	
Country	EAC	Rest of the World	EAC	Rest of the World
Burundi	0.00%	-0.76%	0.75%	-0.41%
Kenya	0.06%	0.77%	0.02%	0.21%
Rwanda	-0.04%	-0.44%	1.90%	-0.98%
Tanzania	-0.02%	-0.15%	0.63%	-0.38%
Uganda	-0.09%	-0.42%	0.55%	-0.34%

Table 4.4: Bilateral welfare effects from EAC's tariff reductions

So far, trade diversion has not been caught, to tackle it, Table (4.4) decomposes the terms of trade and the volume of trade by considering exchanges between countries of the EAC and with the rest-of-the world. In Columns 1 and 2, we verify that the previous results about the deterioration of the terms of trade mainly comes from a deterioration with the rest-of-the world. Column 3 displays the trade creation effect of the EAC, already found in a different way in our section concerning the gravity equation. Finally Column 4 presents clear evidence of trade diversion. This trade diversion has been particularly significant in Rwanda and in Burundi. These countries are also the ones where the trade creation has been the strongest. These results are robust to change in trade elasticities (Table at the bottom of (4.4)).

4.4.1.2 Sectoral analysis

The tables ((4.5) and (4.6)) present the sectoral contribution on welfare (still with the elasticities obtained from Caliendo and Parro (2015) and computed from Feenstra (1994), Broda and Weinstein (2006) and Soderbery (2018)).

The agricultural sector is the sector which explains the bulk of our results concerning the deterioration of the terms of trade in Burundi, Uganda, Rwanda and Tanzania and the appreciation of them in Kenya. Petroleum and Chemicals also have a significant contribution in almost all countries (excepted in Burundi). For instance in Uganda the deterioration is mainly explained by two sectors, Agriculture and Petroleum/Chemicals which contribute to 90% of the reduction in the terms of trade. This result, that most of the aggregate change in terms of trade is explained by few sectors is also found by Caliendo and Parro (2015). In their analysis of the NAFTA, this result comes from the strong input-output feedback in three sectors (Electrical Machinery, Communication Equipment, and Autos). In the EAC, such a possibility is credible for Chemicals and Agriculture (think to fertilizers), but the main explanation lies in the strong reduction of tariffs in the sectors that stand out from the rest. For instance the agricultural sector has recorded the most significant reduction in tariffs (see Appendix D.2, Table). This reduction is magnified by the share of materials used in the production. Indeed large shares of materials and strong reductions in tariffs have large impact on sectoral export prices and then on the sectoral contribution on welfare. Three of five countries had in 1999 very high tariffs (above the mean and median), for instance, Burundi applied a tariff of 26% (while the mean and the median across sectors were of 24% and 20%). Consequently, the reduction of tariffs in the agricultural

Sectors	Counterfactuals based on elasticities computed from Caliendo and Parro's Methodology					
	Burundi		Kenya		Rwanda	
	Terms of Trade	Volume of Trade	Terms of Trade	Volume of Trade	Terms of Trade	Volume of Trade
Agriculture	95.60%	3.80%	82.30%	18.80%	85.80%	3.09%
Fishing	0.60%	0.40%	0.15%	0.01%	0.03%	-0.58%
Mining & Quarrying	0.88%	5.03%	1.87%	4.68%	5.15%	2.12%
Food & Beverages	-0.16%	13.60%	3.39%	4.16%	-0.29%	24.00%
Textiles & Wearing	0.78%	18.10%	1.99%	2.89%	0.29%	6.24%
Wood & Paper	-0.02%	16.60%	0.80%	5.73%	0.28%	16.40%
Petroleum, Chemicals	1.82%	47.90%	7.46%	43.30%	7.48%	48.30%
Metal Products	0.18%	5.44%	0.84%	4.40%	0.95%	2.05%
Electrical & Machinery	0.09%	-5.46%	0.74%	10.30%	0.13%	-1.70%
Transport Equipment	0.10%	-5.74%	0.31%	4.81%	0.15%	-0.62%
Other Manufacturing	0.09%	0.35%	0.15%	0.85%	0.05%	0.72%

Sectors	Counterfactuals based on elasticities computed from Feenstra's Methodology					
	Burundi		Kenya		Rwanda	
	Terms of Trade	Volume of Trade	Terms of Trade	Volume of Trade	Terms of Trade	Volume of Trade
Agriculture	98.00%	3.91%	82.00%	9.70%	88.60%	0.99%
Fishing	0.40%	0.03%	0.11%	0.03%	0.02%	-0.91%
Mining & Quarrying	0.58%	0.36%	1.18%	3.39%	2.90%	0.25%
Food & Beverages	-0.03%	21.50%	4.42%	7.08%	-0.25%	43.30%
Textiles & Wearing	0.53%	7.16%	2.07%	3.13%	0.26%	3.24%
Wood & Paper	0.03%	2.49%	0.86%	5.09%	0.28%	4.22%
Petroleum, Chemicals	1.22%	-12.90%	6.84%	31.70%	7.01%	23.30%
Metal Products	-0.94%	104%	1.19%	14.10%	0.87%	29.00%
Electrical & Machinery	0.07%	-12.20%	0.79%	15.40%	0.14%	-3.63%
Transport Equipment	0.12%	-15.20%	0.33%	8.52%	0.12%	-1.63%
Other Manufacturing	0.05%	0.65%	0.17%	1.50%	0.05%	1.83%

Table 4.5: Sectoral contribution to welfare effects from EAC's tariff reductions (with elasticities from Caliendo and Parro's Methodology)

Counterfactuals based on elasticities computed from Caliendo and Parro's Methodology				
	Tanzania		Uganda	
Sectors	Terms of Trade	Volume of Trade	Terms of Trade	Volume of Trade
Agriculture	66.10%	-0.44%	81%	-0.77%
Fishing	0.71%	0.00%	0.53%	0.02%
Mining & Quarrying	10.70%	0.26%	0.89%	2.15%
Food & Beverages	5.40%	5.63%	3.64%	6.61%
Textiles & Wearing	1.12%	1.22%	0.54%	5.84%
Wood & Paper	1.00%	23.00%	0.70%	20.20%
Petroleum, Chemicals	9.32%	68.40%	10.60%	74.10%
Metal Products	2.70%	3.57%	1.53%	2.26%
Electrical & Machinery	1.70%	-0.67%	0.65%	-7.64%
Transport Equipment	0.65%	-1.02%	0.35%	-2.61%
Other Manufacturing	0.68%	0.03%	0.08%	0.20%

Counterfactuals based on elasticities computed from Feenstra's Methodology				
	Tanzania		Uganda	
Sectors	Terms of Trade	Volume of Trade	Terms of Trade	Volume of Trade
Agriculture	69.20%	-1.49%	79%	-1.92%
Fishing	0.57%	0.00%	0.31%	0.00%
Mining & Quarrying	6.02%	-0.75%	0.91%	0.31%
Food & Beverages	6.81%	9.93%	5.14%	19.60%
Textiles & Wearing	1.11%	0.11%	0.57%	2.04%
Wood & Paper	0.89%	6.53%	0.76%	9.66%
Petroleum, Chemicals	7.10%	14.40%	10.60%	18.40%
Metal Products	5.64%	80.80%	1.72%	74.30%
Electrical & Machinery	1.42%	-6.32%	0.69%	-15.60%
Transport Equipment	0.51%	-3.28%	0.38%	-6.75%
Other Manufacturing	0.75%	0.04%	0.08%	-0.05%

Table 4.6: Sectoral contribution to welfare effects from EAC's tariff reductions (with elasticities from Caliendo and Parro's Methodology), continued

sector (from 26% to 5% in 2009) explains the strong contribution of this sector to change in price and volume. The impact on the volume of trade has been more balanced. But there are some sectors with strong contribution such as Textile and Wearing in Burundi, Electrical and Machinery in Kenya, Food and Beverages in Rwanda and Wood and Paper in Uganda and Tanzania. In each cases, the strong decreases in the degree of protection linked to the concentration of productivity explains these results. Finally in all countries, the Petroleum and Chemicals sector matter to explain the volume of trade. This sector is a relatively homogeneous sector and then even a small change in tariffs has a strong impact on trade since it is easy to find substitute suppliers (i.e this sector is characterized by a relatively high elasticity, $\theta^j \simeq 5$ in our analysis based on Feenstra and four time higher according to Caliendo and Parro (Table 1, $\theta^j \simeq 18$)).

To study how the EAC has affected sectoral specialization, Tables ((4.7) and (4.8)) present export shares by industry before and after the EAC trade integration. The interesting result is that the customs union has succeeded to slightly diversify these economies. In all countries, the export share of agricultural product has decreased leaving place mainly to the Petroleum and Chemicals sector but also to other sectors. For instance in Kenya, the agricultural sector account for 66% of the total export before the EAC, while after this trade integration shock, the concentration of exports in this sector is halved (33%). Rwanda exports more Wood and Paper, Metal Products and other Manufacturing goods. In Tanzania and Uganda, the decrease in the share of the agricultural sector seems to have been compensated by the increase in the share of export coming from the Petroleum and Chemicals sector. The Herfindhal Index at the bottom of Table (4.7) confirms this diversification of economies.

