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# The effects of colonial history and the declaration of independence on the development of bilateral trade between African and European countries in the years 1962-2000

Master´s Thesis

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# Author's Declaration

Unless otherwise indicated in the text or references, or acknowledged above, this thesis is entirely the product of my own scholarly work. Any inaccuracies of fact or faults in reasoning are my own and accordingly I take full responsibility. This thesis has not been submitted either in whole or part, for a degree at this or any other university or institution. This is to certify that the printed version is equivalent to the submitted electronic one.

Graz, January 2014

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# Zusammenfassung

Diese Masterarbeit untersucht im Rahmen einer empirischen Analyse, wie die koloniale Vergangenheit und die Unabhängigkeitserklärung die Entwicklung des bilateralen Handels zwischen afrikanischen und europäischen Ländern in der post-kolonialen Zeit beeinflussten. Die Erforschung der Determinanten des bilateralen Handels trägt in erster Linie wissenschaftliche Relevanz. Darüber hinaus ist das Wissen über die wichtigsten Bestimmungsfaktoren der Handelsentwicklung zwischen afrikanischen und europäischen Ländern eine Grundvoraussetzung für die Ent-wicklung von Strategien und Programmen, welche darauf abzielen, Afrikas marginalisierte Position im Welthandelssystem zu verbessern.

Die Studie verwendet intra- und interkontinentale Handelsdaten zwischen 45 afrikanischen und 18 europäischen Ländern von 1962 - 2000. Davon sind 41 der afrikanischen Länder ehemalige, europäische Kolonien mit Unabhängigkeits-erklärungen 1950+. 6 der europäischen Länder sind ehemalige Kolonialmächte.

Basierend auf der theoretischen Grundlage der Gravitationsgleichung werden Regressionsanalysen verwendet, um die Effekte der kolonialen Vergangenheit und der Unabhängigkeitserklärung auf die postkoloniale Handelsentwicklung zu quantifizieren. Um die Glaubwürdigkeit der Analyseergebnisse zu stärken werden drei verschiedene Schätzmethoden angewendet.

Die OLS Schätzungen deuten darauf hin, dass der bilaterale Handel zwischen afrikanisch-europäischen Länderpaaren mit kolonialer Vergangenheit in der post-kolonialen Zeit durchschnittlich rund 6-mal höher war als der Handel zwischen anderen Länderpaaren. PMLE schätzt, dass die koloniale Vergangenheit den Handel verdoppelte. Dabei wurde kein signifikanter Unterschied in der Höhe des Effektes zwischen ehemaligen französischen und britischen Kolonien gefunden.

Weitere Untersuchungsergebnisse lassen darauf schließen, dass die Unabhängig-keitserklärung keine signifikanten Effekte auf die Exporte afrikanischer Länder ausübte. Indessen wirkte sich die Unabhängigkeit signifikant negativ auf die Importe afrikanischer Länder aus. OLS und PMLE Schätzungen ergeben, dass die Unabhängigkeitserklärung die Importe der afrikanischen Länder durchschnittlich um mehr als 50% reduzierte, wobei der negative Effekt über die Jahre hinweg stetig zunahm. Die Ergebnisse dieser Studie sind großteils konform mit Head, Mayer, Ries (2010) sowie Lavallée und Lochard (2012), welche den Unabhängigkeitseffekt an Handelsdaten ehemaliger Kolonien auf der ganzen Welt untersuchten.

# Abstract

This thesis investigates how colonial history and the declaration of independence affected bilateral trade development between African and European countries in the post-colonial period.

Understanding the determinants of trade between Africa and Europe has a scientific relevance in the first instance. Moreover, given the strong marginalization of Africa in international trade, knowing what determines the evolution of trade is a precondition to develop strategies which might help to improve Africa's role in the world's trading system.

The empirical analysis conducted utilizes data on intra- and intercontinental trade flows between African and European countries from the years 1962-2000. 41 out of the 45 African countries included in the sample used to be European colonies reaching independence after 1950. 6 out of the 18 European countries in scope were former metropoles of these African countries.

The research follows the gravity equation of international trade and the econometric approach of linear regression analysis to quantify the influence of colonial history and the declaration of independence on post-colonial trade development. OLS, PMLE and LSDV estimators are applied and compared to enhance the credibility of the results.

The OLS estimations suggest that in the years 1962 to 2000 trade between African-European country pairs with a colonial history was on average almost 6 times higher than trade between country pairs that have never been in a colonial relationship or have had independence dates prior to 1950. PMLE estimates that country pairs with a colonial history traded almost twice as much compared with other country pairs. The research outcomes do not suggest a difference in the size of the colonial history effect between the French and the British former colonies.

The estimation results indicate that the declaration of independence did not affect African countries' exports to European and other African countries in the post-colonial period. However, African countries' imports were negatively influenced by independence. OLS suggests that independence reduced African countries' imports from Africa and Europe for 57.94%, whereas the negative effect increased gradually over the post-colonial period. PMLE estimates an average import reduction of 53.18%. The findings are largely in line with Head, Mayer, Ries (2010) and Lavallée and Lochard (2012) who investigate the effect of independence utilizing bilateral trade data on former colonies from all over the world.

# Danksagung

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Special thanks are also given to my dearest friends who were always on hand to assist by word and deed. Particularly, I want to thank my best friend Stefan for lending me a sympathetic ear and encouraging me during the writing of the thesis. I also want to thank my roommate Kerstin for providing advice on English grammar and phrasing issues and Christina for correcting the German texts.

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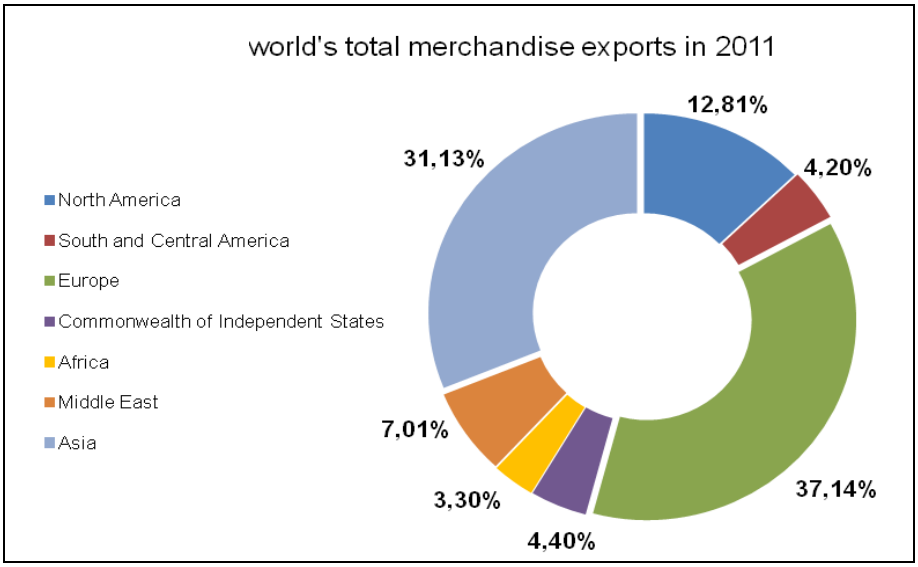
# List of abbreviations

| | | |
|---|---|---|
| ACP | = | Africa, Caribbean and Pacific (trade agreement) |
| DOTS | = | Direction of Trade Statistics |
| FE | = | fixed effects (estimator) |
| GATT | = | General Agreement on Tariffs and Trade |
| GDP | = | gross domestic product |
| IMF | = | International Monetary Fund |
| IV | = | instrumental variable (estimator) |
| LSDV | = | least squares dummy variable (method) |
| NBER | = | National Bureau of Economic Research |
| OLS | = | ordinary least squares (estimator) |
| PMLE | = | Poisson maximum likelihood (estimator) |
| RE | = | random effects (estimator) |
| ROW | = | rest of the world |
| RTA | = | regional trade agreement |
| VIF | = | variance inflation factor |
| WDI | = | World Bank Development Indicators |
| WTO | = | World Trade Organization |

# 1 Introduction

Africa is the world's second largest continent in size, assembling 54 countries with altogether roughly 1.03 billion inhabitants on a geographical area of 30.2 million km². Europe is the world's second smallest continent assembling 50 countries with altogether roughly 0.629 billion inhabitants on a much smaller geographical area of 6.2 million km². However, each continents' contribution to the world's total trade flows is far from what their geographic area and population size might suggest.

According to International Trade Statistics 2012 provided by the World Trade Organization (WTO), Europe accounted for 37.10% of the world's total merchandise exports in 2011 while Africa's contribution to world's exports was only 3.30%. Graph 1 shows the continents of origin of the world's total 2011 merchandise exports:

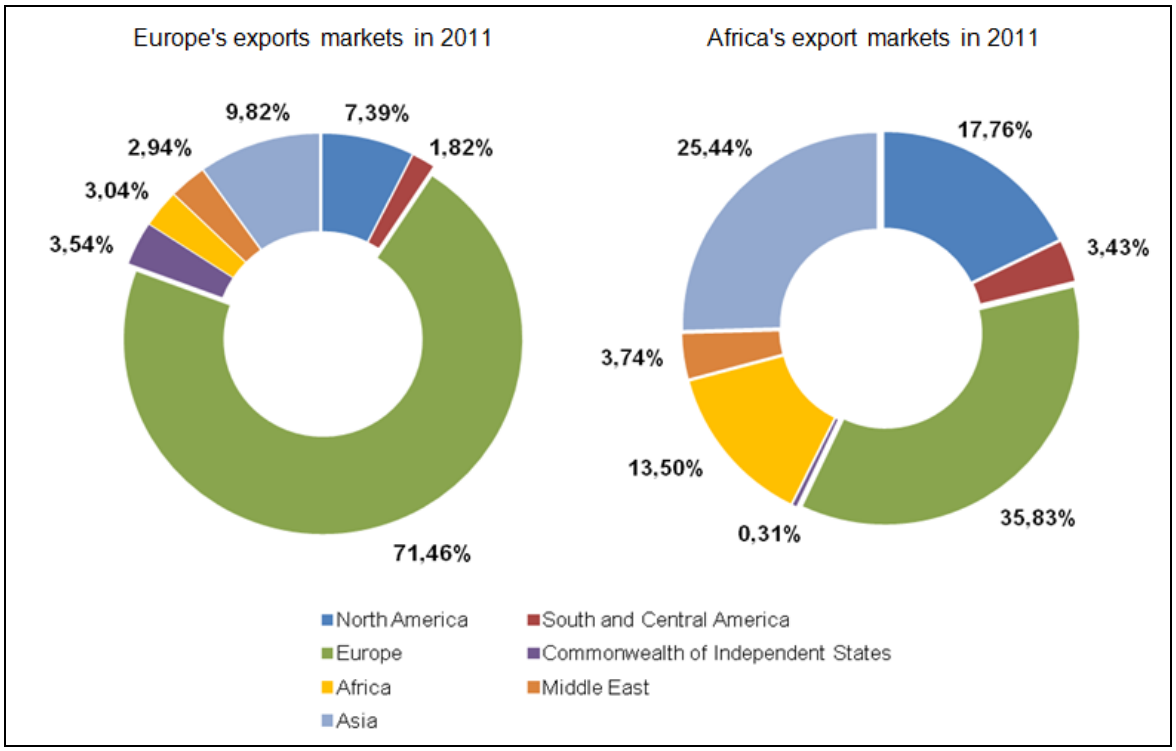



**Graph 1:** World's total merchandise exports 2011 by markets of origin

Turning to Graph 2 which pictures intra- and intercontinental export flows of Africa and Europe, it can be seen that the two continents are in very different positions of economic dependency. With respect to intracontinental trade, Europe yields the world's highest level. 71.46% of Europe's total merchanise exports were directed to other European countries. In strong contrast, Africa's level of intracontinental trade is by far smaller. Only 13.15% of African countries' total merchandise exports were directed to other African countries.

Looking at intercontinental trade flows of merchandise between Africa and Europe, the role of the other continent as export market is very imbalanced. Since 35.83%

of Africa's merchandise exports in 2011 were shipped to European countries, Europe is Africa's most important merchandise export market. At the same time only 3.04% of Europe's exports were directed to African countries, making Africa a rather marginal export market for Europe.




**Graph 2:** Europe's and Africa's merchandise export markets in 2011

Statistical data on the world's, Europe's and Africa's total imports of merchandise in 2011 is presented in the appendix on page I and II. However, export and import data tell the same story. Africa is marginalized in the world's international trading system and the mutual dependency of Africa and Europe as trade partners is very imbalanced.

## 1.1 Scope and motivation of research

This thesis looks at intra- and intercontinental bilateral trade data of African and European countries. It is in scope of this master thesis to evaluate the effects of economic, geographic, sociocultural and historical factors on bilateral trade flows in order to identify the main determinants of the African-European trade development. Given the distinctive African-European economic relationship in the 19th and 20th centuries, the influences of colonial history and the declaration of independence on trade development are in the focus of this investigation.

The hypothesis that colonial history positively affects bilateral trade between African and European countries seems intuitively plausible due to the close economic integration of European and African countries during the era of colonization. As indicated in Eichengreen and Irwin (1996), the set-up of market-specific sales, distribution and service networks between European metropoles and African colonies might have allowed to generate a considerably greater level of trade flows as it would be predicted by the sizes of their markets and the geographical distance between. Since the economic integration during colonization allowed bilateral trade costs to be sunk persistently of time, this disproportionate greater level of trade flows is very likely to be long-lasting and hold on even after African countries' decolonization. However, the potentially trade-creating influence of the colonial history may vary with circumstances and a heavy shock such as African countries' declaration of independence may lift the hand of history and initiate a reversed, trade-deteriorating development.

To evaluate the effects of colonial history and the declaration of independence on trade development, the research utilizes aggregated trade data on inter- and intracontinental trade flows between 45 African and 18 European countries in the years 1962-2000. The database incorporates roughly 135,000 observations. Given the fact that the majority of African countries gained independence in the late 1950s and early 1960s, data on African countries' trade flows pictures to a large degree post-independence trade. Exceptions are data on 4 African countries which either have never been under European colonial rule or have had independence dates prior to 1950. Moreover, the sample includes pre-independence trade data on 7 African countries which gained independence after 1965. However, the proportion of trade data on African-European country pairs in ongoing colonial relationships is rather small.

The estimation results are presented and compared for the pooled ordinary least squares estimator (OLS), the Poisson maximum likelihood estimator (PMLE) and the least squares dummy variable (LSDV) estimator.

It shall be noted that it is beyond the scope of this thesis to question the theoretical foundation and the efficiency of the three estimators. Moreover, it is not in scope of this master thesis to evaluate trade development between Africa and other continents of the world except Europe. Therefore, the sample does not include any other trade data than intra- and intercontinental trade data between African and European countries.

## 1.2 Research interests

It is the interest of this research to investigate the main determinants of bilateral trade between African and European countries in the post-colonial years.
In order to get a full picture of all relevant determinants of bilateral trade as well as to minimize the possibility of spurious correlations to omitted variables which might have influenced trade development between African and European countries in 1962-2000, following research question sets the starting point of this investigation:

**Research question on the determinants of trade**

- *Which geographic, sociocultural and economic variables had a significant influence on the development of bilateral trade between African and European countries in the years 1962-2000?*

Since the empirical research focuses on the economic consequences of colonization and decolonization on trade development, another five research questions are formulated, out of which two are linked to the effect of colonization and three are linked to the effect of decolonization:

**Research question on the effect of colonial history**

- *How much did African-European country pairs that once have been in a colony-colonizer relationship trade more than other country pairs?*
- *Did the size of the colonial history effect vary significantly between former African colonies that were ruled by different colonizers?*

**Research question on the effect of the declaration of independence**

- *Did the declaration of independence exhibit a significant effect on the exports and imports of African countries?*
- *How did the independence effect evolve over time?*
- *Did the size of the independence effect vary significantly according to different trade partners of African countries?*

These six research questions form the basis of this thesis and constitute the framework of the empirical analysis.

## 1.3 Scientific relevance

International trade is a key element in all manners of economic relationships. There is demand for knowing what determines trade flow, what is the expected trade value between a given country pair and which factors lead to a deviation from this expected value.

According to Rooutan and Pritchett (1993), Rodrik (1998), Coe and Hoffmaister (1999), Africa's marginalization in international trade is mainly due to low income levels and the geographical isolation of African countries. This assumption is supported by the gravity equation of international trade concept, which claims that the economic masses and the distance between a given country pair are basically the main determinants of trade flows between two countries.

In the late 1990s economists introduced other than the conventionally regarded economic mass and geographical variables in the gravity equation of international trade. They found that besides economic and geographic factors other variables proxying sociocultural factors and historical events also showed significant effects on trade development. This indicates that various different factors can exhibit a significant influence on international trade development under certain circumstances.

In the preceding decade a couple of econometric analyses investigated the influences of colonial history and independence events on trade development. For example Bosker and Garretsen (2008) find that present-day bilateral trade of Sub-Saharan African countries with former colonizers is much higher than trade with other countries. Lochard and de Sousa (2010) find that African countries once under British rule trade more with OECD, emerging and other African countries than former French colonies. Head, Mayer and Ries (2010) find that after independence former colonies' bilateral trade erodes not only with former colonizers but also with siblings and the countries from the rest of the world (ROW).

This research aims at producing further knowledge on what determines post-colonial trade and how colonization and decolonization affect trade development by investigating intra- and intercontinental trade flows between African and European countries in the years 1962-2000.

Knowing the main determinants of African-European post-colonial trade development has scientific relevance at the first stage. At the second stage this knowledge is a basic requirement to develop economic strategies and public

policies which aim at influencing or direct trade development. Given Africa's marginalized role in international trade, investigating trade determinants is a promising field of research which might help to improve Africa's position in the world's trading system.

Moreover, Bosker and Garretsen (2008) as well as Coxhead, Foltz and Mogues (2012) argue that bilateral trade positively influences productivity change and socioeconomic performance of countries. Bosker and Garretsen (2008) find that bilateral trade between Sub-Saharan African countries does have a significant positive effect on countries' GDP per capita. If this holds, knowing the determinants of bilateral trade development might help to develop strategies which increase the socioeconomic performance of countries. Given the fact that the majority of African countries is characterised by poor socioeconomic development as it is discussed in Sachs et al. (2004), identifying the determinants of post-colonial trade development might bring scholars and politicians one step closer to develop strategies which improve living conditions and help Africa to socioeconomically catch up with more developed continents.

# 2 Methodological approach

This research makes use of econometrics to identify significant determinants of inter- and intracontinental trade between African and European in the years 1962-2000. Based on the gravity equation of international trade, the empirical implementation follows the econometric approach of linear regression analysis. The linear regression analysis enables to estimate the effects of selected economic, geographic, sociocultural and historic variables on bilateral trade development.

## 2.1 Theoretical models

The gravity model of international trade is a theoretical concept used in economic science with the aim to explain determinants of international trade flows. Essentially, it is an expenditure equation with a market-clearing condition imposed. Inspired by Newton's law of gravity in physics and elaborated in Baldwin and Taglioni (2006), the force of gravity between two objects is proportional to the product of the objects' masses divided by the square of the distance between them:

(1)
$$\begin{matrix} force\ of \\ gravity \end{matrix} = G\frac{M_1 M_2}{(dist_{12})^2}$$

Replacing the force of gravity with the value of bilateral trade and the two mass terms $M_1$ and $M_2$ with the trade partners' gross national incomes $Y_1$ and $Y_2$, we obtain the simplest gravity equation of international trade:

(2)
$$\begin{matrix} bilateral \\ trade \end{matrix} = G\frac{Y_1 Y_2}{(dist_{12})^{elasticy-1}}$$

This traditional model dates back to works of Tinbergen in 1962. Tinbergen initiated the development of a vast theoretical and empirical literature on the determinants of international trade. Anderson (1979) was then the first to provide microfoundations on the gravity equation of international trade. As pictured in equation (2), in its simplest form, international trade flow is explained by the countries' economic masses and the geographical distance, which enter the equation in a multiplicative form. While trade increases proportional to the incomes of the trading countries, bilateral distance has a negative effect on the trade value.

At this point of research G is regarded to be constant in both physics and economics.

A more recent effort to microfound the gravity equation of international trade was taken by Anderson and Van Wincoop (2001) and (2003). Their theory is very close to Anderson (1979), however, Anderson and Van Wincoop (2001) and (2003) treat the G term differently. They argue that the traditional model of gravity equation is misspecified since, in contrast to physics, G is not a constant in the economic world. Anderson and Van Wincoop (2001) and (2003) refer to G as the "gravitational (un)constant" and explain it as follows:

(3) $$G \equiv \frac{1}{\Omega_o} \frac{1}{P_d^{1-elasticity}} \quad \text{with} \quad \Omega_o \equiv \sum_{i=1}^{R} (\tau_{oi}^{1-\sigma} \frac{E_i}{P_i^{1-\sigma}})$$

$\Omega_o$ is called "market potential". It refers to the openness of the world to a nation's exports. $P_d^{1\text{-elasticity}}$ depicts the openness of a nation to imports from the world. $\Omega_o$ is measured by the sum of the trade partners real incomes divided by the bilateral distance. Since real incomes and bilateral trading costs vary over time, G is not constant. Anderson and Van Wincoop rewrite the microfounded gravity equation (2) as follows:

(4) $$V_{od} = \tau_{od}^{1-\sigma} (\frac{Y_o E_d}{\Omega_o P_d^{1-\sigma}})$$

$V_{od}$ indicates the trade flow from exporting nation o to importing nation d. $\tau_{od}^{1-\sigma}$ indicates transportation costs which are mainly proxied by distance. $Y_oE_d$ refers to the economic masses proxied by both trading nations' incomes. $\Omega_o$ and $P_d^{1\text{-elasticity}}$ indicate the gravitational (un)constant G. $\Omega_oP_d^{1\text{-elasticity}}$ is proxied by multilateral resistance terms that control for country fixed effects. According to Anderson and van Wincoop (2003) the multilateral resistance terms to account for the fact that *"(...) the more resistant to trade with all others a region is, the more it is pushed to trade with a given bilateral partner"*[1].

The application of the gravity equation concept is widely spread in empirical researches. A number of high-profile papers such as McCallum (1995), Frankel (1997) and Rose (2002) have promoted the respectability of the gravity model in the last 50 years. Silva and Tenreyro (2006) suggest that theories based on

[1] Anderson, James E.; Wincoop, Eric van; Gravity with Gravitas: A Solution to the Border Puzzle, American Economic Review 93 (1), 2003, pp. 170-192, here p. 171

different foundations for trade, including endowment and technological differences, increasing returns to scale, and Armington demands, all predict a gravity relationship for trade flows which is analogue to Newton's law of gravitation. Anderson (1979), Bergstrand (1985) as well as Deardorff (1984) have suggested that the gravity equation framework is compatible with the Heckscher-Ohlin model and theories of trade in the presence of imperfect competition.

According to Eichengreen and Irwin (1996), the attraction of the gravity equation does not only lie in its compatibility with various theoretical models of foreign trade. The gravity equation of international trade enables to explain variations in bilateral trade flows across a wide variety of countries and periods.

## 2.2 Empirical models

Baldwin and Taglioni (2006) refer to the gravity equation as a "workhorse" tool for a wide range of empirical studies. The gravity model of international trade is empirically implemented via instruments of econometrics. Utilizing empirical data, econometric applications allow to estimate the influences of various factors on international trade development.

According to Griffiths, Hill, Judge (1993), econometric analyses test whether theoretical models, concepts and assumptions are consistent with real world experiences. Thereby economic relationships are investigated and the effects of selected policies and decisions can be predicted.

The popularity and dispersal of econometric applications increased considerably since the data necessary to conduct econometric analysis became easily accessible to many researchers. Furthermore, the increasing number of high-profile papers not only established the gravity model's respectability but also broadcasted a set of standard practices on empirical issues and choices that empirical researchers have to deal with.

The step from theory to empirics is taken by specifying an empirical model out of the theoretical model. This involves the challenging task of identifying and collecting empirical data which are suiTable to proxy the relevant parameters in the theoretical model. For the gravity equation of international trade, it is a well-established common practice to proxy the economic mass variables by data on the two trading countries' gross domestic products (GDP) and population sizes, whereas distance is straightforwardly measured by the geographical distance between the two trading countries. The empirical version of the traditional

theoretical model presented in equation (2) can be rewritten as following linear regression equation:

(6) $\ln T_{12} = \beta_0 + \beta_1 \ln Y_1 + \beta_2 \ln Y_2 + \beta_3 \ln dist_{12} + \varepsilon_{12}$
whereas $\varepsilon_{12} \sim N(0, \sigma^2)$

The empirical equation includes the estimation coefficients $\beta_0$, $\beta_1$, $\beta_2$, $\beta_3$, which measure the effects of the economic masses variables $Y_1$ and $Y_2$ and the distance variable $dist_{12}$ on the dependent bilateral trade variable $T_{12}$. By including the error term $\varepsilon_{12}$, the empirical model becomes a stochastic version of the theoretical model. This allows to make probability statements on the relationships between the variables. The error term $\varepsilon_{12}$ is assumed to be normally distributed around zero with a constant variance $\sigma$. In trade literature there is a long tradition to log-linearize the theoretical model and use a linear regression to estimate the coefficients of interest using an OLS estimator. The reasons for this practice, the properties of the OLS estimator as well as the estimator's assumptions on the error term are discussed in section 4.2 on estimation specifications.

The expected bilateral trade flow between the two trading countries is estimated by relating variations of the dependent trade variable $\ln T_{12}$ on the left hand side of the equation to variations of the independent variables $\ln Y_1$, $\ln Y_2$ and $\ln dist_{12}$ on the right hand side of the equation. The coefficient estimates $\beta_0$, $\beta_1$, $\beta_2$, $\beta_3$ indicate how changes of the independent variables lead to changes in the dependent trade variable. As suggested by Anderson (1979), typical coefficient estimates of the gravity equation find income variable elasticities that are not significantly different from one. The distance variable usually shows a significant negative effect on the trade variable.