4.4.2 Trade in intermediate goods matters

We now analyze how results are modified by some important changes in the model assumptions, especially when we remove the presence of Input-Output, when we consider only one sector and when we drop intermediate goods. The model without I/O and without materials are multi-sector models, thus comparing the results of these model (Column 1 and 3) with the one sector model (Column 2) shows that both intermediate goods and input-output linkages amplify the welfare

	Counterfactuals based on elasticities computed from Caliendo and Parro's Methodology					
	Burundi		Kenya		Rwanda	
Sectors	Before	After	Before	After	Before	After
Agriculture	95.00%	94.00%	66.00%	33.00%	84.00%	81.00%
Fishing	0.51%	0.51%	0.11%	0.11%	0.00%	0.00%
Mining & Quarrying	2.90%	2.60%	2.40%	1.90%	12.00%	10.00%
Food & Beverages	0.43%	0.50%	9.40%	7.00%	0.45%	0.34%
Textiles & Wearing	0.08%	0.10%	3.40%	3.00%	0.10%	0.13%
Wood & Paper	0.11%	0.40%	1.50%	6.70%	0.22%	1.10%
Petroleum, Chemicals	0.11%	1.30%	13.00%	44.00%	1.60%	5.60%
Metal Products	0.01%	0.01%	1.70%	2.40%	0.58%	1.00%
Electrical & Machinery	0.06%	0.12%	2.00%	0.18%	0.62%	0.72%
Transport Equipment	0.28%	0.32%	0.61%	0.44%	0.03%	0.09%
Other Manufacturing	0.00%	0.00%	0.20%	0.16%	0.02%	2.20%
Normalized Herfindahl	0.91	0.88	0.44	0.28	0.72	0.65

	Counterfactuals based on elasticities computed from Feenstra's Methodology					
	Burundi		Kenya		Rwanda	
Sectors	Before	After	Before	After	Before	After
Agriculture	96.00%	96.00%	65.00%	41.00%	90.00%	0.85%
Fishing	0.34%	0.32%	0.08%	0.06%	0.00%	0.00%
Mining & Quarrying	2.10%	2.00%	1.50%	1.10%	6.00%	5.00%
Food & Beverages	0.57%	0.73%	12.00%	10.00%	0.75%	0.64%
Textiles & Wearing	0.10%	0.10%	3.50%	2.80%	0.13%	0.13%
Wood & Paper	0.12%	0.16%	1.60%	2.20%	0.26%	0.44%
Petroleum, Chemicals	0.09%	0.19%	12.00%	13.00%	1.30%	1.50%
Metal Products	0.03%	0.04%	2.40%	27.00%	1.40%	6.70%
Electrical & Machinery	0.07%	0.10%	1.50%	1.50%	0.23%	0.40%
Transport Equipment	0.30%	0.35%	0.63%	0.53%	0.04%	0.04%
Other Manufacturing	0.00%	0.00%	0.23%	0.23%	0.03%	0.05%
Normalized Herfindahl	0.92	0.92	0.42	0.24	0.80	0.72

Table 4.7: Sectoral export shares

Counterfactuals based on elasticities computed from Caliendo and Parro’s Methodology				
	Tanzania		Uganda	
Sectors	Before	After	Before	After
Agriculture	70.00%	61.00%	92%	82.00%
Fishing	0.74%	0.64%	0.56%	0.51%
Mining & Quarrying	13.00%	12.00%	0.24%	0.23%
Food & Beverages	7.50%	8.30%	5.80%	5.50%
Textiles & Wearing	1.50%	1.70%	0.16%	0.53%
Wood & Paper	0.54%	1.80%	0.08%	3.00%
Petroleum, Chemicals	3.10%	11.00%	0.61%	7.20%
Metal Products	1.40%	1.20%	0.21%	0.’0%
Electrical & Machinery	1.40%	0.36%	0.57%	2.44%
Transport Equipment	0.09%	0.17%	0.18%	2.79%
Other Manufacturing	1.10%	0.98%	0.01%	0.02%
Normalized Herfindahl	0.49	0.38	0.84	0.67

Counterfactuals based on elasticities computed from Feenstra’s Methodology				
	Tanzania		Uganda	
Sectors	Before	After	Before	After
Agriculture	69.00%	64.00%	89.00%	85.00%
Fishing	0.55%	0.50%	0.32%	0.30%
Mining & Quarrying	7.00%	6.40%	0.16%	0.15%
Food & Beverages	10.00%	12.00%	8.40%	9.20%
Textiles & Wearing	1.60%	1.60%	0.17%	0.26%
Wood & Paper	0.57%	0.68%	0.07%	0.37%
Petroleum, Chemicals	2.50%	‘.20%	0.49%	1.00%
Metal Products	7.00%	9.70%	0.72%	3.30%
Electrical & Machinery	0.77%	0.99%	0.’8%	0.44%
Transport Equipment	0.10%	0.10%	0.17%	0.21%
Other Manufacturing	1.20%	1.20%	0.01%	0.04%
Normalized Herfindahl	0.47	0.41	0.79	0.79

Table 4.8: Sectoral export shares (Continued)

effects of the EAC. We can also note that there are few differences between the model without I/O and the model without materials. Only the gains in Kenya and in Uganda slightly increase from respectively 1.54% to 1.55% and from 0.23% to 0.24% when we compare the two models. Similar small changes are also found for the NAFTA concerning the U.S. and Canada (the welfare varies by respectively 0.01% and -0.01%), but with a noticeable difference concerning Mexico where the model with intermediate goods leads to predict a 0.16% increases in the welfare gain (see Caliendo and Parro (2015, Table 11)). Clearly members of the EAC are similar developed countries not characterized by the kind of vertical specialization in the manufacturing sector that the NAFTA has fostered in Mexico. In fact the introduction of intermediate goods and I/O feedback leads to reduce the welfare gains obtained thanks to the EAC for all countries excepted for Kenya (compare our benchmark result in (4.3) with the Table (4.9) below). Models that do not take into account intermediate goods and the heterogeneity of sectors leads to overestimate the positive impact of the EAC in Burundi, Rwanda, Tanzania and Uganda. Furthermore, this table also shows that the main result of our baseline (see Table (4.3)) are robust to significant change in assumptions: welfare gains are small and the main winners are Kenya and Rwanda.

4.4.3 About Trade Deficit

The previous analysis was not based on the raw observed data but on the counterfactual equilibrium that eliminates aggregate deficits in all countries. The trade balance assumption is commonly used in many general equilibrium models despite its highly unrealistic nature. However, in most cases, the introduction of a trade imbalance does not affect the outcome (see Dekle et al., 2007). This is also the case for the EAC.

Table (4.10) shows that when we take into account trade deficits, there are small welfare gains for all members. Countries that benefit the most are still Kenya and Rwanda.

Impact of real wages is less negative which is quite logical since the trade balance assumption leads to strong adjustment of nominal wages. The current analysis thus leads to have a more optimistic point of view regarding the impact of the EAC on real wages in particular in Rwanda (in Kenya the effect was already positive

Counterfactuals based on elasticities computed from Caliendo and Parro's Methodology			
	Welfare		
Country	Without I/O	One sector	No materials
Burundi	0.33%	0.23%	0.33%
Kenya	0.65%	0.85%	0.65%
Rwanda	1.55%	1.48%	1.54%
Tanzania	0.40%	0.43%	0.40%
Uganda	0.24%	0.04%	0.23%

Counterfactuals based on elasticities computed from Feenstra's Methodology			
	Welfare		
Country	Without I/O	One sector	No materials
Burundi	0.03%	0.23%	0.03%
Kenya	0.70%	0.85%	0.70%
Rwanda	0.83%	1.48%	0.82%
Tanzania	0.31%	0.43%	0.31%
Uganda	-0.05%	0.04%	-0.04%

Table 4.9: Welfare gains and trade effects from EAC tariff changes 1999 - 2009 (%)

with a percentage of 2.4% compare to 2.3% now, and in Tanzania the percentage is now positive but however small).

Counterfactuals based on elasticities computed from Caliendo and Parro's Methodology				
	Welfare			
Country	Total	Term of Trade	Volume of Trade	Real Wage
Burundi	0.04%	-0.01%	0.05%	-0.66%
Kenya	0.34%	0.09%	0.25%	2.30%
Rwanda	0.16%	-0.03%	0.18%	1.00%
Tanzania	0.06%	0.00%	0.07%	-0.26%
Uganda	0.03%	-0.03%	0.06%	-0.33%

Counterfactuals based on elasticities computed from Feenstra's Methodology				
	Welfare			
Country	Total	Term of Trade	Volume of Trade	Real Wage
Burundi	0.03%	-0.01%	0.04%	-0.46%
Kenya	0.23%	0.08%	0.15%	1.70%
Rwanda	0.07%	-0.03%	0.10%	-1.30%
Tanzania	0.06%	0.00%	0.06%	0.22%
Uganda	0.02%	-0.03%	0.05%	-0.31%

Table 4.10: Welfare effects from EAC tariff reductions, with trade deficit

Table (4.11) shows the evolution of the terms of trade and the volume of trade with EAC members and the rest of the world. Trade diversion is lower than previously found in a situation without a deficit (compare with Table (4.4)). The overall picture is however similar to what has been obtained with trade balance.