Anderson and Van Wincoop (2003) tackle the well-established practice of estimating the traditional gravity model as it is specified in equation (6). They argue that simply regressing the trade flow variable on the economic mass and distance variables leads to biased coefficient estimates and is source of a large number of errors in the gravity equation literature. Since equation (6) ignores G, the gravitational un-constant is incorporated in the regression residual $\varepsilon_{12}$. This leads to following issue: the transportation costs $\tau_{12}^{1-\sigma}$ enter the equation not only as independent regressor proxied by the distance variable $dist_{12}$, $\tau_{12}^{1-\sigma}$ also enters the equation via the residual error $\varepsilon_{12}$. This is because $\varepsilon_{12}$ incorporates G, whereas

G itself depends on $\tau_{12}^{1-\sigma}$ as it is shown in equation (3). The result is a correlation between the independent regressor variable $dist_1$ and the residual error $\varepsilon_{12}$, both on the right hand side of the equation. This regressor-residual correlation raises the issue of endogeneity and leads to inconsistent coefficient estimates. Section 4.3 on specification issues discusses the issue of endogeneity in more detail.

Relevant at this point, Baldwin and Taglioni (2006) suggest an alternative empirical model based on Anderson and Van Wincoop's theoretical concept presented in equation (4). They account for the multilateral resistance terms $\Omega_o$ and $P_d^{1-elasticity}$ in the regression equation by either introducing country dummies for cross-sectional data or pair dummies for time series data. Since the underlying sample includes time series data over the years 1962-2000, this research uses pair dummies to capture multilateral resistance terms. Equation (7) bases on Anderson and Van Wincoop's theoretical gravity model presented in equation (4) and re-formulates it as follows:

$$(7) \qquad \ln V_{od,t} = (1-\sigma)\ln\tau_{od,t} + \ln Y_{o,t}E_{d,t} - \ln(\Omega_{o,t}P_{o,t}^{1-elasticity})$$

Capturing the effects of $\Omega_o P_d^{1-elasticity}$ with pair dummies, the theoretical equation (7) can be re-written as following empirical equation:

$$(8) \qquad \ln V_{od,t} = \beta_0 + \beta_1 \ln dist_{od,t} + \beta_2 \ln Y_{o,t} + \beta_3 \ln E_{d,t} + \beta_4 D_{od} + \varepsilon_{12}$$

Regression equation (8) is being performed in two steps. First the left-hand side trade variable $\ln V_{od,t}$ is regressed on the pair dummies $D_{od}$. The pair dummy turns 1 for all observations of trade between a given pair of nations. Since it is a binary dummy, n-1 pair dummies are included in the regressions. The first stage strips out any time-invariant pair influences, including all time-invariant influences of omitted determinants of bilateral trade. In the second step the residuals from the first regression are regressed on the independent right hand side variables $dist_{od,t}$, $Y_{o,t}$ and $E_{d,t}$ and the coefficient estimates $\beta_0$, $\beta_1$, $\beta_2$ and $\beta_3$ are estimated. The coefficient estimates are free of any bias stemming from the time-invariant part of G. However, biases stemming from the time-varying part of G remain. Up to this point of research there is no satisfactory solution of how to eliminate all bias stemming from the time-varying part of G. According to Baldwin and Taglioni

(2006) the best way to deal with biases stemming from G so far is to including time-varying country dummies and time-invariant pair dummies.

## 2.3 Summary on theoretical and empirical models

To sum up, the empirical research conducted within this thesis regards two different theoretical and empirical formulations of the gravity equation.

The first and traditional formulation of the gravity equation introduced by Tinbergen (1962) regards G to be a constant term in the theoretical model and therefore excludes G from the empirical formulation. The effects of trade determinants are estimated by simply regressing the dependent bilateral trade variable on potentially trade-influential variables.

The second approach introduced by Anderson (1979) and elaborated by Anderson and Van Wincoop (2001) and (2003) regards G to be a non-constant term. They suggest that G varies over time since it is dependent on real incomes and bilateral trading costs. To capture the effects of G on trade development, they introduce multilateral resistance terms in the theoretical formulation and introduce nation or pair dummies in the empirical model.

Both the traditional and the Anderson and Van Wincoop theoretical model formulations are considered in the analysis and different model specifications are estimated and compared.

# 3 The African-European colonial history

This chapter provides a short historical overview on the African-European trade relationship. This shall provide some foundation to the hypothesis that Africa's colonization and decolonization may have affected bilateral trade development between African and European countries in the years 1962-2000.

## 3.1 African-European trade between the 15th and 19th century

According to Thatcher (1981), there has been renewed and intensified transcontinental contact between Africans and Europeans since the Spanish and Portuguese expeditions in the 15th century. What started with the establishment of trade ports to exchange products and resources between Europe, Africa and Latin America, shifted to an oppressive transatlantic triangular trade with African slaves during the Great European Expansion in the 16th century. However, it was not until the second half of the 19th century, when Europeans started to be interested in other African resources than work force.

The volume of what Wallerstein (1986) calls “legitimate trade” between Africa and Europe increased greatly in the middle of the nineteenth century. This led to changes in African countries' economies. The subsistence agriculture was modified, agricultural surpluses were exchanged against European products, the trade sector developed and European merchants migrated to Africa. As pictured in Freund (1988), the economic development initiated modifications in the African social and political environment. The Africans imported an increasing number of European manufactures including military equipment. With these new weapons the Africans started to fight wars against each other in order to expand their territories and power. The new socioeconomical and political developments were not desirable for Europeans involved in trade with Africa. African ruling classes increased the price of commodities, trade routes were blocked during war and the Europeans had to pay off new networks of Africa-based merchants. The situation heated up during the depression in 1870. African currencies suffered from an intensifying devaluation. At the same time the Europeans' demands for African raw materials doubled since the 2nd Industrial Revolution had started. The Europeans were seeking sTable political and social conditions in Africa to ensure a cheap and efficient large-scale mineral production. However, Africa’s political situation was

unsTable and the socioeconomic conditions were not close to meet Western countries' commercial ambitions.

## 3.2 African-European trade in the late 19th and 20th century

The Industrial Revolution brought a fast development of new technologies which seriously cheapened the production of industrial goods. The new enhancements in the mass production of military good seriously cheapened costs of military expansion and conquest. In the 1870 the unsTable political and socioeconomical situation in Africa intensified and kicked off the European scramble for African countries. The first colonial build-ups were established in African areas where commercial relations with Europe were already developed: the Gold Coast, Senegambia and the Niger delta. Existing trade agreements on local resources including minerals, palm oil, ivory and wild rubber were abolished. Within a view years Europeans conquered African territories with military forces. The British, French, Belgium, Germans and Portuguese split almost the entire African continent into colonies and took on political control. Bismarck hosted a big conference in Berlin to avoid conflicts between Europeans, which were competing against each other to occupy African territories. In course of the Berlin Conference 1884 the most important European powers agreed on the colonial partition of Africa without involving any Africans. Apart from Ethiopia and Liberia all African countries came under European rule. As discussed in Kerbo (2006), colonial boundaries were drawn with European interests in mind, regardless of Africans' sociocultural needs. Graph 9 in the appendix on page III shows a map of Africa in the year 1950, when it was still parted into European colonies.

In "Europäische Kolonialherrschaft 1880-1949" Albertini shows that colonization largely destroyed the fundamental rhythm of pre-colonial social and economic life. It was a reign of a minority of Europeans over a majority of different African races and civilizations. In contrast to previous conquistadors which had entered Africa before, the Europeans did not mix with Africans. The races remained separate with the Europeans forming the ruling class and the African being inferior natives.

Economic decisions in the colonies were taken abroad in the ministry of the European metropoles. A new central administration was introduced, which followed a rational, written and impersonal organization form based on the division of labour. The European administration established a communication network with teleGraphs and post offices, police stations, a central court and a fiscal system.

Africa was integrated in the world economy. It was in the interest of the Europeans to import tropical fruits and raw materials from their colonies and create a new export market for European manufactures. An open market system and a monetary economy were introduced. The land cultivation and product pricing was ruled by Europeans. Modernization and industrialization were focused in sectors, in which enhancements met European interests, other sectors remained traditional. External trade increased, but African capital accumulation and socioeconomic development were largely blocked since capital were transferred and assets were European properties. Since economic surpluses were transferred to the metropole, Africa suffered from a “drain of wealth”.

According to Springhall (2001), after World War II the British, French, Belgian, Spanish and Portuguese were confronted with rising nationalist demands in African colonies. At the same time the economic benefits of keeping African colonies were questioned by the Europeans. Colonies were far from being economically independent from the metropoles as initially intended by the Europeans. The costs of administering the colonies were high, especially since uprisings of African nationalists intensified. From a cost-benefit point of view the Europeans evaluated whether colonies should be released into independence. Since the majority of colonies showed substantial fiscal deficits, the European shifted their interests from colonization to the establishment of independent African states., which would release the Europeans from the costs of administration.

In 1951 Libya was released from the French and British UN trusteeship, in 1954 Ghana was among the first African countries to become independent from the British rule. 1960 was the momentous "African year" in which a large share of African colonies gained independence from the Europeans. Altogether, 16 new African states entered the United Nations in 1960. French colonies in West and Equatorial Africa gained independence and became Senegal, Mauritania, Guinea, Burkina Faso, Cote d’Ivoire, Mali, Benin, Togo, Chad, Niger, Moyen-Congo, Gabon and the Central African Republic. In the following years the British departed from East Africa and other European colonizers followed to withdraw from Africa in the subsequent years. Table 9 in the appendix on pages V and VI gives the dates in which African countries became independent from their European colonizers.

Decolonization and the rapid withdrawal of Europeans left the newly independent African countries in an environment of political and socioeconomical instability. The boundaries between the new African states were drawn to meet the

Europeans' needs in the late 19th century and the political and economical administration and infrastructure were tailored to the needs of the former metropoles. This brought long-lasting political, economical and sociocultural consequences which shape living conditions in African countries until present day.

It is regarded that all the changes caused by colonization and decolonization processes presented above may have substantially affected trade development between African and European countries in the post-colonial period. To examine this assumption, colonial history and independence dummies are introduced in the empirical model of the gravity equation.

# 4 Literature review on relevant econometric studies

This chapter reviews how historical factors entered the gravity equation of international trade and presents econometric researches which investigate the effects of colonial history and independence events on bilateral trade development.

## 4.1 The effects of historical factors on trade development

In the last 50 years the basic gravity equation was advanced and a wide range of other variables than the economic masses and bilateral distance terms entered the gravity equation of international trade. Variables proxying trade agreements, exchange rate volatility, currency unions, border effects, common language and many other factors were included in the regression to evaluate their effects on international trade development.

Frankel and Wei (1993) were among the first to add variables proxying sociocultural aspects in the gravity model. They introduced the common language variable to test their hypothesis that a common language reduces transaction costs and therefore encourages bilateral trade. Frankel and Wei (1993) find a common language variable coefficient estimate significantly different from zero, indicating that cultural factors do affect trade development.

Alike culture, history was largely neglected in theories and empirics of international trade until the 1990s. Eichengreen and Irwin (1996) were among the first to introduce historical variables in econometric analyses. In 1996 they published a study which dealt with the role of history in shaping the trade development of international trade flows.

In "The Role of History in Bilateral Trade Flows" Eichengreen and Irwin question the trade-creating influence of regional trade agreements. Preceding econometric studies found that coefficient estimates on trade agreement dummy variables suggest that members of regional groupings trade more with one another than it would be predicted by their economic masses and bilateral distance variables. However, Eichengreen and Irwin showed scepticism on these findings. They postulated that countries participating in regional trade agreements had traded significantly more with one another than otherwise predicted even before the regional arrangements came into effect. Official international trade agreements were often preceded by other arrangements less formal and less comprehensive

in commodity coverage but with roughly the same participating countries. Eichengreen and Irwin's concern was that the coefficient estimates on trade agreement dummy variables incorporate effects which are not caused by the preferential trade arrangements in scope but stem from influences that existed even before the agreements under investigation came into force. As a result, the coefficient estimates of trade agreement variables are contaminated by omitted-variable bias. Eichengreen and Irwin (1996) set up the hypothesis that historically evolved trade patterns influence current trade flows more than trade agreements. They assumed that countries with a history of trade - whether for reasons related to public policies or other factors - generally continue to trade with each other. This assumption was tested by introducing a "lagged trade" variable proxying past trade flows in the gravity equation of international trade. Equation (9) shows the empirical gravity equation as it is specified in Eichengreen and Irwin (1996):

$$(9) \quad \ln TRADEij = \beta_0 + \beta_1 \ln(Y_i Y_j) + \beta_2 \ln(P_j P_j) + \beta_3 \ln(DIST_{ij}) + \beta_4 \ln(CONT_{ij}) + \beta_5 \ln(LAGTRADE_{ij}) + \varepsilon_{ij}$$

$TRADE_{ij}$ is the dependent variable representing current trade flows. At the right hand side of the equation $Y_iY_j$ is the product of the two countries' national incomes, $P_iP_j$ is the product of the two countries' per capita incomes, $DIST_{ij}$ is the straight-line distance between the economic centers of the two countries, $CONT_{ij}$ is a dummy variable indicating whether the two countries are contiguous and $LAGTRADE_{ij}$ is the lagged trade variable in focus of their analysis proxying past trade flows.