Counterfactuals based on elasticities computed from Caliendo and Parro's Methodology				
	Terms of Trade		Volume of Trade	
Country	EAC	Rest of the World	EAC	Rest of the World
Burundi	-0.01%	0.00%	0.39%	-0.34%
Kenya	0.02%	0.07%	0.01%	0.24%
Rwanda	-0.02%	0.00%	1.20%	-1.00%
Tanzania	-0.01%	0.00%	0.18%	-0.12%
Uganda	-0.03%	-0.01%	0.36%	-0.30%

Counterfactuals based on elasticities computed from Feenstra's Methodology				
	Terms of Trade		Volume of Trade	
Country	EAC	Rest of the World	EAC	Rest of the World
Burundi	-0.01%	-0.01%	0.26%	-0.22%
Kenya	0.02%	0.06%	0.01%	0.14%
Rwanda	-0.02%	-0.01%	1.00%	-0.91%
Tanzania	-0.01%	0.00%	0.11%	-0.05%
Uganda	-0.02%	-0.01%	0.24%	-0.19%

Table 4.11: Bilateral welfare effects from EAC tariff reductions, with trade deficit

4.5 Conclusion

The debate about the benefit of RTAs has a long history. With regard to African countries, the consensus in the 1990s was based on little hope of trade creation and a high risk of trade diversion (Foroutan and Pritchett, 1993; Rodrik, 1998). However, the statistical tools and the data available at the time, prevented researchers from going beyond mere speculation. Using a structural gravity equation we provide consistent estimates of the trade creation effect of the EAC agreement. The flip side of this analysis is that by controlling for multilateral resistances, we cannot study trade diversion. Then we rely on the general equilibrium model proposed by Caliendo and Parro (2015) to assess the whole impact of the EAC. We find that this agreement deteriorates the terms of trade, diverts trade from the rest-of-the world and negatively affects real wages. Only Kenya and Rwanda record significant welfare gains. The good news for other countries, however, is in the sector analysis. Indeed, in all countries, the share of agricultural exports has declined, leaving room for other sectors. This structural change is welcome in countries where demographic profiles require job creation. In other words, although the static trade model presented here projects small welfare gains, it is possible that the structural change observed may be much more beneficial in the long term.[7]

[7] However, we observed an increasing share of oil and chemical exports that certainly represents development opportunities, but also, potential resource curses.

Conclusion

Between 1950 and 2017, the growth of trade in volume was 4018%. According to the literature, this considerable growth of trade is due to many factors. Baier and Bergstrand (2001) highlight some of them, among which income growth, transport costs and tariffs. This thesis studies some of the international trade determinants. Firstly, we analyze in the first chapter the impact of income and competition on export prices of French wines. In Chapter 2 and 3, we analyze tariffs throught Regional Trade Agreements focusing on African countries. Finally, in the last Chapter, we quantify the impact of water as determinant of agricultural trade and the impact of climate change on this resource and trade. In this conclusion, Isummurize the main results and I suggest some perspectives for each of the chaptersfor future researches.

Regarding Chapter 1, empirical results confirm the effect of income and competition on export prices as predicted by the Generalized Ideal Variety Model of Hummels and Lugovskyy (2009) for the wine sector. The model predicts an increase in prices due to an increase in income because consumers are willing to pay more to buy a product which is close to their ideal variety. Then, firms can set prices higher. At the contrary, the size of market will have a negative impact due to the entry of new firms attracted by potential profits. Estimations confirms the theoritical model, a 1% increase in GDP per capita generates on average, an increase in price differential of between 0.55% and 1.13%. To the contrary, an increase of 1% in the competition effect leads to a decrease between 0.49 and 1.10 % in price differential. The results of our estimations are robust to changes of all variables approximating wealth concentration .

Chapter 2 studies the water endowments as determinant of agricultural trade.

A new water indicator is developed to capture the available water given local and product specificities rather than using the water endowment at the agregated level which can hidden heterogeneity between regions and products. The empirical part shows that our indicator is positive and significative meaning the water is a determinant of trade. An increase of 1% of the effective availability of the water resources increases the likelihood of exporting water intensive goods by 31.4%. Such a result is important as the climate change has and will have a huge impact on the water resources across the world. The distribution of this resources, already inequal between regions could intensify due to the increasing occurences of extrem climatic events. Using projections data about rainfalls, temperatures, evapotranspiration and populations, we calculate new values for our indicator and its impact on the trade. Results are given by countries and by products. Countries less impacted by the climate change seems to be those of the northern hemisphere with an average decrease of 10%. Regarding theproducts, the more impacted by the climate change are the Oil seeds and Starches but the severity of impact depends on the specialization of countries.

Turning to Chapter 3, we investigate of the African RTAs on trade and welfare for members. Firstly, the gravity equation reveals that the implementation of African RTAs has a positive impact on trade for these countries. African RTAs have a large increase of trade about 96%, over a long period. The individual analysis highliths only some RTAs are significant as ECOWAS or COMESA, for instance. Secondly, the use of the methodology of Mayer et al. (2019) based on a model developed by Arkolakis et al. (2012) allows us to quantify the welfare effects. We focus on three agreements among those studied previously, which are COMESA, SADC and ECOWAS. Despite the strong decrease of trade frictions for all agreement studied, between 49% and 69% and welfare gains positive, the amplitude of welfare is still relatively small. Morethan, results vary substantially between agreements with larger gains for ECOWAS and SADC and countries inside the same area.

Finally, Chapter 4 focuses on the Economic African Community (EAC). We perform the counterfactual exercise about the creation of EAC and measure these effects on members and non members. This model is more completed including intermediate goods, input-output linkages and trade deficit. We can divide the welfare effects in terms of trade and in volume. Main results are this agreement has a positive impact on members but the welfare gains are weak with an increase around 1% for the Kenya and Rwanda and a negligible impact for the other members. The increase of welfare comes mainly from increase in volume of trade for all countries. Kenya is the sole country to improve terms of trade and where the gains in terms of trade are superior to volume of trade gain, which are equal to 0.59% and 0.30%, respectively. Morethan, gains inside the agreement vary strongly as esposed in the previous chapter.

The possibility to implement more tariffs on French wine imports by United States was invoked twice by the american government. This increase of tariffs could make more difficult the entry of French wines on the american market. We could ask how the French wine exports will be impacted by a such policy. More interesting, the analysis could be lead in function of French regions. Actually, as shown in Appendix A.2, some regions are not impacted as some other, this is the case for the Bordeaux wines. The results of estimation indicate Bordeaux wines are the sole wine where the competition effect is not significant. The hypothesis of a such result is that this effect is balanced by a reputational effect, neutralizing the competition for this kind of wine.

The climate change is a major issue for the coming years. An increasing number of studies (World Bank) highlights consequences for the World and the impact on countries, especially for agriculture sector. The second chapter has been a preliminary work, on which we would like to based a future research about the evaluation of General Equilibrium effects on trade futher to a change in water endowment inside countries. Indeed, as showed by the simulations part of this chapter, the climate change should have a substantial impact on trade, particularly for the intensive water good. The General Equilibrium effects should be implemented in order to have a good evaluation on the climate change impact on trade.

Regarding the Regional Trade Agreements in Africa, two possible extensions could be studied. Firstly, The African Union decided to create a very large Free Trade Area since October 2018, the Continental African Free Trade Area. This agreement will be the most important agreement in Africa with 44 countries. One of the most important objectives is to reduce tariffs by 90% between the members in order to promote the intra-trade. This agreement will lead to a very important decrease of tariffs for a large number of countries. At the contrary of some regions of the World as Europe and North America, in the African countries, it is very difficult to perform counterfactual scenarios due to a lack of data. Yet, in the recent years, there is an improvement for data in Africa, especially for the international trade, where tariffs are more and more available. It would be interesting to use this recent data and the quantitative trade model to evaluate the impact of the new free trade area in terms of welfare. Secondly, we focused only if the agreement or not in Africa has had an impact on these countries. But our analysis do not give any informations about the contain of these agreements. With countries which are very specialized in few sectors, namely, in agriculture sector, the nature of agreement is essential to have an impact. Tariff changes in tariffs for some manufactured sectors will not effect on some African countries.