For the lagged trade variable, Eichengreen and Irwin (1996) use interwar trade data collected for the period 1928-1938 and provided by Hilgert (1942). For the present trade variable they use data on post war trade for the years 1949-1964. Data on present trade is drawn from the Direction of Trade Statistics (DOTS) database provided by the International Monetary Fund (IMF). Other data on national and per capita incomes is taken from the International Financial Statistics, again provided by the IMF. Their estimation specification bases on the theoretical model of the traditional gravity equation. To increase the reliability of their estimation results, they employ different econometric specification methods using OLS in levels, OLS in logs, scaled OLS and Tobit estimators.

Eichengreen and Irwin succeeded to provide empirical evidence for their hypothesis. The different estimators produced similar estimation results. Besides the significant positive effect of $LAGTRADE_{ij}$ on $TRADE_{ij}$, Eichengreen and Irwin (1996) find that the anticipated positive correlation between the lagged trade variable and the preferential trade arrangements variable is statistically significant. This indicates that historically evolved trade influences the participation in trade arrangements.

However, critical reviews on this study address the issue of endogeneity bias when introducing a lagged trade variable. Having $TRADE_{ij}$ on the left and $LAGTRADE_{ij}$ on the right hand-side of the equation might lead to a misspecification of the gravity model and inconsistent coefficient estimates caused by a regressor-error correlation or a serial correlation of the errors.

Aside from those critical comments, Eichengreen and Irwin's study brings two important insights for this research: Firstly, they exemplify the importance of history in shaping trade flows. Historically evolved trade flows significantly affect present trade flows.

Secondly, this study shows that omitting past trade flows in the equation specification leads to a spurious attribution of historical effects to the correlated preferential trade agreement variable included in the specification. This causes misleading coefficient estimates. Therefore, the core statement of Eichengreen and Irwin (1996) is that standard gravity model specifications suffer from omitted-variable bias if historical factors are neglected from model specifications. Explaining international trade and omitting historical factors leads to spurious or exaggerated estimates on the conventionally included variables, if the considered economic and geographical variables correlate with the omitted historical factors.

## 4.2 The effect of colonial history on trade development

The effect of colonial history on international trade development was tested in a number of econometric researches. For example Rauch (1999), Rose (2000) or Glick and Taylor (2006) find a persistent, significantly positive effect of present and former colonial relationships on bilateral trade flows.

In 2010 Lochard and De Sousa published a paper with the title "Trade and colonial status". In this paper the authors elaborate the research question whether colonization explains differences in trade performances across developing countries. They tested for a different impact of British versus French colonial

legacies on present-day trade flows of African countries. They set up the hypothesis that the institutional heritage from the colonial period shapes current trade flows of African countries. They assumed that since French and British colonies experienced different institutional legacies, their development of trade flows also differs. Lochard and De Sousa expected that a superior British legacy causes higher present-day trade flow values of former British colonies compared with former French colonies.

Lochard and de Sousa (2010) follows the theoretical gravity model based on Anderson and Van Wincoop (2003), which they formulate as follows:

$$(10) \quad Xij = \frac{YiYj}{Y_w}\left(\frac{\tau_{ij}}{P_iP_j}\right)^{1-\sigma}$$

Equation (10) relates current bilateral exports $X_{ij}$ from country i to country j to the size of their respective economies $Y_iY_j$, the nominal world income $Y_w$, the bilateral trade costs $\tau_{ij}$ and the trade partners' implicit price indices $P_iP_j$, whereas $Y_w$ and $P_iP_j$ proxy multilateral resistance terms in order to account for the gravitational (un)constant G.

The transportation costs $\tau_{ij}$ are assumed to be a loglinear function of observable factors affecting bilateral trade. Therefore, they include the variables distance, non-African trade, common language, regional free trade agreements and a set of variables reflecting colonial history in their empirical model and specify following gravity equation:

$$(11) \quad \ln(X_{ijt}) = k + \ln(Y_{it}) + \ln(Y_{jt}) + \sum_{m=1}^{m}\lambda m(\ln(z_{ijt}^{m})) + \alpha(\text{British\_col})_{i/j} - (1-\sigma)P_{it} - (1-\sigma)P_{jt} + \varepsilon_{ijt}$$

Their variable of interest is British_col, which represents the British colonial legacy. $z_{ijt}$ incorporates a set of other variables, which De Sousa and Lochard regard to influence $\tau_{ij}$. Further explanation on the terms included in equation (11) is provided by Lochard and De Sousa (2010) on pp. 11-12.

Equation (11) is estimated utilizing data on 53 countries, out of which 29 are African and 24 non-African. All 29 African countries are either former British or former French colonies. For the dependent current trade variable they use data

covering the period 2000-2006 which is taken from the DOTS database provided by the IMF.

To control for the time and country specific multilateral resistance terms, Lochard and de Sousa perform 4 different specification methods. Among these are 1) an OLS estimator with a vector of exporter and importer country dummies, 2) an OLS estimator with a vector of country-year dummies, 3) a dyadic fixed effects estimator using within variation only and 4) the Mundlak (1978) approach, which reconciles the random effects estimator and the within estimator.

All estimators yield similar coefficient estimates. Lochard and De Sousa find that both European powers significantly trade more with their former African colonies as it would be predicted by the other observable characteristics and the average behaviour of the countries in the sample. This mirrors the results of other researches investigating the effect of colonial history on international trade. More interestingly for their research question, Lochard and de Sousa (2010) find that France significantly trades 10.2 times more with former colonies whereas Britain trades 3.7 times more with former colonies compared with country pairs that have never been in a colonial relationships. Initially, De Sousa and Lochard suggested that this difference may be due to differences in French versus British legacies and attitudes towards trade. While the British Empire favoured free trade policies of their colonies during colonization, the French generally enforced protectionism. French colonies were forced to predominately export from and import to the French metropole. This could have persistently shaped trade flows until present time and might explain the higher coefficient estimate of the French colonial history dummy.

To further investigate the effect of British versus French colonial legacies on current trade flows of African countries, de Sousa and Lochard (2010) introduces a British_col variable and tests its effect on current trade, using both cross section and panel data. All estimators measure a positive effect of the British_col variable. While controlling for country-pair factors affecting bilateral trade on average, a British colony traded 43% more with OECD, emerging and African countries in the years 2000-2006 than a former French colony did. To check whether the differences in trading performance are driven by systematic differences between the former British and French colonies, De Sousa and Lochard (2010) introduces additional country characteristics in the regression. The use of English, landlockedness, gold production, oil production, infrastructure quality, institutional

quality were included in the specification to test whether these variables are able to explain the better trade performance of former British colonies. However, none of these additionally included country characteristics explains why former British colonies perform significantly better than French colonies.

At this point of research de Sousa and Lochard concluded that their hypothesis holds and the better trade performance is due to the relative superiority of British institutions. However, historians argued that Britain's trade with African countries preceded colonization. The core concern is a non-random selection of colonies by the British, which might bias the coefficient estimate of the colonial legacy dummy.

Responding to these critical comments, Lochard and De Sousa (2010) controlled for a potential correlation between the error term and the British_col variable, tackling the issue of endogeneity. Since data on pre-colonial trade values were not accessible, De Sousa and Lochard looked for another appropriate instrumental variable for British_col in order to perform an instrumental variable (IV) regression and check the consistency of the British_col coefficient estimates. De Sousa and Lochard found a strong relationship between the African area colonized by the French and the year in which the British territories were colonized, suggesting that the probability of being colonized by the British (British_col) increased with the French colonial expansion (AreaEmpire).

Assuming that the AreaEmpire instrumental variable has no effect on the current trade performance of former British colonies other than through the British_col variable, de Sousa and Lochard performed an IV regression as described in Wooldridge (2002).

The critical comments were justified. Instrumenting the AreaEmpire variable on the British_col variable to control for pre-colonial conditions, the variable loses its significant effect and the "British effect" vanishes. This suggests that differences in British and French colonial legacies do not systematically influence present day trade flows of former colonies, rather, Lochard and De Sousa concluded that the apparent better performance of British ex-colonies might be explained by pre-colonial conditions.

Two findings of Lochard and de Sousa are relevant for the empirical analysis conducted in frame of this research. Firstly, historical factors such as a colonial history do influence international trade. Lochard and de Sousa find that trade between country pairs with a colonial history is significantly higher than trade between country pairs which have no colonial tie. This supports Eichengreen and

Irwin's (1996) core statement that history plays an important role in shaping international trade flows.

Secondly, this study shows how omitting trade influential variables can lead to spurious correlations and produce substantial bias in coefficient estimates. The hypothesis that the overall superior trade performance of former British colonies compared with former French colonies is due to a systematic difference between the British and French colonial legacies was supported in the first stage of their analysis, with the British_col variable showing a significant positive coefficient estimate. However, after instrumenting the British colonial legacy variable with the pre-colonial trade variable AreaEmpire, the hypothesis has to be rejected since British_col turns insignificant.

## 4.3 The effect of independence on trade development

In "The Erosion of Colonial Trade Linkages after Independence" published in 2010 Head, Mayer, Ries investigate the effect of independence on bilateral trade. While having had a colonial relationship has a long-lasting positive effect on trade flows, they assumed that the event of independence may initiate a gradual erosion of trade in the post-colonial years, which may eat up the trade-promoting colonial history effect. They set up the hypothesis that independence events exhibit a persistent negative effect on trade flows between former colonies and former metropoles. Additionally, they tested for a potential redirection of trade to siblings and ROW countries in the years after independence.

For their research Head, Mayer, Ries utilized bilateral trade flows data from DOTS provided by the IMF. This sample encompasses data on almost every country of the world for the years 1948-2006. Due to this large panel their regressions include 600,000 observations on average. The principal variables of interest are the independence dummies turning on for each number of years since the declaration of independence. The CIA World Factbook was used as source for independence dates. The sample includes 255 country pairs with colonial histories. 34 out of the 255 pairs were still in colonial relationship at the time of research. The two main colonizers of the sample are France and Britain.

With respect to their methodological approach, Head, Mayer, Ries (2010) identifies the main determinants of bilateral trade with the common practice of modelling expected bilateral trade via the gravity equation of international trade. To measure the impact of independence over years they use a non-parametric estimation

specification. This research bases on a theoretical model that accounts for the gravitational (un)constant. However, Head, Mayer, Ries (2010) do not use the Anderson and van Wincoop (2003) approach to eliminate the multilateral resistance terms, because of computational difficulties of estimating country-year fixed effects. To eliminate multilateral resistance terms they implement the method of "tetrads". Head, Mayer, Ries formulate the empirical model as follows:

$$(12) \quad \ln x_{ijt} = \ln G_t + \alpha_1 \ln N_{it} + \alpha_2 \ln y_{it} + \alpha_3 \ln N_{jt} + \alpha_4 \ln y_{it} + \delta D_{ijt} + u_{ijt}$$

In equation (12) $G_t$ is a common year-specific factor determining trade. Year dummies are introduced to capture $G_t$. The $N_{it}$ and $N_{jt}$ terms refer to the population sizes of the exporting country i and the importing country j in a specific year t. $y_{it}$ and $y_{jt}$ express per capita incomes of the exporting and importing countries in year t. $D_{ijt}$ is a linear combination of factors that affect transportation costs between i and j.

$D_{ijt}$ consists of the time-invariant variables distance, shared border, shared language, shared legal origin and the time-variant variables common currency, regional trade agreement (RTA), General Agreement on Tariffs and Trade (GATT) membership and African, Caribbean and Pacific (ACP) trade agreement. Furthermore, they include a set of colonial linkage variables, which identify the effects of being in a current or former colonial relationship. The $ColHist_{ij}$ variable proxies country pairs that once have been or still are in a colonial relationship, the $ColAlways_{ij}$ variable proxies country pairs in ongoing colonial relationships and a comprehensive set of independence dummies $Indep1_{ijt}$ to $Indep60_{ijt}$ measures the effect of independence for each number of years since independence event up to a cap of 60 years.

Head, Mayer, Ries discusses five different estimation specifications: 1) pooled OLS, 2) pooled OLS with lagged trade, 3) Poisson PMLE, 4) dyadic fix effects and 5) the method of "tetrads". Head, Mayer, Ries developed the tetrad approach to eliminate multilateral resistance terms. This method is an extension of existing ratio approaches which exploits the multiplicative functional form of the gravity equation and takes the ratio of ratios of trade flows and enables the authors to eliminate the monadic effects of exporters and importers including multilateral resistance terms. For a detailed explanation of the tetrad method see Head, Mayer, Ries (2010) p. 3.