Appendix

Appendix A

Chapter 1

Appendix A1 : Generalized Model of Ideal Variety (GMIV)

Two goods are consumed, an homogeneous good a produced under constant returns to scale and wine which is a differentiated good denoted c_i.Varieties of this differenciated goods are uniformly distributed on a circle of unit-circumference. Because this product space is finite (circle), more varieties reduces differentiation. Lastly satisfaction is decreasing in distance between the current wine consumption and the most preferred type i.e the "ideal variety". The utility function is defined by:

$$U = a^{\mu} \left(c_i/h_i\right)^{1-\mu}$$

where h_i represents the cost of not consuming the ideal variety. More precisely this compensation function is given by:

$$\begin{aligned} h_i &= 1 + q_i^{\alpha} c_i^{\psi} d^{\gamma} \\ \text{with } (\alpha, \psi) &\in [0, 1] \text{ and } \gamma > 1 \end{aligned}$$

where d represents the distance between the variety consumed and the ideal variety. In comparison with the initial model we add a parameter q_i which represents a marginal extension to Hummels and Lugovskyy (2009). We consider this parameter as a reputation shifter to analyzed how reputation by interacting with the current consumption and with the distance to the ideal variety impacts on optimal choices. This introduction implies that higher the reputation of a wine, stronger the disastisfaction of the consummer regarding the distance between the wine he consummes and its ideal variety. This introduction allows to parametrize the compensation function of Hummels and Lugovskyy (2009) where the current consumption has the same disutility effect with respect to the expected ideal whatever the wine reputation.

Regarding the supply side, wine is produced under monopolistic competition. In this sector each individual supplies l hours of work and earn w per hour. w is taken as the numeraire. Hummels and Lugovskyy (2009) consider l as a variable that can be approximated by GDP per capita. The total number of agent L represents the market size. Moreover according to the numeraire chosen L can also be interpreted as GDP (indeed $wL = L$). A fixed number of workers, denoted f, is required to supply x quantity of wine. The marginal costs of production in terms of labor is denoted m. Profit maximization under free entry and exit gives:

$$p = \frac{m\varepsilon}{\varepsilon - 1}, \tag{A.0.1}$$

$$x = \frac{f}{m}(\varepsilon - 1) \tag{A.0.2}$$

The number of varieties under full employment is given by:

$$n = \frac{lL}{f\varepsilon}$$

Lastly distance between varieties depends on the numbers of varieties and on the circumference of the product space, since we assume unit length one gets:

$$d = \frac{1}{n} \tag{A.0.3}$$

In reason of Nash competition and of uniform distribution of varieties around a circle, the demand in wine 1 depends only on the closest substitute on its right and left hand. These competitive varieties are symmetrically distant from variety 1 (see Figure .a).

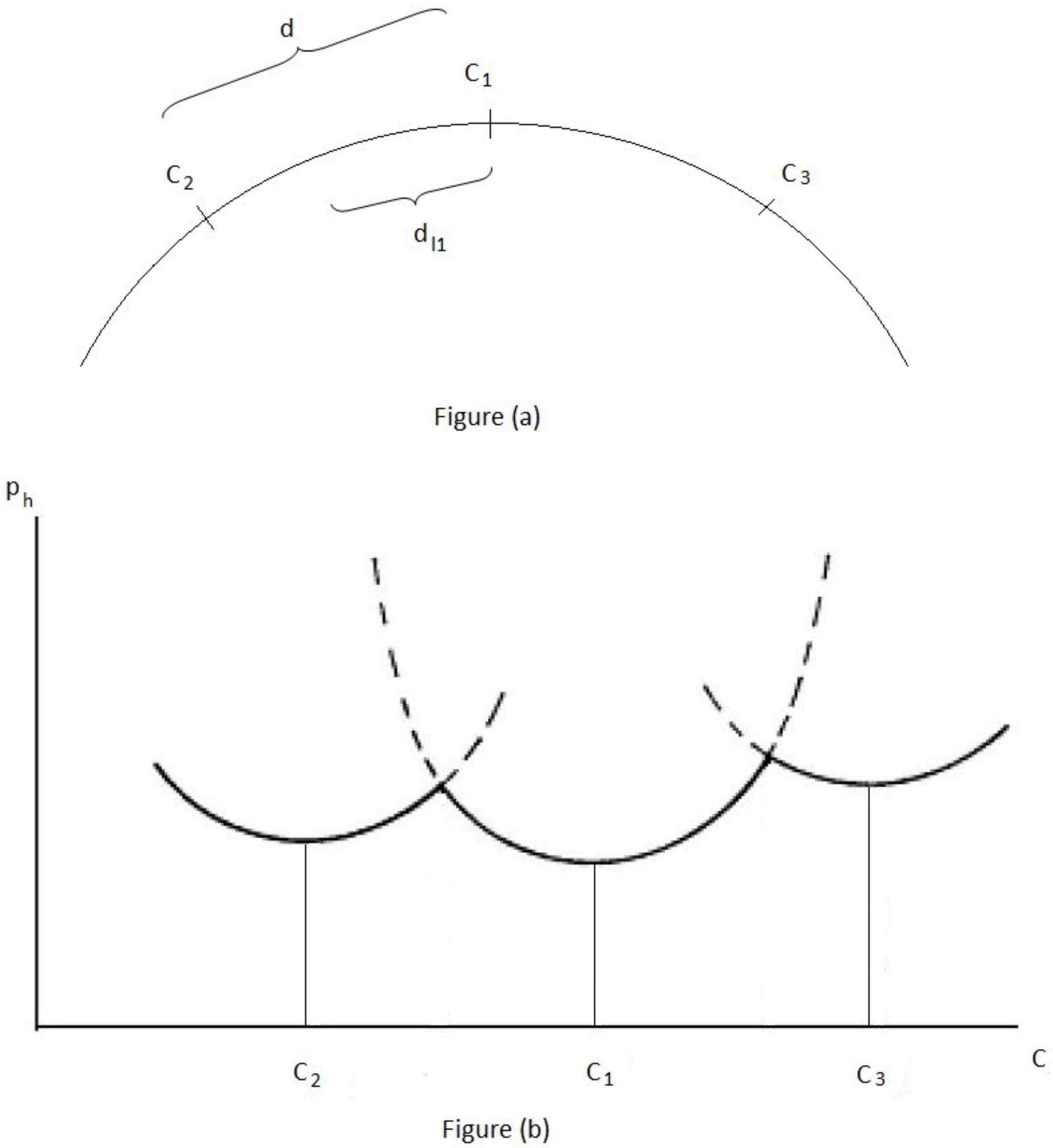


Figure A.1: Lancaster's space of varieties

The ideal variety between wine 1 and 2 (or indifferent consumer between wine 1 and 2) is located at d_{l1}. As illustrated by Figure .b, which represents the effective price with respect to varieties, such a situation of wine equivalence is defined by:

$$p_2\left[1+q_2^{\alpha}c_2^{\psi}\left(d-d_{l1}\right)^{\gamma}\right]=p_1(1+q_1^{\alpha}c_1^{\psi}d_{l1}^{\gamma})$$

Similarly the ideal variety between 1 and 3 is given by:

$$p_3\left[1+q_3^{\alpha}c_3^{\psi}\left(d-d_{r1}\right)^{\gamma}\right]=p_1(1+q_1^{\alpha}c_1^{\psi}d_{r1}^{\gamma})$$

Because utility maximization of one individual gives $c = wl/p$ one obtains from the previous equation the following equation:

$$\begin{aligned} p_2\left[1+q_2^{\alpha}\left(wl\right)^{\psi}p_2^{-\psi}\left(d-d_{l1}\right)^{\gamma}\right] &= p_1+q_1^{\alpha}\left(wl\right)^{\psi}p_1^{1-\psi}d_{l1}^{\gamma}) \\ p_3\left[1+q_3^{\alpha}\left(wl\right)^{\psi}p_3^{-\psi}\left(d-d_{r1}\right)^{\gamma}\right] &= p_1+q_1^{\alpha}\left(wl\right)^{\psi}p_1^{1-\psi}d_{r1}^{\gamma}) \end{aligned}$$

we derive with respect to p_1, which gives:

$$\begin{aligned} \frac{\partial d_{l1}}{\partial p_1} &= -\frac{\left(wl\right)^{-\psi}+\left(1-\psi\right)q_1^{\alpha}p_1^{-\psi}d_{l1}^{\gamma}}{q_2^{\alpha}p_2^{1-\psi}\gamma\left(d-d_{l1}\right)^{\gamma-1}+q_1^{\alpha}p_1^{1-\psi}\gamma d_{r1}^{\gamma-1}}<0 \\ \frac{\partial d_{r1}}{\partial p_1} &= -\frac{\left(wl\right)^{-\psi}+(1-\psi)q_1^{\alpha}p_1^{-\psi}d_{r1}^{\gamma}}{q_3^{\alpha}p_3^{1-\psi}\gamma\left(d-d_{r1}\right)^{\gamma-1}+q_1^{\alpha}p_1^{1-\psi}\gamma d_{r1}^{\gamma-1}}<0 \end{aligned}$$

By imposing symmetry i.e

$$d_{l1} = d_{r1}\equiv\frac{d}{2}, \quad (A.0.4)$$

$$q_2 = q_3\equiv q, \quad (A.0.5)$$

$$p_2 = p_3\equiv p. \quad (A.0.6)$$

one gets:

$$\frac{\partial d_{l1}}{\partial p_1}=\frac{\partial d_{r1}}{\partial p_1}=-\frac{\left(wl\right)^{-\psi}\left(d/2\right)^{1-\gamma}+\left(1-\psi\right)q_1^{\alpha}p_1^{-\psi}d/2}{2q^{\alpha}p^{1-\psi}\gamma} \quad (A.0.7)$$

These expressions are next used to analyze the aggregate demand. Indeed because utility maximization of one individual gives $c = wl/p$, the aggregate demand in 1 is:

$$C_1=\frac{(d_{l1}+d_{r1})wl}{p_1} \quad (A.0.8)$$

deriving with respect to p_1 and using using (A.0.4) yields:

$$-\frac{p_1 \partial C_1}{C_1 \partial p_1} = 1 - 2\frac{\partial d_{l1}}{\partial p_1}\frac{p_1}{2d}$$

and with (A.0.7) and $p_1 = p$ one gets:

$$\varepsilon = 1 + \frac{l^{-\beta}\left(d/2\right)^{-\gamma} p^{\psi} q^{-\alpha} + (1-\psi)}{2\gamma} \tag{A.0.9}$$

Inserting (A.0.1) and (A.0.3) in (A.0.9) yields the implicit solution for the price elasticity.

Differentiating by L and l, Hummels and Lugovskyy (2009) have already analyzed the elasticity of price with respect to market size and incomes per workers. More precisely differenciating ε with respect to l yields the expression presented in the text (eq (1.2.1), with the notable difference that we change notations for a reading convenience i.e. GDP per capita l is rewritten in the text Y/L and GDP here characterized by L is noticed Y) :

$$\frac{\partial \varepsilon/\varepsilon}{\partial l/l} = \frac{\partial \varepsilon/\varepsilon}{\partial L/L} - \frac{\psi}{\gamma}\frac{\partial \varepsilon/\varepsilon}{\partial L/L}$$

Analysing the effect of reputation, we add to this literature this intuitive result:

Reputation of wine reduces the price elasticity of the demand. This reputation effect is stronger on large market.

Proof. By implicit derivation of Equation (A.0.9) we get:

$$\frac{\partial \varepsilon/\varepsilon}{\partial q/q} = -\frac{2^{\gamma} l^{-\psi} \alpha(\varepsilon-1)p^{\psi}}{t(\varepsilon-1) + 2^{\gamma} l^{-\psi}(\psi + (\varepsilon-1)\gamma)p^{\psi}} \tag{A.0.10}$$

where t is a positive term:

$$t = 2q^{\alpha}\gamma\varepsilon\left(\frac{\varepsilon f}{Ll}\right)^{\gamma}$$

because $\varepsilon > 1$ (see A.0.9) we have proved that:

$$\frac{\partial \varepsilon/\varepsilon}{\partial q/q} < 0$$

Lastly the market size L reduces t which reduces the denominator of (A.0.10) which prove the last part on the Proposition 1 asserting the stronger negative impact of reputation on the price elasticity in large market.

□

Appendix A2 : Price elasticity and geographical reputation

To investigate whether the previous results hold at a more disaggregated level, we pursue the econometric exercise by focusing on French regional wines. This choice was made in order to treat specific heterogeneous behaviour not fully captured by fixed effect and/or to consider aggregation bias. By estimating the previous equation with firms and time fixed effect and by separating wine by region we can compare the effects of both competition and income on wines produced in different locations.

We consider three regions: Bordeaux, Alsace and Languedoc Roussillon. Bordeaux is reputed worldwide for its wine production and wines produced there have the best reputation in our sample.

To consider a region producing white wines with a clear differentiation we chose Alsace which includes the reputable dry Riesling and Gewürztraminer wines. This region also has the advantage of being located near the corridor of urbanisation of Western Europe, with a population of around 111 million, providing to producers an advantage in terms of market access.

Lastly, we consider the Languedoc Roussillon region which is one of the main producers of wine in France, with annual production volumes that have been known to surpass the production of nations like the United States. However the production is heterogeneous in terms of quality and the region suffers from a poorer reputation than wines produced elsewhere (e.g. in Bordeaux).

Table (A.1) presents the results. It is worth noting that while Hummels and Lugovskyy (2009) pool over multiple exporters and provide results at an industrial level (HS2). We have enough data variation to lead the estimation at the HS8 level maintaining firms fixed effects. This detailed analysis confirms the previous results, a rise in GDP per capita favours wine exportation for many varieties, while GDP growth, theoretically associated with more competition, is detrimental.

Wine	Bordeaux	Alsace	Lang Rous	Not AOC or PGI
GDP per capita	1.26	1.88	1.63	1.15
	(0.706)[c]	(0.971)[c]	(0.506)[a]	(0.322)[a]
GDP	-0.85	-1.97	-1.52	-1.03
	(0.676)	(0.970)[b]	(0.429)[a]	(0.318)[a]
Year fixed effect	Yes	Yes	Yes	Yes
Firms fixed effect	Yes	Yes	Yes	Yes
R-square	0.16	0.08	0.13	0.03
Obs	13506	3514	4648	17734

Notes: OLS with RSE in brackets corrected by clusters on destination market. a: significant at 1%, b: significant at 5%, c: significant at 10%All variables are in Log

Table A.1: Price regressions for French wines

Interestingly, for Bordeaux wines the coefficient of market size is insignificant, indicating that competition is less fierce for these wines. This result supports the GMIV model extended to take into account reputational effects, which can neutralize the effect of competition. The total effect of per capita GDP growth, only depends therefore on a_2 in Equation (1.3.1) and is equal to 1.26, which is clearly the strongest impact. For wines produced in Alsace and in Languedoc Roussillon the total effect is of $\widehat{a}_1 + \widehat{a}_2 = -0.09$ and of 0.11 respectively. The negative total effect for Alsace wines is worth noting since it has never been obtained until now, indicating that the total effect of per capita GDP growth can increase price elasticity. A vast majority of wines produced in these regions are products benefitting from labels such as the AOC classification (Appelation d'Origine Contrôlée) or PGI (Protected Geographical Indication) providing a positive reputation effect on these wines. The last column of Table (A.1) confirms that conclusions of the GMIV model also hold for wines without AOC and PGI classifications.

Appendix A.3: data

	Obs.	Mean	Std. Dev.	Min	Max	Sources
PIB	4 496	240299.67	1 121 194.33	0	21 233 314.65	WDI Database
Population	4 868	31 342 438.23	120 051 717.3	8 949	1 350 695 000	WDI database
Production	697	4470.36	9919.54	0	57 386	OIV (Organisation Internationale du vin et de la vigne). Total partner country wine production (2001 to 2011)
Imports	5 377	29 965 639.42	195 976 058.88	1	3 414 783 339	Comtrade Nominal exports at the 6 digit of the Harmonized System 2001 to 2011
Income share of top 10%	992	32.94	6.20	13.96	53.31	World Top Income Database
Exports	678 037	57 809.67	401 432.14	0	58 698 319	SAD (Single Administrations Declarations). Exports of wine, by mode of transport, by exporters on every markets, each month, at the 8 digit of the Harmonized System.

Table A.2: Summary Statistics

Appendix B

Chapter 2

Appendix B.1: List of HS4 product used in regressions

$HS4$	*Description*
0701	Potatoes; fresh or chilled
0702	Tomatoes, fresh or chilled
0703	Onions, shallots, garlic, leeks and other alliaceous vegetables; fresh or chilled
0704	Cabbages, cauliflowers, kohlrabi, kale and similar edible brassicas; fresh or chilled
0705	Lettuce (lactuca sativa) and chicory (cichorium spp.) fresh or chilled
0706	Carrots, turnips, salad beetroot, salsify, celeriac, radishes and similar edible roots; fresh or chilled
0708	Leguminous vegetables; shelled or unshelled, fresh or chilled
0709	Vegetables, n.e.c in chapter 07, fresh or chilled
0713	Vegetables, leguminious; shelled, whether or not skinned or split, dried
0803	Bananas, including plantains; fresh or dried
0804	Dates, figs, pineapples, avocados, guavas, mangoes and mongosteens; fresh or dried
0805	Citrus fruit; fresh or dried
0806	Grapes, fresh or dried
0808	Apples, pears and quinces; fresh

Table B.1: List of product include in regressions

*HS*4	*Description*
0901	Coffee, whether or not roasted or decaffeinated; husks and skins; coffee substitutes containing coffee in any proportion
0902	Tea
0904	Pepper of the genus piper; dried or crushed or ground fruits of the genus capsicum or of the genus pimenta
0905	Vanilla
1001	Wheat and meslin
1003	Barley
1005	Maize (corn)
1006	Rice
1007	Grain sorghum
1008	Buckwheat, millet and canary seeds; other cereals
1201	Soya beans, whether or not broken
1207	Oil seeds and oleaginous fruits, n.e.c. in chapter 12; whether or not broken
1212	Locust beans, seaweeds and other algae, sugar beet, sugar cane, fresh, chilled, frozen or dried, whether or not ground; fruit stones, kernels and other vegetable products (including unroasted chicory roots) used primarily for human consumption, n.e.c.