The timing of the independence events raises the concern of endogeneity since the countries under colonial rule choose if and when to separate. Head, Mayer, Ries (2010) refers to historical accounts, which suggest a significant random component to independence events. Nevertheless, the political and economic attributes of the metropoles and the colonies as well as the strength of their bilateral association may affect the likelihood of independence. To minimize the possibility of regressor-error correlation, Head, Mayer, Ries use three approaches: First, they control for a large number of covariates commonly used in gravity equations. Second, they apply the tetrad method which removes time-varying importer and exporter as well as dyadic fixed effects. Third, they carry out falsification exercises in which they randomly create false colonial links and test for significant coefficient estimates on the false independence variables.

The core finding of their research is that independence exhibits an extensively eroding effect on bilateral trade. The negative effect is not only found on trade flows between former colonies and metropoles, but also on trade flows between former colonies and siblings as well as former colonies and ROW countries. While the short-term effects of independence on bilateral trade are rather small, the long-term effects of independence on bilateral trade are enormous. After four decades, trade between former colonies and metropoles contracts by roughly 65%. Trade between former colonies of the same empire erodes as much as trade with the metropoles while trade with third countries decreases for about 20%. Categorizing the independence events into hostile and amicable separations, they find that hostile separations are more immediately destructive to trade than amicable separations. When examining the impact of independence on the extensive margin of trade, they find that independence has a strong, but gradual negative influence on the probability of positive trade flows between former colonies and former metropoles. Head, Mayer, Ries suggest the gradual trade deterioration after independence is due to *"(...) the depreciation of trade promoting capital embodied in institutions and networks of individuals with knowledge of trading opportunities"*.[2]

To prove that the declines in trade between colonies and metropoles are caused by independence rather than by historical trends which happen to coincide with independence, Head, Mayer, Ries ran falsification exercises. They entered false

[2] Head; Mayer; Ries; The Erosion of Colonial Trade Linkages after Independence, p. 11

colonial links with random dates of independence and conducted the estimations. For the countries in false colonial relationships no evidence of independence effects was found. After running regressions with different estimation specifications and testing for the possibility of endogeneity their research findings remained significant.

The main findings of Head, Mayer, Ries (2010) - that independence negatively influences bilateral trade development - supports the hypothesis supports the hypothesis on the basis of this thesis.

Referring to Head, Mayer, Ries (2010) another paper published by Lavallée and Lochard in 2012 gives further insights into the impact of decolonization on post-colonial trade patterns. They raised the additional research question whether independence has affected former colonies' exports and imports differently. Subsequently, they compared the consequences of independence on exports and imports for different colonial powers. Lavallée and Lochard constructed a new bilateral database which is also based on DOTS but is supplemented with pre-independence trade data on French colonies. This additional data was obtained from various official French sources. Their final sample includes bilateral trade data on 71 reporting countries (former colonies from all over the world) and 189 trade partners for the period 1947-2007. For estimation Lavallée and Lochard (2010) uses a fixed effects PMLE.

Lavallée and Lochard (2010) finds that independence reduces both exports to and imports from the former metropole. The size of the negative independence effect differs between colonial powers. Independence is suggested to exhibit a more negative effect on former French colonies' trade with France as compared with former British colonies' trade with Britain. Over the post-colonial period French colonies' trade (exports and imports) with the former metropole has reduced by roughly 50% on average. Lavallée and Lochard (2010) also suggests that former French colonies trade about 65% less with their siblings after independence, whereas especially exports were negatively affected. With regards to a redirection of trade, after independence trade of all former colonies with ROW countries increased.

Turning to the evolution of the independence effect over time, the research findings of Lavallée and Lochard (2012) indcate that the erosion of former French' colonies trade flows to France reaches its long-term value 15 years after independence for former colonies' exports and 25 years after independence for former colonies' imports. For former British colonies they do not find a similar erosion of trade.

## 4.4 Research gap

Head, Mayer and Ries (2010) investigated the research question: *What impacts do independence events have on post-colonial bilateral trade patterns?*

Lavallée and Lochard (2012) add on to this research by answering the two additional questions raised by the findings of Head, Mayer and Ries (2010): *Do independence effects change according to colonial power?* and *Are exports and imports impacted in the same way?*

To the best of my knowledge, all existing econometric researches with the aim to investigate the effects of independence events on trade development utilize data on former colonies all over the world. This research investigates these three research questions related to the effect of independence on bilateral trade for a geographically restricted sample of countries. This analysis pools intra- and intercontinental trade data on 45 African and 18 European countries for the years 1962-2000. Instead of utilizing the frequently used DOTS database, this study utilizes bilateral trade data from the National Bureau of Economic Research (NBER) "world trade flow" database constructed by Feenstra et all. in 2005. This database incorporates more exhaustive data on trade flows for the countries and years in scope.

No econometric analysis so far examined the effects of independence on post-colonial trade between Africa and Europe. Keeping the strong marginalization of the African continent in present day international trade networks in mind, it is especially interesting to investigate whether African countries' declaration of independence in the early 1960s may have negatively affected Africa's trade development in the ensuing 40 years. The colonization of Africa by the Europeans in the late 19th century as well as the decolonization in the second half of the 20th century both followed unique patterns which differ distinctively from colonization and decolonization events that took place in other periods and parts of the world. Trade flows between Africa and other continents of the world are excluded from

this analysis. Restricting the sample to intra- and intercontinental trade flows between African and European countries holds the benefit that the effects of colonial history and independence events are tested in a more homogeneous setting. The pre- and post-colonial context of the African countries in scope of the analysis is more similar as if former colonies from all over the world were included in the sample. This is because:

- the African countries in scope have only been colonized by European powers,
- the dates of colonization and decolonization lie relatively close to each other,
- the geographic and socioeconomic preconditions influencing bilateral trade costs are more alike

# 5 Empirical analysis

Basing on the theoretical model of the gravity equation the effects of colonial history and the declaration of independence on the development of bilateral trade between African and European countries in the years 1962-2000 are empirically investigated by taking the econometric approach of linear regression analysis.

## 5.1 Data

The sample underlying this study comprises data on 45 African and 18 European countries in the years 1962-2000. The research utilizes data on intra- and intercontinental bilateral trade flows between African and European countries provided by NBER. The comprehensive "world trade flow" database was constructed by Feenstra et. all and got published in 2005. It incorporates one-directional trade data on African to European, European to African, African to African and European to European export flows.

As compared with the DOTS database commonly utilized for trade data, the NBER database has the advantage of having only few missing values on bilateral trade flows between the country pairs in scope of this research. However, the drawback of this database is that it does not comprise trade flow data prior to 1962. Hence, it lacks on pre-independence trade data.

41 out of the African countries included in the sample are former colonies of Europe with independence dates after 1950. The remaining four countries have either never been under European rule or have had earlier independence dates. Six out of the 18 European countries in the sample are the former colonial powers of these African countries. Considering the special cases Somalia and Libya, there are altogether 44 African-European country pairs which have been in a colonial relationship. Tables 7 and 8 in the appendix on pages IV and V list the countries in scope of this research. Further information on the special cases Somalia and Libya and the selection of the countries in scope of the sample is provided in the appendix on page VII.

For accurate dates of African countries' declaration of independence, this thesis relies on information provided by the CIA World Factbook. All former African colonies in scope have been released into independence between the years 1950 and 1980, whereas a large share of African countries became independent around the "African Year" 1960 as Table 9 in the appendix on pages V and VI shows.

Already mentioned above, the trade flow data reflects to a large share post-independence trade. Yet, in the underlying sample only 0.09% out of the 132,717 observations refers to bilateral trade data between African colonies and European metropoles prior to independence. This makes it unfortunately impossible to evaluate the effect of independence by comparing postcolonial to colonial trade flows.

The main data source for the regressor variables on the right hand side of the equation is the gravity database provided by CEPII, the French research center in international economics. The gravity database incorporates quantitative and qualitative data from various sources, covering the years 1949-2006. The CEPII gravity database provides data on the gravity variables income and population, which is mainly taken from the World Bank Development Indicators (WDI). Moreover, this database provides information on many variables influencing transportation costs. Data for the colonial tie variables common colonizer, colonial history and current colony as well as data on the geographic, sociocultural and economic variables landlockedness, contiguity, common language, common legacy, common currency, GATT, RTA and ACP are also taken from the CEPII gravity database. Information on the distance variable comes from the CEPII distance dataset. This research utilizes the distw variable, which reflects the distance between the capitals of the two trading countries - in kilometres - weighted against each capital's population share of the country's total population. A more detailed description on the variables included in this analysis is provided in Table 1 on the pages 31 and 32.

## 5.2 Estimation specifications

The empirical model for this research grounds on the traditional theoretical gravity equation established by Anderson (1979). Derived from equation (2) the basic empirical model formulation for this analysis is:

$$(13) \quad \ln T_{ij,t} = \beta_0 + \beta_1 \ln gdpcap\_i_t + \beta_2 \ln pop\_i_t + \beta_3 \ln gdpcap\_j_t + \beta_4 \ln pop\_j_t + \delta(\tau_{ij,t}) + \varepsilon_{ij,t}$$

whereas $\tau_{ij,t}$ is a linear combination of factors which influence trade costs between exporter i and importer j:

(14) $\delta(\tau_{ij,t}) = \beta_{n(}geo\_var) + \beta_{n(}socu\_var) + \beta_{n(}col\_var)_t + \beta_{n(}eco\_var)_t + \varepsilon_{ij,t}$

According to equation (13) the bilateral trade value $T_{ij,t}$ between exporting country i and importing country j at time t is explained by the per capita incomes ($lngdpcap\_i_{,t}$; $lngdpcap\_j_{,t}$) and population sizes ($lnpop\_i_{,t}$; $lnpop\_j_{,t}$) of the exporting and importing countries as well as the transportation costs $\tau_{ij,t}$ at time t. Increasing per capita incomes and population sizes are expected to increase bilateral trade flows while increasing transportation costs are expected to decrease bilateral trade flows. The error term $\varepsilon_{ij,t}$ captures all unobserved determinants of bilateral trade. Turning to equation (14), the bilateral transportation costs are explained by a set of various time-variant and time-invariant geographic, sociocultural, colonial and economic variables. These variables are regarded to either increase or decrease $\tau_{ij,t}$. The error term $\varepsilon_{ij,t}$ captures all unobserved determinants of transportation costs. The focus of this research lies on the influence of the set of colonial-tie variables, referred to $\beta_{n(}col\_var)_t$ in equation (14). Table 1 describes the coding system of the variables included in the analysis. A more detailed description of the panel and variable characteristics is presented in the appendix starting on page VII. This description also includes information on whether the underlying panel is balanced or not and how the variation of the entire sample and the single variables splits into between and within variations.

| **dependent variable Tij,t** | |
|---|---|
| lntrade | log of (export) trade value |
| trade | (export) trade value in thousands of current US$ |

| **regessors** | |
|---|---|
| *gravity variables* | |
| lngdpcap_i | log of exporter's income per capita |
| lnpop_i | log of exporter's population |
| lngdpcap_j | log of importer's income per capita |
| lnpop_j | log of importer's population |
| *time-invariant geographic and sociocultural variables influencing transportation costs* | |
| lndistw | log of population weighted distance |
| landlocked_i | 1 for landlocked exporter |
| landlocked_j | 1 for landlocked importer |
| contig | 1 for country pair sharing a border |
| Africa | 1 if exporter and/or importer is an African country |
| comlang | 1 if country pair shares a language which is spoken by at least 9% of each countries' population |

| | |
|---|---|
| comleg | 1 if country pair has a common legal origin |
| *colonial-tie variables influencing transportation costs* | |
| comcol | 1 for African country pair with common former metropole (time-invariant) |
| AEcolony50 | 1 for African-European country pair with colonial history and independence date after 1950 (time-invariant) |
| a) curcol_i_colony<br>b) curcol_i_metropole | a) 1 for African-European country pair in ongoing colonial relationship in year t, exporter = African colony (time-variant)<br>b) 1 for African-European country pair in ongoing colonial relationship in year t, exporter = metropole (time-variant) |
| a) i_indcol<br>b) j_indcol | a) 1 if exporter is African, a former European colony and independent in year t (time-variant)<br>b) 1 if importer is former African, a former European colony and independent in year t (time-variant) |
| a) i_indcol_col<br>b) j_indcol_col | a) 1 for African-European country pair with colonial history and independence date after 1950, exporter = African country, t = at least one year after the declaration of indep.<br>b) 1 for African-European country pair with colonial history and independence date after 1950, exporter = European country, t = at least one year after the declaration of indep. |
| c) i_indcol_sib<br>d) j_indcol_sib | c) 1 for African country pair with the same former European metropole, exporter = African country, t = at least one year after the declaration of independence<br>d) 1 for African country pair with the same former European metropole, exporter = sibling, t = at least one year after the declaration of independence |
| e) i_indcol_oth<br>f) j_indcol_oth | e) 1 for exports from former African colony to other European or African country, t = at least one year after the declaration of independence<br>f) 1 for exports from other European or African country to former African colony, t = at least one year after the declaration of independence |
| indep1 to indep49 | independence dummies turning 1 for each number of years elapsed since independence (time-variant) |
| *time-variant economic variables influencing transportation costs* | |
| comcur | 1 if country pair has a common currency in year t |
| GATT_both | 1 if exporter and importer are GATT/WTO members in year t |
| RTA | 1 if a regional trade agreement is in force in year t |
| ACP_to_eu | 1 for African-European country pair with ACP trade agreement in year t, exporter = African country |
| eu_to_ACP | 1 for African-European country pair with ACP trade agreement in year t, exporter = European country |

**Table 1:** Variables included in the analysis

The linear regression analysis is the econometric tool applied to yield coefficient and inference estimates on the variables presented in Table 1. This enables to quantify the influences of the listed variables on the value of bilateral trade

between African and European countries in the post-independence years. The regression analysis is carried out using three estimators with different properties. Estimating equation (13) with different estimators and comparing the results shall give more credibility to the findings of this empirical research.