Table B.2: List of product include in regressions (Continued)

Appendix B.2: List of countries used in regressions

$ISO-3$	$Name$
ARG	Argentina
BGD	Bangladesh
BRA	Brazil
CAN	Canada
CHN	China
COL	Colombia
DEU	Germany
DZA	Algeria
EGY	Egypt
ESP	Spain
FRA	France
GBR	United Kingdom
IDN	Indonesia
IND	India
IRN	Iran, Islamic Republic of
ITA	Italy
JPN	Japan
KEN	Kenya
KOR	Korea, Republic of
MAR	Morocco
MEX	Mexico
PAK	Pakistan
PHL	Philippines
POL	Poland
RUS	Russian Federation
THA	Thailand
TUR	Turkey
TZA	Tanzania, United Republic of
UKR	Ukraine
USA	United States
VNM	Viet Nam
ZAF	South Africa

Table B.3: List of countries include in regressions

Appendix B.3: Simulations results by exporters

$ISO-3$	Water Change	All Change	Rainfall Change	Evapotranspiration Change	Population Change	Temperature Change
ARG	0.01	-21.20	-21.55	-21.64	-21.76	-21.76
AUS	0.10	-32.02	-32.02	-32.01	-32.00	-31.97
BGD	-0.19	-69.31	-69.47	-69.77	-69.59	-69.58
BRA	0.08	-23.22	-22.87	-23.08	-22.85	-22.84
CAN	-0.34	-19.93	-20.16	-20.01	-19.90	-19.89
CHN	-0.04	-16.62	-16.68	-16.56	-16.53	-16.05
COL	0.15	-45.40	-45.77	-44.41	-44.35	-44.29
DEU	-0.48	-15.92	-16.81	-16.00	-16.14	-16.35
DZA	1.14	-77.50	-77.51	-77.59	-77.58	-77.56
EGY	-0.22	-46.39	-46.40	-46.57	-46.57	-46.53
ESP	-0.04	-3.80	-3.82	-3.85	-3.81	-3.73
FRA	-0.63	-9.30	-9.00	-8.91	-8.41	-8.49
GBR	0.46	-25.85	-25.78	-25.46	-25.60	-25.63
GHA	0.67	-60.88	-60.77	-60.71	-60.81	-60.81
IDN	-0.23	-52.53	-53.20	-53.11	-53.66	-53.66
IND	-0.11	-31.66	-31.67	-31.42	-31.37	-31.36
IRN	0.13	-27.13	-27.17	-27.25	-27.21	-27.15
ITA	-0.10	-1.10	-1.63	-2.44	-2.58	-2.52
JPN	-0.12	-49.50	-49.62	-49.14	-49.31	-49.27

Notes : The first colum corresponds to water variable change for the year 2005. The second column corresponds to climate change (including internal movements of population for the year 2050 (SSP1), precipitations, evapotranspiration and temperatures for the year 2050). For evapostranpiration, we choose the increase of evapostranspiration relative to a increase of 4°C. All results are change in percentage relative to the last year of database (2005). These results are means.

Table B.4: Simulations results by exporters

$ISO-3$	Water Change	All Change	Rainfall Change	Evapotranspiration Change	Population Change	Temperature Change
KEN	0.02	-56.26	-56.11	-56.10	-56.02	-56.02
KOR	-0.16	-45.70	-45.31	-46.03	-45.63	-45.65
LKA	-0.02	-75.81	-75.82	-75.82	-75.82	-75.82
MAR	0.20	-32.71	-32.74	-32.71	-32.69	-32.61
MEX	-0.07	-6.99	-7.01	-7.04	-6.91	-6.86
MOZ	0.22	-81.53	-81.34	-81.42	-81.46	-81.45
MYS	0.12	-73.72	-73.82	-73.53	-73.65	-73.64
NPL	0.19	-63.92	-63.33	-66.33	-65.59	-65.55
PAK	0.02	-78.41	-78.40	-78.40	-78.39	-78.37
PER	-0.41	-37.32	-37.25	-37.96	-38.43	-38.47
PHL	-0.04	-58.01	-58.01	-58.01	-58.01	-58.01
POL	0.11	-21.77	-21.44	-22.03	-21.44	-21.56
RUS	-0.26	-41.59	-41.89	-41.07	-41.74	-41.74
SAU	-0.01	-55.38	-55.38	-55.38	-55.38	-55.38
THA	-0.23	-38.32	-38.60	-37.90	-38.12	-38.13
TUR	-0.10	-23.99	-24.01	-24.12	-24.05	-23.93
TZA	-0.78	-55.58	-55.44	-55.35	-55.03	-55.02
UGA	-3.64	-67.45	-66.83	-65.88	-65.53	-65.53
UKR	-0.24	-41.81	-42.32	-41.27	-42.25	-42.22
USA	-0.03	-2.59	-2.52	-2.60	-2.55	-2.52
VEN	-0.27	-61.86	-61.91	-62.11	-62.00	-62.02
VNM	-0.44	-52.98	-52.88	-52.88	-52.67	-52.65
YEM	0.10	-24.10	-24.06	-24.06	-24.06	-24.09
ZAF	-0.06	-35.80	-35.63	-35.90	-35.72	-35.70

Notes : The first colum corresponds to water variable change for the year 2005. The second column corresponds to climate change (including internal movements of population for the year 2050 (SSP1), precipitations, evapotranspiration and temperatures for the year 2050). For evapostranpiration, we choose the increase of evapostranspiration relative to a increase of 4°C. All results are change in percentage relative to the last year of database (2005). These results are means.

Table B.5: Simulations results by exporters (Continued)

Appendix B.4: Simulations results by products

$HS4$	Water Change	All Change	Rainfall Change	Evapotranspiration Change	Population Change	Temperature Change
0701	-2.95	-42.35	-42.18	-37.93	-42.26	-42.23
0702	-0.04	-21.16	-21.08	-10.59	-21.09	-21.05
0703	-1.19	-22.72	-22.91	-15.78	-22.60	-22.56
0704	-1.26	-19.20	-19.14	-9.58	-19.16	-19.10
0705	-1.10	-19.02	-18.91	-9.20	-18.92	-18.87
0706	-1.78	-21.74	-21.65	-12.84	-21.60	-21.55
0707	4.36	-29.17	-29.11	-23.42	-29.01	-28.98
0708	-2.23	-17.90	-17.65	-18.45	-17.80	-17.75
0709	-0.19	-3.83	-3.69	5.17	-3.68	-3.64
0713	0.99	-18.48	-18.34	-21.73	-18.52	-18.49
0803	-2.01	-29.07	-28.76	-20.83	-28.77	-28.77
0804	1.57	-32.53	-32.85	-34.90	-32.48	-32.50
0805	0.75	-21.00	-21.44	-23.77	-21.08	-21.07
0806	-0.41	-17.73	-18.04	-6.66	-18.18	-18.15
0808	-0.38	-20.60	-20.54	-22.70	-20.31	-20.32
0901	-3.10	-10.59	-10.48	-10.71	-10.23	-10.25
0902	-1.28	-21.17	-20.66	-12.32	-20.78	-20.79
0904	1.71	-19.35	-19.27	-13.66	-19.$\oint$21	-19.18
0905	0.04	-42.81	-42.58	-41.61	-42.91	-42.92
1001	1.33	-17.71	-17.85	-16.40	-17.49	-17.49
1003	-0.43	-37.33	-38.52	-39.32	-38.84	-38.84
1005	0.44	-15.33	-15.24	-14.77	-15.27	-15.24
1006	0.40	-34.51	-34.63	-28.87	-34.43	-34.40
1007	1.27	-17.13	-17.16	-23.15	-17.27	-17.23
1008	2.24	-52.29	-52.26	-53.61	-52.39	-52.38
1201	0.80	-14.21	-14.19	-12.49	-14.27	-14.24
1202	1.16	-42.53	-42.37	-40.74	-42.43	-42.42
1207	-1.81	-53.96	-53.82	-61.03	-54.26	-54.25
1212	2.81	-25.75	-26.98	-20.60	-26.65	-26.64

Notes : The first colum corresponds to natural change (precipitations, evapotranspiration and temperatures for the year 2050). For evapostranpiration, we choose the increase of evapostranspiration relative to a increase of 4°C. In colum 2, results correspond to a internal movements of population for the year 2050 (SSP1). And the last colum corresponds to a combined change of previous colum. All results are change in percentage relative to the last year of database (2006). These results are means.

Table B.6: Simulations results by products

Appendix C

Chapter 3

Appendix C.1

The following Chart shows the RTAs notified to the WTO and analyzed in this paper, it also illustrates to what extent these agreements are inter-linked.