### 5.2.1 Pooled ordinary least squares estimator

Equation (13) on page 30 follows the conventional method of double-log-linearizing the gravity equation and estimating the coefficients $\beta_0$-$\beta_n$ via OLS. The OLS estimator pools data in a simple linear regression. The least square rule fits a regression line in which the sum of the squares of the vertical distances from each point to the line (= sum of the residuals) is as small as possible. According to Cameron and Trivedi (2009) OLS is a well-established commonly used estimator since it has a minimum on sampling variability and is at the same time computationally simple. However, the OLS estimator is only the most efficient estimator producing unbiased coefficient estimates and confidence intervals if certain conditions about the regression residual $\varepsilon_{ij,t}$ are met. The consistency of the OLS estimator relies on the following assumptions on the residual term:

1. $E(\varepsilon_{ij,t}|x_{ij,t}) = 0$ (exogeneity of regressors)
2. $E(\varepsilon_{ij,t}^2|x_{ij,t}) = \sigma^2$ (conditional homoskedasticity)
3. $E(\varepsilon_{ij,t}\varepsilon_{kl,t}|x_{ij,t}x_{kl,t}) = 0$; $ij,t \neq kl,t$ (conditionally uncorrelated observations across country pairs, cross section relevant)
4. $E(\varepsilon_{ij,1}\varepsilon_{ij,2}|x_{ij,1}x_{ij,2}) = 0$, $ij,1 \neq ij,2$ (conditionally uncorrelated observations within country pairs along different periods, time series relevant)

$x_{ij,t}$ refers to the set of regressors on the right hand side of the gravity equation. Assumption 1 is essential for the consistency of the coefficient estimates $\beta_0$-$\beta_n$ and implies that the conditional mean $x_{ij,t}$ is correctly specified. The correct specification of equation (13) is provided when the conditional mean is linear and all trade determining variables are included in the model. Assumptions 2 to 4 are preconditions for unbiased estimates on standard errors. Meeting 2 to 4 is relevant for obtaining reliable confidence intervals and testing hypothesis. In order to yield unbiased OLS estimates the following section 4.3 on specification issues discusses how assumptions 1-4 can be met in presence of heteroskedasticity and autocorrelation.

### 5.2.2 Poisson maximum likelihood estimator

The least squares estimator is a linear estimator. Alternatively, the parameters can be consistently estimated using the non-linear PMLE. In contrast to the OLS rule, the maximum likelihood rule uses the criterion of choosing coefficient estimates that maximize the probability of obtaining the sample of data that we observe. This probability is maximized if the coefficient estimates make the residual sum of squares in the exponent a minimum. Model specification (15) for the PMLE estimation is obtained by re-expressing equation (13):

(15) $T_{ij,t} = \exp(\ln gdpcap\_i_t + \ln pop\_i_t + \ln gdpcap\_j_t + \ln pop\_j_t + \tau_{ij,t})\eta_{ij,t}$
whereas $\eta_{ij,t} \equiv \exp(\varepsilon_{ij,t})$

It is assumed that the expectation of η conditional on the covariates equals one. Equation (15) can be rewritten and estimated as follows:

(16) $T_{ij,t} = \exp(\beta_0 + \beta_1 \ln gdpcap\_i_t + \beta_2 \ln pop\_i_t + \beta_3 \ln gdpcap\_j_t + \beta_4 \ln pop\_j_t + \delta(\tau_{ij,t}) + \varepsilon_{ij,t})$

As it can be seen in equations (15) and (16), for the PMLE estimator, the dependent trade variable measured in levels is used. According to Silva and Tenreyro (2006), the PMLE specification assumes that the conditional variance is proportional to the conditional mean. All that is needed for this estimator to be consistent is a correct specification of the conditional mean.

### 5.2.3 Least squares dummy variable estimator

Taking into account the critique Anderson and Van Wincoop (2001) and (2003) on the traditional gravity equation, a third estimation specification is used to control for multilateral resistance terms. Literature proposes to use country-year fixed effects in OLS regressions to absorb the multilateral resistance terms. Since the sample consists of observations on 63 countries over 39 years, this would involve 4,913 dummies. This requires a massive matrix inversion that is beyond the capability of the statistical software used. Therefore, another approach called the LSDV method with pair dummies is applied in frame of this analysis to capture parts of the multilateral resistance terms. Absorbing the categorial country pair variable, the LSDV estimator fits a dyadic fixed effects estimator. The LSDV approach produces the same coefficient estimates as the conventional fixed-effects (FE)

estimator, however, its standard errors are of smaller sizes. Alike FE models, the LSDV estimator exploits the time series properties of the data, using only within variation to estimate the coefficients. Based on (8) and (13) the equation for the LSDV model becomes:

$$(17)\quad \ln T_{ij,t} = \beta_0 + \beta_1 \ln gdpcap\_e_t + \beta_2 \ln pop\_e_t + \beta_3 \ln gdpcap\_i_t + \beta_4 \ln pop\_i_t + \delta(\tau_{ij,t}) + \beta_5 D_{12} + \varepsilon_{ij,t}$$

This model is able to remove all bias stemming from time-invariant unobservable country-pair characteristics. As all FE models this estimator studies variations within an entity, therefore, for this research it represents variation within the country pairs only. One big disadvantage is this specification cannot produce coefficient estimates on bilateral time-invariant variables influencing bilateral trade development.

The suitability of FE versus random effects (RE) models is discussed in the appendix on page XVIII. Given the data properties of the underlying sample, the Hausman test suggests that the FE model is to be preferred to the RE model for this research.

### 5.2.4 Specifications controlling for time

Additionally, as suggested by Baldwin and Taglioni (2006), including time dummies in all regression specifications will control for residual conversion factors and pick up idiosyncratic year-specific shocks. Including time dummies in the OLS, PMLE and LSDV models presented above yield following final equations:

$$(18)\quad \ln T_{ij,t} = \beta_0 + \beta_1 \ln gdpcap\_i_t + \beta_2 \ln pop\_i_t + \beta_3 \ln gdpcap\_j_t + \beta_4 \ln pop\_j_t + \delta(\tau_{ij,t}) + \beta_5 T_t + \varepsilon_{ij,t}$$

$$(19)\quad T_{ij,t} = \beta_0 + \beta_1 \ln gdpcap\_i_t + \beta_2 \ln pop\_i_t + \beta_3 \ln gdpcap\_j_t + \beta_4 \ln pop\_j_t + \delta(\tau_{ij,t}) + \beta_5 T_t + \varepsilon_{ij,t}$$

$$(20)\quad \ln T_{ij,t} = \beta_0 + \beta_1 \ln gdpcap\_i_t + \beta_2 \ln pop\_i_t + \beta_3 \ln gdpcap\_j_t + \beta_4 \ln pop\_j_t + \delta(\tau_{ij,t}) + \beta_5 D_{12} + \beta_6 T_t + \varepsilon_{ij,t}$$

The 38 time dummies $T_t$ will remove all year-specific factors determining trade. A the $D_{12}$ pair dummies, the $T_t$ time dummies are binary. This is why t-1 time periods have to be considered.

Introducing bilateral country_pair dummies and time dummies via the LSDV specification will produce estimates free of bias resulting from time-invariant determinants of bilateral trade and free of bias caused by a general evolution of trade. This will reduce the bias caused by multilateral resistance terms to a minimum.

## 5.3 Specification issues

### 5.3.1 Regressor-error correlation

As already mentioned, the consistency of the OLS coefficient depends on the fundamental assumption that the regressors in $x_{ij,t}$ are exogenously determined and uncorrelated to the regression residual $\varepsilon_{ij,t}$. If any regressor is correlated to the model residual $\varepsilon_{ij,t}$ and therefore endogenenously determined, the coefficient estimates on the variables on the right hand side of the equation can be substantially biased and the estimated marginal effects of the regressor variables on the dependent trade variable can no longer be relied on. The potential regressor-error correlation is also known under the issue of endogeneity.

In the gravity equation of international trade endogeneity is a crucial issue. Eichengreen and Irwin (1996) tackle this problem by showing that omitting historical factors in the gravity equation of international trade causes bias in the coefficient estimates on the gravity variables and substantially exaggerated coefficient estimate on the trade agreement variable which is considered in the model specification. These misleading results are caused by a correlation between the omitted historical factors incorporated in the $\varepsilon_{ij,t}$ and the considered variables in $x_{ij,t}$.

The importance of considering the possibility of endogeneity when investigating the effects of colonial factors is exemplified in De Sousa and Lochard (2010). This paper shows how correlations between variables reflecting colonial factors and $\varepsilon_{ij,t}$ causes serious misleading coefficient estimates on colonial variables under investigation. As discussed in section 3.2.2. De Sousa and Lochard initially assumed that differences between former British and former French trade performances are due to the relative superiority of British institutions inherited from the colonial era. Estimating their original model specifications they obtained a

coefficient estimate on the British legacy dummy which showed a significant trade-creating effect. However, keeping the possibility of endogeneity in mind, De Sousa and Lochard (2010) instrumented the British legacy dummy with a variable based on colonization history. After performing an instrumental variable (IV) estimation, the British legacy dummy turned insignificant and the assumption of a systematic difference between the British and French colonial legacies could no longer be supported.

The possibility of regressor-error correlation is also a concern when it comes to estimating the effect of the independence on trade development. There is a possibility that the decision to become independent correlates with colonies' trade performances. For example a metropole might choose to give independence to a colony because it does not expect any further gain from trade with it. If this was the case, the OLS, the PMLE and LSDV estimations deliver biased estimates on the independence variables. However, Head, Mayer and Ries (2012) as well as Lavallée and Lochard (2012) suggest it is very unlikely that trade flows were a crucial determinant of colonies' independence. Head, Mayer and Ries refer to historical accounts which regard independence to be idiosyncratic events with a significant random component. Lavallée and Lochard (2012) state that decolonization processes are regarded to be predominantly related to political and financial issues rather than colonies' trade performances. To back this assumption they refer to Kleiman (1976), who shows that colonies generally accounted for only a small part of the metropoles' total trade flows. This made colonies trade partners with only limited significance for their metropoles. Moreover, trade between metropoles and colonies had been increasing rather than decreasing in the three or four decades before independence, which again indicates that trade was not a major driver of colonies' independence.

However, the threat of endogeneity has to be kept in mind when formulating the conditional mean $x_{ij,t}$, choosing the appropriate estimation method and interpreting the regression results.

Cameron and Trivedi (2009) suggest to conduct a linktest in order to test whether the conditional mean of the dependent variable is correctly specified and all relevant trade influencing factors are incorporated in the model specifications. The test results for all three specifications are listed in the appendix on pages XIII to XV. The outcomes show that all specifications - OLS, PMLE and LSDV - do have omitted variables. This is an expected finding since there are many factors

influencing bilateral trade, which cannot all be observed or proxied by measurable variables. These omitted factors end up in the error term of the model. However, the existence of unobserved factors in $\varepsilon_{ij,t}$ is no critical issue per se. Omitted trade-influential factors do not bias the coefficient estimates of the variables included in the model as long as there is no correlation between the unobserved factors or variables in $\varepsilon_{ij,t}$ and the considered variables in $x_{ij,t}$.

According to Cameron and Trivedi (2009) one way to test potentially endogenous regressor variables is to extend the model with an instrumental variables (z) and perform an instrumental variable estimation. The IV estimator provides a estimation under the very strong assumption that the valid instrumented variable z is correlated with the potentially endogenous regressor x but uncorrelated with the error term $\varepsilon_{ij,t}$ of the model. The IV estimator is the original and leading approach for estimating coefficients of endogenous regressors models and errors-in-variables models. Practically, it can be very difficult to obtain valid z instruments. When z is only weakly correlated with the potentially endogenous regressor, the standard asymptotic theory provides a poor guide in finite samples. Since it is very difficult to find an appropriate instrumental variable for the colonial history and independence dummies, this analysis follows other approaches to reduce the threat of endogeneity.

Firstly, a large set of variables is included in the specification models to avoid omitting important trade-influencing factors. This shall reduce the threat of biased coefficient estimates on the colonial history and independence variables caused by spurious correlations between the colonial-tie variables in scope and other trade influencing variables incorporated in the $\varepsilon_{ij,t}$ term. The LSDV estimator accounting for multilateral resistance terms is able to eliminate all potential regressor-error correlations stemming from time-invariant pair influences including all omitted determinants of bilateral trade that are time invariant. Head, Mayer and Ries (2010) take another approach to deal with endogeneity. They introduce a lagged dependent variable to control for unobserved trade developments that evolve gradually over time. Since they find the estimates of the lagged-trade specification to be inconsistent due to endogeneity, this approach is not applied in frame of this paper. Rather, time dummies are included in the regressions to remove year-specific factors determining trade.