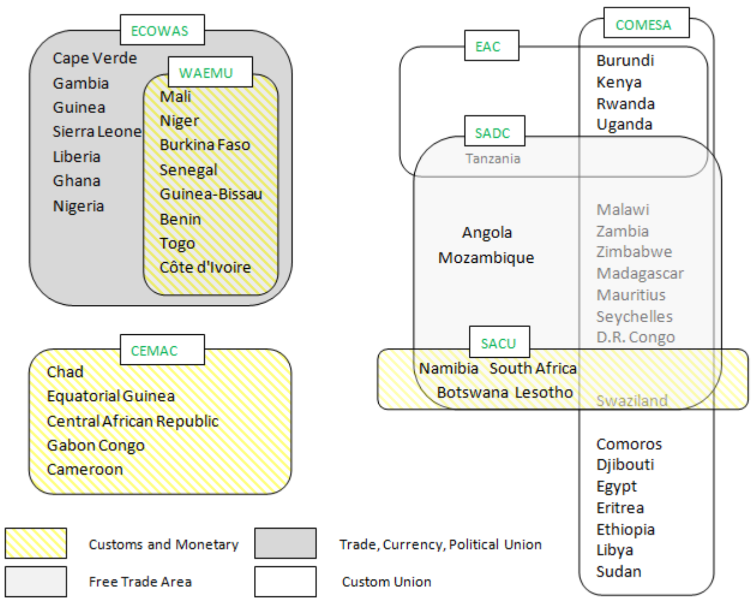


Figure C.1: Spaghetti bowl of RTAs in Africa

The origin of this Spaghetti bowl, comes from the 1950s. During that period, French and English speaking countries come together to form the first Regional Trade Agreement in Sub-Saharan Africa.

Successive Regional Trade Agreements were created, namely West African Customs Union (WACU) and Customs Union of West African States (CUWAS) for West Africa. Equatorial Customs Union (ECU) and Central African Customs and Economic Union (CACEU) for Central Africa and the last one is East African Community (EAC) for the east of the continent. Central and West African agreements are better known by their French acronyms which are respectively: UDAO, UDEAO for West Africa and UDE, UDEAC for Central Africa.

Regional agreements in West Africa start in 1959 with seven members engaged in UDAO with his headquarters in Abidjan. These members were Benin, Burkina Faso, Côte d'Ivoire, Mali, Niger, Senegal and Mauritania. UDAO encounters many difficulties among which the distribution of customs revenues collected on imports. It was replaced by UDEAO conserving the same membership.

Concerning RTAs in Central Africa, Central African Republic, Gabon, Chad and Congo are the founding members of UDE which was established in june 1959 and joined by Cameroun in 1962. This union moves on to UDEAC in 1964 with the same members exepted Chad.

The only English-speaking agreement on that period was the East African Community. Since 1917, EAC was a political union before to become an economic community in june 1967. The treaty was signed between Kenya, Tanzania and Uganda but was quickly dissolved in 1977 in reason of internal opposition and war in Uganda.

Appendix C.2

In order to measure diversion effects of African countries indepedently of the agreements to which they belong (African or not), we add to our trade costs function, dummies RTA_{o-dt} and RTA_{d-ot} as well as african exporters and importers dummies ($AFR_o$and AFR_d) taking value 1 respectively for african exporters and importers. RTA_{o-dt} takes 1 when the country o is a member of any RTA which excludes d. Similarly, RTA_{d-ot} takes 1 if importer d has signed any other RTA with any outside trade partners. Then 3.2.2 become:

$$\begin{aligned} X_{odt} = \psi_1 RTA_{odt} + \psi_2 RTA_{odt} AFR_{od} + \psi_3 RTA_{d-ot} + \psi_4 AFR_d RTA_{d-ot} \\ + \psi_5 RTA_{o-dt} + \psi_6 AFR_o RTA_{o-dt} + bZ_{od} + \epsilon_{odt} \end{aligned} \tag{C.0.1}$$

In comparison with the analysis of trade creation, studying trade diversion through (C.0.1) requires to remove importer/exporter-year effects since fixed effects directly capture variation over time at the destination or at the origin of exports. As a result, year-exporter and year-importer fixed effects are used to properly analyze trade creation in the core of the paper but must be omitted to study trade diversion here.

The interaction term between african and diversion dummies variables capture trade diversion of an agreement that one of the african countries has with another country. As explain by Soloaga and Winters (2001) and Carrère (2004) if $\psi_2 > 0$ and $\psi_4 < 0$ then the propensity to import from the rest of the world decrease whereas the propensity to to trade with others members increase (import diversion). Similary, there is an export diversion when $\psi_2 > 0$ and $\psi_6 < 0$.

	(2)	(3)	(4)	(5)	(6)
$WAEMU$	2.194^a (0.389)	1.237^a (0.460)	1.240^a(0.460)	RTA$_{odt}$	0.458^a(0.054)
$WAEMU_{export}$	-0.165 (0.216)	0.035 (0.218)	0.034 (0.217)	$RTA_{odt}AFR_{od}$	0.842^a(0.154)
$WAEMU_{import}$	-0.453^a (0.160)	-0.583^a (0.220)	-0.583^a (0.220)	$log(d_{od})$	-0.509^a(0.030)
$WAEMU$ $(before\, 1974)$	1.980^a (0.394)	2.117^a (0.421)	2.123^a (0.420)	RTA_{o-dt}	-0.204^a (0.051)
$WAEMU_{export}$ $(before\, 1974)$	0.446 (0.272)	0.449 (0.294)	0.449 (0.293)	RTA_{d-ot}	-0.119^b(0.050)
$WAEMU_{import}$ $(before\, 1974)$	-0.134 (0.240)	-0.008 (0.233)	-0.007 (0.233)	$RTA_{o-dt}AFR_i$	0.162^c(0.092)
$WAEMU$ $(before\, 1993)$	1.811^a (0.383)	1.421^a (0.433)	1.425^a (0.433)	$RTA_{d-ot}AFR_j$	0.079 (0.093)
$WAEMU_{export}$ $(before\, 1993)$	0.036 (0.218)	-0.027 (0.209)	-0.027 (0.208)		
$WAEMU_{import}$ $(before\, 1993)$	-0.361^b (0.169)	-0.448^a (0.159)	-0.448^a (0.159)		
$CEMAC$	1.293 (0.867)	1.300 (0.867)	1.302 (0.866)		
$CEMAC_{export}$	0.481 (0.416)	0.478 (0.416)	0.477 (0.415)		
$CEMAC_{import}$	0.318 (0.409)	0.326 (0.409)	0.325 (0.408)		
$CEMAC$ $(before\, 1994)$	1.585^c (0.878)	1.596^c (0.878)	1.600^c(0.877)		
$CEMAC_{export}$ $(before\, 1994)$	0.535 (0.393)	0.535 (0.393)	0.533 (0.393)		
$CEMAC_{import}$ $(before\, 1994)$	1.116^a (0.411)	1.116^a (0.411)	1.114^a (0.411)		
$SADC$	2.072^a (0.303)	2.018^a (0.307)	2.044^a (0.307)		
$SADC_{export}$	0.169 (0.137)	0.167 (0.137)	0.170 (0.137)		
$SADC_{import}$	0.239 (0.146)	0.251^c (0.147)	0.254 ^{c} (0.146)		
$SADC$ $(before\, 1993)$	1.892^a (0.384)	1.106^b (0.469)	1.171^b (0.469)		
$SADC_{export}$ $(before\, 1993)$	0.041 (0.231)	-0.007 (0.258)	0.014 (0.258)		
$SADC_{import}$ $(before\, 1993)$	0.268^c (0.157)	0.308^b (0.157)	0.309^b (0.156)		
$ECOWAS$		1.116^a (0.338)	1.117^a (0.337)		
$ECOWAS_{export}$		-0.258 (0.212)	-0.258 (0.211)		
$ECOWAS_{import}$		0.201 (0.211)	0.200 (0.211)		
$ECOWAS$ $(before\, 1993)$		0.483 (0.323)	0.483 (0.323)		
$ECOWAS_{export}$ $(before\, 1993)$		0.077 (0.187)	0.076 (0.186)		
$ECOWAS_{import}$ $(before\, 1993)$		0.207^b(0.081)	0.206^b (0.081)		
$COMESA$		0.810^a (0.259)	0.688^a (0.231)		
$COMESA_{export}$		0.038 (0.098)	0.051 (0.096)		
$COMESA_{import}$		-0.112^c (0.064)	-0.100 (0.064)		
$COMESA$ $(before\, 1994)$		1.319^a (0.323)	1.205 ^{a} (0.323)		
$COMESA_{export}$ $(before\, 1994)$		0.201 (0.164)	0.124 (0.171)		
$COMESA_{import}$ $(before\, 1994)$		-0.134^c (0.079)	-0.150^c (0.080)		
EAC			2.014^a (0.317)		
EAC_{export}			-0.594 ^{a} (0.130)		
EAC_{import}			-0.162 (0.103)		
EAC $(before\, 2000)$			1.925^a(0.403)		
EAC_{export} $(before\, 2000)$			0.717^a (0.159)		
EAC_{import} $(before\, 2000)$			0.237 (0.146)		
$Other\ RTA$	0.374^a (0.085)	0.372^a (0.085)	0.372^a (0.084)		
$Other\ RTA_{export}$	-0.104^b (0.049)	-0.108^b (0.049)	-0.108^b(0.049)		
$Other\ RTA_{import}$	-0.028 (0.060)	-0.028 (0.060)	.-0.028 (0.059)		
Obs			874163		
Pseudo R^2			0.854		
log likelihood	-2.895e+13	-2.892e+13	-2.890e+13		-2.823e+13

Notes: $^{a\,b\,c}$ denote significance at the 1, 5 and 10 percent level respectively. Estimations have been done with PPML. Robust clustered standard errors are reported under each coefficient. Individual and bilateral fixed effects (f_o , f_d , f_t) have been introduced in all regressions as well as the usual bilateral variables. The latter have the appropriate signs but we do not report them in this table.$^{export\,import}$ denote respectively exporter and importer trade diversion dummies.