### 5.3.2 Cross-sectional and serial error correlation

The assumptions concerning constant variances and uncorrelated observations across country pairs and periods are preconditions for unbiased estimates on standard errors, confidence intervals and hypothesis tests. For the gravity equation of international trade error correlation is a crucial issue. To evaluate whether the preconditions are met, the underlying sample is tested for heteroskedasticity and autocorrelation. The strong correlation between present trade values and first-order lagged trade values is one first indicator for a serial error correlation. Further tests on the panel found that the underlying data is both strongly heteroskedastic and autocorrelated. This is due to the large number of country pairs and years included in the panel. The error characteristics and outcomes of the error correlation tests are described more in detail in the appendix on pages XV to XVIII.

To cope with homoscedasticity and error autocorrelation in order to obtain unbiased standard errors and confidence intervals, the pooled OLS and PMLE regressions use cluster-robust standard errors rather than the Stata defaults. While clustering for country pairs allows the error variances to differ across country pairs, the robust option corrects for serial error correlations. According to Cameron and Trivedi (2009), this leads to a robust estimate of the variance-covariance matrix.

### 5.3.3 Missing data and treatment of zero trade values

The NBER database provides more extensive trade flow data on the countries and years in scope as compared with DOTS. However, there is still missing data on trade values between certain country pairs in certain periods. Out of the altogether 132,717 observations, zero trade is reported for 1,625 observations and 78,612 observations have missing trade values. Data inaccuracies such as incorrect zeros caused by rounding or reporting errors cannot be excluded. According to Cameron Silva and Tenreyro (2006), missing data and data inaccuracies have the potential to distort estimation results, if they are not randomly distributed. The non-random distribution of incorrect zeros and missing data is a crucial issue since they are generally more likely to occur for small and distant countries. Moreover, with respect to the underlying data of this research, missing values accumulate for colony-colonizer trade flows in the years prior to independence dates due to missing records on colonial trade.

Log-log formulating the gravity equation and applying the OLS estimator which converts zeros trade values to missing and simply drops all observations with missing trade values. This holds the potential to introduce selection bias. For the underlying sample dropping observations with zero and missing trade values implicates that 39% of the total sample's observations are excluded from the regression analysis. There are several approaches to deal with this problem. One alternative approach is to express the dependent variable in levels and estimate the equation using the Tobit method. Tobit incorporates observations with zero trade flows but makes strong parametric assumptions on the error term including homoskedasticity and log normality. Moreover, Tobit results are difficult to interpret because the constant elasticity relationship is lost. Another way to handle zero trade values is to estimate the model with $T_{ij,t} + 1$ for the dependent trade variable. Thereby, the log-log relationship is preserved and zero trade observations enter the analysis with a trade value of 1. The equation is then estimated by scaled OLS. However, both Tobit and scaled OLS generally lead to inconsistent estimates of the parameters of interest. The PMLE is an attractive alternative estimator which incorporates the zeros but delivers consistent estimates as long as $\eta_{ij,t}$ in equation (15) has an expectation of one on the covariates.

Head, Mayer and Ries (2010) find that the estimated coefficients of the independence dummies are very sensitive to the treatment of zeros. After running regressions with different estimators they conclude to estimate their model in a double-logarithmic form, apply the pooled OLS estimator and drop observations in which trade is recorded as zero or missing. To verify the robustness of their results, they also report Poisson estimates. This analysis follows the same approach and compares coefficient estimates of pooled OLS with PMLE estimates.

### 5.3.4 Log-log versus level-log model specifications

In literature there is the fundamental discussion whether the dependent trade variable shall be measured in logs or in levels. No rule of thumb exists whether the log-log or the level-log model specification is superior. Rather, it depends on the properties of the underlying sample and the research interest which functional form is to be preferred.

The log-log model is implemented via using an OLS estimator while the level-log model is estimated via PMLE. The assumptions, properties, features as well as flaws of both estimators have to be considered when deciding on which estimator

to rely on. The outcomes of the log-log and level-log estimations are interpreted differently. While the log-log model measures elasticities the level-log model measures the changes of the dependent variable in levels. The coefficient estimates of OLS and PMLE can vary substantially, painting a very different picture of international trade determinants.

As indicated before, there is a long tradition in trade literature to double-log-linearize the gravity equation and estimate the parameters of interest by least squares. The OLS estimator is regarded to be the most efficient linear estimation method given that all regressors included in the sample are exogenous and all the assumptions on the error term are met. However, Silva and Tenreyro (2006) argue that in practice the assumption of a homoscedastic error term is almost never met. Heteroskedasticity is a severe problem in both the traditional gravity equation introduced by Tinbergen (1962) and the gravity equation of Anderson and van Wincoop (2003). According to Silva and Tenreyro (2006) the error term is generally heteroskedastic and the error variances always depend on the regressors. As a result, OLS produces biased estimates of the true elasticities. Silva and Tenreyro (2006) therefore argue that a double-log-linearization of the gravity equation leads to a severe model misspecification. According to them the ordinary least squares estimator exaggerates the roles of colonial tie and geographical proximity variables greatly, while the coefficient estimates on the exporter's and importer's incomes are significantly smaller than the expected value of one. Even when it is controlled for fixed effects, the log-log gravity model is very likely to generate substantially different estimates. Therefore, Silva and Tenreyro (2006) suggest the application of the linear-log model-based PMLE. They find PMLE to be a more appropriate method which is able to produce consistent estimates in the presence of different patterns of heteroskedasticity.

Another advantage of the PMLE method is that it provides a natural way of dealing with zero trade values. As discussed in the previous section the OLS log-log specifications drop observations with zero trade values. This can lead to biased coefficient estimates. PMLE instead includes observations with zero trade values, reducing the threat of selection bias.

Stata provides possibilities to test whether a log-log or level-log model is more appropriate to describe the economic relation between the dependent trade variable and the regressors. The outcomes of the tests depend on the data properties of the sample. Graph 3 shows that the trade value data of the

underlying sample is very skewed. This indicates that the regression analysis measured in level-log might provide very poor predictions since it restricts the effects of regressors to be additive. Taking the natural logarithm of the trade value variable eliminates most skewness and kurtosis.

| variable | N | mean | p50 | sd | skewness | kurtosis |
|---|---|---|---|---|---|---|
| value | 78612 | 326068.6 | 3294 | 2081138 | 12.53217 | 198.9928 |
| lnvalue | 78612 | 7.978646 | 8.099858 | 3.540646 | -.10572 | 2.731768 |

**Graph 3:** Stata summary statistics on trade value in level and in logs

A more detailed description on the trade and lntrade variable characteristics is provided in the appendix on page XX. The Box-Cox transformation is also very helpful when deciding between log-log and level-log models.

Number of obs = 75975
LR chi2(19) = 112580.89
Log likelihood = -759833.59 Prob > chi2 = 0.000

| value | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| /theta | .0741118 | .0006584 | 112.57 | 0.000 | .0728215 | .0754021 |

**Graph 4:** Boxcox model with transformed trade value variable

The log-log model is supported if theta is close to 0, the linear-log model is supported if theta is close to 1. Since for this sample the Box-Cox transformation yields a value of theta = 0.0741118 the log-log model is suggested to be more appropriate.

Although the Boxcox model supports the log-log-linearized model, referring to the implications of heteroskedasticity on estimation consistency as discussed in Silva and Tenreyro (2006), the estimation results will be reported and interpreted for both models, the log-log model estimated via OLS and the level-log model estimated via PMLE.

## 5.4 Estimation results

This section presents the main empirical results. In subsection 4.4.1 the main determinants of post-colonial trade development between African and European countries in the years 1962-2000 are investigated. In 4.4.2 the colonial history effect on post-colonial trade performance is evaluated. Moreover, it is looks at potential variations in the colonial history effect between different European metropoles. Subsections 4.4.3 to 4.4.5 present the effect of independence on African countries' exports and imports. Three different estimation approaches are applied to investigate how the declaration of independence influenced exports and imports of African countries. The first method presented in 4.4.3 measures the overall effect of independence on former colonies' total exports to and imports from African and European countries. Subsection 4.4.4 examines the evolution of the independence effect over 39 years. Finally, 4.4.5 it elaborates whether the independence effect varies across different trade partners.

To prove the credibility of the results the empirical models are estimated via pooled OLS, Poisson and LSDV estimators and the coefficient estimates are presented in comparison. All regressions are cluster-robust for country pairs to ensure that the standard errors and confidence intervals of the coefficient estimates are consistent. Most regressions include time dummies in order to control for a general development of trade. Almost 76,000 observations are included in the regressions. The independence effects is measured on former colonies' exports and former colonies' imports separately. The LSDV estimator uses within variation only and therefore produces no coefficient estimates on time-invariant variables.

### 5.4.1 The determinants of post-colonial trade development

The specifications include a comprehensive set of potentially trade-influential variables which reduces the threat of endogeneity bias and enables to paint a comprehensive picture on which geographic, socioeconomic and historic factors influenced African-European trade development in the post-colonial period. The set of variables includes factors which may have reduced or increased bilateral trade costs between African and European countries in the 1962-2000 period. A detailed description of the variables included in the set is given in Table 1 on page 44 and 45.

Since some coefficient estimates differ substantially when time dummies are included in the regression, following Table 2 compares the coefficient estimates of the specifications excluding time dummies with the coefficient estimates of specifications including time dummies.

Table 2 on the following page presents the coefficient estimates on the variables when the independence colony dummy (indcol) turns 1 for former colonies' exports, the current colony dummy (curcol) turns 1 for colonies' exports to their metropole and the ACP dummy turns 1 for African countries' exports to Europe.

Table 12 in the appendix on page XX to XXII presents the estimates when the independent colony, current colony and ACP dummies turn 1 for African countries' imports. However, it is found that the other variables' coefficient estimates are to a large degree independent of the measurement direction of indcol, curcol and ACP.

| specification | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| method | OLS | PMLE | LSDV | OLS | PMLE | LSDV |
| dep. variable | lntrade | trade | lntrade | lntrade | trade | lntrade |
| | **MODEL EXCL. TIME DUMMIES** | | | **MODEL INCL. TIME DUMMIES** | | |
| lngdpcap_i | 0.7626*** | 0.6112*** | 0.5357*** | 1.0952*** | 0.9942*** | 0.6563*** |
| | (0.020) | (0.033) | (0.016) | (0.030) | (0.056) | (0.024) |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| lnpop_i | 0.8549*** | 0.7067*** | 0.4670*** | 0.9230*** | 0.7392*** | 0.8060*** |
| | (0.019) | (0.026) | (0.047) | (0.019) | (0.025) | (0.062) |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| lngdpcap_j | 0.7353*** | 0.5185*** | 0.5467*** | 0.9645*** | 0.8219*** | 0.6473*** |
| | (0.019) | (0.031) | (0.015) | (0.024) | (0.049) | (0.019) |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| lnpop_j | 0.7957*** | 0.7380*** | 0.9139*** | 0.8350*** | 0.7622*** | 1.2432*** |
| | (0.018) | (0.021) | (0.043) | (0.018) | (0.022) | (0.054) |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| lndistw | -0.7434*** | -0.8756*** | | -0.7685*** | -0.8073*** | |
| | (0.049) | (0.047) | | (0.046) | (0.049) | |
| | 0.000 | 0.000 | | 0.000 | 0.000 | |
| landlocked_i | -0.4089*** | -0.6053*** | | -0.2950*** | -0.6728*** | |
| | (0.066) | (0.097) | | (0.066) | (0.100) | |
| | 0.000 | 0.000 | | 0.000 | 0.000 | |
| landlocked_j | -0.6169*** | -0.3188*** | | -0.5311*** | -0.3721*** | |
| | (0.065) | (0.113) | | (0.062) | (0.104) | |
| | 0.000 | 0.005 | | 0.000 | 0.000 | |
| contig | 0.6792*** | 0.1926*** | | 0.6640*** | 0.1305** | |
| | (0.120) | (0.063) | | (0.125) | (0.065) | |
| | 0.000 | 0.002 | | 0.000 | 0.046 | |
| Africa | -1.0038*** | -0.3388** | | -0.1956* | 0.5369*** | |
| | (0.104) | (0.148) | | (0.109) | (0.170) | |
| | 0.000 | 0.022 | | 0.073 | 0.002 | |
| comlang | 0.2450*** | 0.3356*** | | 0.2589*** | 0.3602*** | |
| | (0.073) | (0.071) | | (0.071) | (0.069) | |
| | 0.001 | 0.000 | | 0.000 | 0.000 | |
| comleg | 0.1237** | 0.1225** | | 0.2236*** | 0.2072*** | |
| | (0.060) | (0.048) | | (0.058) | (0.050) | |
| | 0.040 | 0.011 | | 0.000 | 0.000 | |
| comcol | 0.0385 | -0.8050*** | | 0.3241*** | -0.1371 | |
| | (0.121) | (0.211) | | (0.124) | (0.214) | |
| | 0.750 | 0.000 | | 0.009 | 0.522 | |
| **AEcolony50** | **2.0131*** ** | **0.6485*** ** | | **1.7564*** ** | **0.4667*** ** | |
| | **(0.118)** | **(0.141)** | | **(0.126)** | **(0.131)** | |
| | **0.000** | **0.000** | | **0.000** | **0.000** | |
| curcol_e_colony | -0.6695 | 1.2426* | -0.3221 | -0.5291 | 1.2346* | -0.3267 |
| | (1.264) | (0.720) | (0.333) | (1.376) | (0.721) | (0.329) |
| | 0.597 | 0.084 | 0.333 | 0.701 | 0.087 | 0.320 |
| **i_indcol** | **-0.4828*** ** | **0.0319** | **0.1056** | **-0.1593** | **0.2306** | **0.1029** |
| | **(0.100)** | **(0.223)** | **(0.091)** | **(0.106)** | **(0.188)** | **(0.091)** |
| | **0.000** | **0.886** | **0.244** | **0.133** | **0.219** | **0.259** |
| comcur | 0.6643*** | 0.1302*** | 0.4234*** | 0.5312*** | 0.2496*** | 0.4700*** |
| | (0.140) | (0.035) | (0.047) | (0.140) | (0.046) | (0.048) |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| GATT_both | 0.0396 | 0.2443** | 0.0446** | 0.1462*** | 0.5304*** | 0.0788*** |
| | (0.054) | (0.098) | (0.021) | (0.054) | (0.094) | (0.021) |
| | 0.465 | 0.012 | 0.033 | 0.007 | 0.000 | 0.000 |
| RTA | -0.0058 | 0.2003*** | 0.3293*** | 0.0281 | 0.2080*** | 0.3697*** |
| | (0.078) | (0.076) | (0.020) | (0.073) | (0.069) | (0.021) |
| | 0.941 | 0.008 | 0.000 | 0.702 | 0.003 | 0.000 |
| ACP_to_eu | 0.5072*** | 0.3980*** | 0.0873*** | 0.6872*** | 0.5795*** | 0.1264*** |
| | (0.092) | (0.144) | (0.032) | (0.087) | (0.123) | (0.032) |
| | 0.000 | 0.006 | 0.007 | 0.000 | 0.000 | 0.000 |
| Time dummies | NO | NO | NO | YES | YES | YES |
| Observations | 75,975 | 75,975 | 75,975 | 75,975 | 75,975 | 75,975 |
| R-squared | 0.7364 | | 0.8890 | 0.7523 | | 0.8896 |
| rmse | 1.813 | . | 1.203 | 1.758 | | 1.200 |
| F | 1587 | . | 7428 | 587.6 | | 1706 |