Table C.1: Individual Trade Diversion

Estimates in Table (B.1, column 6) show that the trade diversion has been weak or not significant. In column 2-4, the same regressions are done (i.e. considering different agreements successively and historically). Interpretation of our result in these cases are a little bit different since trade diversion is now induced by only sub saharan RTAs. Above all agreements, the diversion effect is the most clear for WAEMU, considering the imports and the exports as well as past agreements. Export diversion is also found for EAC. Overall, these results show that RTAs in Africa have brought few trade distortions.

Appendix C.3

The following tables show results for alternative years (2000 and 2010) in General Equilibrium analysis. Result are similar to those obtained in the text.

Country	Welfare 2000	Welfare 2010
Angola	0.055%	-0.003%
Burundi	4.355%	5.095%
Djibouti	0.018%	0.039%
Egypt	0.073%	0.055%
Ethiopia	1.493%	1.315%
Kenya	0.032%	0.025%
Libya	0.000%	0.021%
Lesotho	0.077%	0.062%
Madagascar	0.552%	0.823%
Mozambique	0.740%	0.711%
Mauritius	0.025%	0.033%
Malawi	0.090%	0.096%
Rwanda	0.016%	0.040%
Somalia	0.013%	0.025%
Swaziland	0.064%	0.083%
Uganda	0.038%	0.053%
Zambia	0.173%	0.197%
Zimbabwe	0.075%	0.084%

Notes : Some member's countries of COMESA are not present in our results because of a lack in data (Seychelles, Democratic Republic of Congo, Comoros, Eritrea and Sudan).

Table C.2: General Equilibrium effects of COMESA

Country	Welfare 2000	Welfare 2010
Benin	0.033%	0.039%
Burkina Faso	0.024%	0.043%
Côte d'Ivoire	0.029%	0.023%
Cap Verde	0.159%	0.147%
Ghana	0.042%	0.045%
Guinee	0.001%	0.002%
Gambia	0.032%	0.048%
Liberia	0.036%	0.064%
Mali	0.108%	0.124%
Niger	0.018%	0.023%
Nigeria	0.008%	0.008%
Senegal	0.025%	0.035%
Sierra Leone	0.173%	0.094%
Togo	0.053%	0.078%

Notes : Guinee-Bissau not present in our results because of a lack in data.

Table C.3: General Equilibrium Effects of ECOWAS

Country	Welfare 2000	Welfare 2010
Angola	1.099%	0.501%
Botswana	2.645%	5.939%
Lesotho	0.108%	0.089%
Madagscar	NA	1.930%
Malawi	0.099%	0.104 %
Mauritius	0.030%	0.043 %
Mozambique	0.716%	1.897%
South Africa	0.199%	0.258%
Swaziland	0.071%	0.083 %
Tanzania	0.032%	0.038 %
Zambia	1.112%	1.122 %
Zimbabwe	0.565%	0.552 %

Notes : Some member's countries of SADC are not present in our results because of a lack in data (Seychelles, Democratic Republic of Congo and Namibia). Madagascar was not a member of SADC in 2000.

Table C.4: General Equilibrium Effects of SADC

Appendix D

Chapter 4

Appendix D.1

Imports (Millions of dollars)					
Country	Value	Country	Value	Country	Value
Argentina	89 300	Finland	34 700	Malawi	1 140
Australia	48 200	France	338 000	Nigeria	7 760
Austria	51 200	Gabon	1 670	Norway	29 200
Burundi	413	United Kingdom	336 000	New Zealand	24 300
Brazil	764 000	Guinea	938	Portugal	55 600
Central African Rep.	157	Greece	72 400	Rwanda	387
Canada	119 000	Indonesia	36 500	Sweden	51 300
Chili	25 000	India	66 700	Togo	1 060
China	122 000	Ireland	76 500	Tunisia	15 000
Côte d'Ivoire	10 100	Italia	254 000	Turkey	47 500
Cameroon	2 340	Japan	330 000	Tanzania	2 650
Germany	480 000	Kenya	4 520	Uganda	1 760
Denmark	55 000	Madagascar	782	United States	1 020 000
Egypt	25 700	Mexico	135 000	South Africa	25 200
Spain	110 000	Mali	1 460	Zambia	1 420
Ethiopia	2 300	Mauritius	3 940	Rest of the World	1 620 000

Table D.1: Flows by importers in 1999

	Imports Tariffs (%)									
	Burundi		Kenya		Rwanda		Tanzania		Uganda	
Sectors	1999	2009	1999	2009	1999	2009	1999	2009	1999	2009
Agriculture	27.44	4.69	15.39	5.15	41.03	5.15	29.45	5.15	22.96	5.15
Fishing	40.00	20.00	15.97	20.00	60.56	20.00	39.51	20.00	29.02	20.00
Mining & Quarrying	10.86	3.73	14.18	3.73	13.13	3.73	22.97	3.73	10.86	3.73
Food & Beverages	38.09	24.63	19.80	24.95	78.32	24.95	33.66	24.95	43.61	24.95
Textiles & Wearing	34.75	21.07	19.51	21.09	49.81	21.09	18.85	21.09	23.33	21.09
Wood & Paper	20.56	14.90	18.19	14.90	39.67	14.90	29.98	14.90	18.34	14.90
Petroleum, Chemicals	16.42	9.86	15.48	9.86	29.33	9.86	21.93	9.86	13.95	9.86
Metal Products	16.96	11.22	16.07	11.22	27.99	11.22	26.32	11.22	15.39	11.22
Electrical & Machinery	18.78	8.57	13.26	8.57	33.86	8.57	22.05	8.57	16.22	8.57
Transport Equipment	19.67	7.21	12.14	7.21	24.08	7.21	17.17	7.21	14.37	7.21
Other Manufacturing	34.90	22.05	20.55	22.05	64.86	22.05	26.92	22.05	26.01	22.05

Table D.2: Tariff changes between 1999 and 2009

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Résumé

Cette thèse a pour but d'étudier certains déterminants du commerce international. Le premier chapitre analyse l'évolution des prix des exportations de vin français. L'analyse se base sur le modèle d'Hummels et Lugovskyy (2009) où deux effets de force opposées sont à l'œuvre. D'une part, l'augmentation du niveau de vie conduit à une augmentation des prix (les consommateurs étant prêt à payer plus cher pour obtenir un bien plus proche de leur variété idéale). D'autre part, une plus grande concurrence, devrait réduire les prix (les profits potentiels attirant plus d'entreprises). Ces fondations théoriques sont confirmées par les résultats des estimations réalisées pour le marché du vin. Le second chapitre cherche à mettre en évidence si l'eau est un déterminant du commerce agricole. Pour estimer cet impact, nous construisons un nouvel indicateur nous permettant d'obtenir une meilleure approximation de l'eau disponible au sein d'un pays corrigé des caractéristiques locales ainsi que de celles liées aux produits. Puis, des simulations sur l'impact du changement climatique sur le commerce ont été réalisé, démontrant un effet négatif de ce dernier sur le commerce mais surtout de grandes inégalités entre les pays. Les chapitres 3 et 4 s'intéressent aux Accords Commerciaux Régionaux (ACR) comme déterminant du commerce pour les pays africains. En utilisant deux méthodologies différentes, nous estimons l'impact des ACR sur le commerce africain, pour lesquels peu d'études ont été réalisées. Le premier des deux chapitres quantifie l'impact de plusieurs accords (COMESA, SADC,...) sur le commerce. Le second poursuit l'analyse en se concentrant uniquement sur l'EAC. Les résultats indiquent qu'il y a bien une augmentation de bien-être pour ces pays mais que celle-ci reste faible.

Mots clés : Commerce, Agriculture, Accord Commerciaux Régionaux, Eau.

Abstract

This dissertation studies several determinants of international trade. The first Chapter focuses on prices evolution for French wine export. It explains the recent stability of wine price by an increasing competition faces by French exporters that thwarts the increasing global demand due to the growth of higher income in emerging market (mainly in China). In the second Chapter, we investigate whether water is a determinant of agricultural trade. To estimate this impact, we construct a new indicator that allows to get a better approximation of available water by correcting some local and product specificities. This analysis is completed with simulations about the climate change impact on trade. Simulations highlights a negative impact of climate change on trade but the effect is inequaly distributed among countries. Chapter 3 and 4 analyse the Regional Trade Agreement as determinant of trade for African countries. The third chapter quantifies the impact of several agreements (COMESA, SADC,...) on trade while the fourth chapter is focusing more specifically on the EAC agreement. Main results show an increase of welfare for African countries but with an amplitude of such an increase relatively weak.

Keywords: Trade, Agriculture, Regional Trade Agreement, Water.