**Table 2:** Estimation results on the whole set of variables determining postcolonial trade; indcol, curcol, ACP turn 1 for imports; robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

The bottom line of Table 2 shows that the formulated empirical model proves to work well. With an OLS $R^2$ value of 0.7523 when time dummies are included, the model is able to explain more than 3/4 of the dependent trade variable's variation by variations of the independent variables. The remaining 1/4 of the trade variable's variation is caused by unobserved variables, which end up in the regression residual $\varepsilon_{ij,t}$. When controlling for time-invariant multilateral resistance terms in specification (6) the LSDV estimator achieves an even higher $R_2$ value of 0.8896.

The OLS and Poisson specifications produce similar coefficient estimates on the gravity variables. When time dummies are included in the specification the elasticities of the income variables are very close to the expected magnitude of 1. For example the PMLE specification (5) suggests that a 1.0% increase in income per capita of the exporting country generates a, ceteris paribus, 0.9942% increase in trade value while a 1.0% increase in distance comes with a, ceteris paribus, 0.8073% reduction in trade value.

Looking at specifications (1) to (3) excluding time dummies, all dummy variables proxying various trade cost influencing factors show the expected sign. With regards to variables representing geographical factors, the highly significant, negative coefficient estimate on the Africa dummy in (1) OLS suggests that African or African-European country pairs trade on average (exp(-1.0038)-1)*100 = 63.35% than European country pairs. The (2) PMLE specification suggests a similar result, country pairs in which at least one trade partner is African trade on average (exp(-0.3388)-1)*100 = 28.73% less. Specifications (4) OLS and (5) PMLE including time dummies paint a different picture on the effect of the Africa dummy. After controlling for a general development of trade the OLS coefficient estimate on the Africa dummy turns insignificant, while the coefficient estimate of PMLE turns positive, indicating a high correlation of the Africa dummy with the time dummies. The coefficient estimates of the other geographic variables are largely independent from the effects of time.

The sociocultural variables common language and common legacy exhibit a relatively low influence on trade with low the significance levels on the common legacy variable in both specifications (1) OLS and (2) PMLE. Controlling for time the (4) OLS and (5) PMLE coefficient estimates on the common legacy dummy increase in significance and their estimated effect doubles. Specification (5) PMLE suggests that country pairs with a common language trade on average

(exp(0.3602)-1)*100 = 43.36% more as country pairs sharing no official language while country pairs with a common legacy trade on average (exp(0.2072)-1)*100 = 23.02% more.

With regards to the colonial history variables, African country pairs having had a common colonizer do not significantly trade more than other country pairs according to specification (1) OLS. The PMLE estimation in specification (2) suggests differently. African country pairs which have had the same metropole are suggested to trade (exp(-0.8050)-1)*100 = 55.29% less than the other country pairs in the sample. When time dummies are included in the model the findings are reversed. Comparing (1) OLS with (4) OLS the size and the significance of the effect increases considerably when controlling for the effects of time. (4) OLS suggests that country pairs having had the same metropole trade on average (exp(0.3241)-1)*100 = 38.28% more. Comparing (2) PMLE with (5) PMLE the negative effect of the common colony dummy vanishes and turns insignificant. The coefficient estimates of the colonial history dummy (AEcolony50) as well as the independence dummies (curcol_e_colony and e_indcol) are discussed in more detail in the subsequent sections.

Turning to the economic variables, a common currency exhibits a strong positive effect on trade flows in the OLS and LSDV specifications. In PMLE the currency effect is suggested to be less trade-influential. Regarding the effects of different trade agreements, GATT exhibits an effect which is either of low magnitude or at a low significance level in all specifications excluding time dummies. The magnitude and significance of GATT rises considerably when controlling for time. With respect to the RTA dummy it proves to have no effect in OLS specifications while RTA is suggested to be trade-creating in PMLE and LSDV estimations. Having an ACP agreement positively affects exports from African to European countries. ACP is suggested to exhibit the most positive effect out of all trade agreements in the OLS and PMLE specifications. The estimation results of PMLE (5) suggest that a common currency magnifies trade by a factor of exp(0.2496) = 1.28 while GATT increases trade by exp(0.5304)-1)*100 = 69.96%, RTA by exp(0.2080)-1)*100 = 23.12% and ACP by exp(0.5795)-1)*100 = 78.51%.The positive effect of the ACP trade agreement vanishes to a large extend in the LSDV estimation when only within variation is considered.

### 5.4.2 The colonial history effect

The estimates on the AEcolony50 dummy reported in Table 2 on page 45 and 46 suggest that having a colonial history exhibits a strong trade-promoting effect in the post-colonial era. The (1) OLS specification excluding time dummies implies that trade between African-European country pairs that have been in a colony-colonizer relationship trade as much as exp(2.0131) = 7.49 times more than country pairs which have no colonial history or became independent before 1950. (2) PMLE estimates that trade of African-European country pairs with a colonial history is on average exp(0.6485) = 1.91 times higher than trade of country pairs without.

Turning to specifications (4) OLS and (5) PMLE including time dummies, the coefficient estimates on AEcolony50 decrease for roughly one third, however a colonial history still exhibits a highly significant trade-promoting effect. (4) OLS suggests that trade between African-European country pairs once in a colonial relationship is exp(1.7564) = 5.79 times higher while PMLE (5) suggests it is exp(0.4667) = 1.59 times higher compared with country pairs that have no colonial history or independence dates before 1950.

Table 2 reports the colonial history coefficient estimates while controlling for the independent colony (indcol), current colony (curcol) and ACP dummies measured on exports. Considering the possibility of multicorrelation between the colonial tie variables, the coding of the independence and current colony dummies might influence the coefficient estimates of the colonial history variable (AEcolony50). Therefore, Table 3 compares the estimates on AEcolony50 when the independent colony , current colony and ACP dummies turn 1 for African countries' exports in specifications (1) and (2) with the estimates on AEcolony50 when the independent colony, current colony and ACP dummies turn 1 for African countries' imports in specifications (3) and (4).

| specification | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| method | OLS | PMLE | OLS | PMLE |
| dep. variable | lntrade | trade | lntrade | trade |
| | **INDEP + ACP EFFECTS ON EXPORTS** | | **INDEP + ACP EFFECTS ON IMPORTS** | |
| lngdpcap_i | 1.0952*** | 0.9942*** | 1.1024*** | 0.9429*** |
| | (0.030) | (0.056) | (0.023) | (0.046) |
| | 0.000 | 0.000 | 0.000 | 0.000 |
| lnpop_i | 0.9230*** | 0.7392*** | 0.9092*** | 0.7328*** |
| | (0.019) | (0.025) | (0.018) | (0.025) |
| | 0.000 | 0.000 | 0.000 | 0.000 |
| lngdpcap_j | 0.9645*** | 0.8219*** | 0.8761*** | 0.7661*** |
| | (0.024) | (0.049) | (0.028) | (0.046) |
| | 0.000 | 0.000 | 0.000 | 0.000 |
| lnpop_j | 0.8350*** | 0.7622*** | 0.8216*** | 0.7469*** |
| | (0.018) | (0.022) | (0.018) | (0.022) |
| | 0.000 | 0.000 | 0.000 | 0.000 |
| lndistw | -0.7685*** | -0.8073*** | -0.8071*** | 0.8137*** |
| | (0.046) | (0.049) | (0.045) | (0.046) |
| | 0.000 | 0.000 | 0.000 | 0.000 |
| **AEcolony50** | **1.7564*** ** | **0.4667*** ** | **1.8100*** ** | **0.6326*** ** |
| | **(0.126)** | **(0.131)** | **(0.120)** | **(0.136)** |
| | **0.000** | **0.000** | **0.000** | **0.000** |
| time dummies | YES | YES | YES | YES |
| oth. var. | YES | YES | YES | YES |
| Observations | 75,975 | 75,975 | 75,975 | 75,975 |
| R-squared | 0.7523 | | 0.7556 | |
| rmse | 1.758 | | 1.746 | . |
| F | 587.6 | | 613.7 | . |

**Table 3:** Comparison of the colonial history effect when indcol, curcol and ACP are measured on exports vs. imports; robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; all specifications control for time dummies and the set of other variables influencing trade costs which was presented in Table 2

Table 3 shows that the coefficient estimates on the colonial history variable AEcolony50 remain at a similar magnitude and high level of significance when the independence and ACP dummies turn 1 for African countries' imports instead of exports. In comparison, the effect of colonial history is slightly larger when the dummies are measured on imports. Controlling for time and the whole set of variables influencing transportation costs, (3) OLS suggests that trade of country pairs with a colonial history is exp(1.8100) = 6.1 higher than trade of other country pairs. (4) PMLE suggests a exp(0.6326) = 1.88 times higher trade value while controlling for time and other variables in the set.

In order to answer the second research question related to colonial history, namely whether the colonial history effect varies between African countries formerly ruled by different European colonizers, the colonial history dummy AEcolony50 is split up into 6 dummies. The 6 new dummies measure the colonial history effect for each European metropole separately. AEcolony50 is therefore replaced by Frenchcol, Britishcol, Portuguesecol, Italiancol, Belgiancol and Spanishcol.

AEcolony50 turns 1 for all African-European country pairs with a colonial history and independence date after 1950 regardless of the metropoles' identities. The new dummies turn 1 for African-European pairs with a colonial history and a specific European colonizer. For example Frenchcol turns 1 for trade between former or exiting French colonies and France, Britishcol turns 1 for trade between former or existing British colonies and Britain and so on. Table 4 on the following page reports the estimation results for the colonial history effects measured for each European colonizer separately. Again, to consider measurement differences due to correlations between the colonial history and the independence variables, specifications (1) and (2) show the results when indcol, curcol and ACP are measured on exports and specifications (3) and (4) show the results when indcol, curcol and ACP are measured on imports.

| specification | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| method | OLS | PMLE | OLS | PMLE |
| dep. variable | lntrade | trade | lntrade | trade |
| | **INDEP + ACP EFFECTS ON EXPORTS** | | **INDEP + ACP EFFECTS ON IMPORTS** | |
| lngdpcap_i | 1.1059*** | 0.9907*** | 1.1100*** | 0.9400*** |
| | (0.030) | (0.054) | (0.023) | (0.045) |
| | 0.000 | 0.000 | 0.000 | 0.000 |
| lnpop_i | 0.9297*** | 0.7421*** | 0.9153*** | 0.7362*** |
| | (0.019) | (0.025) | (0.018) | (0.025) |
| | 0.000 | 0.000 | 0.000 | 0.000 |
| lngdpcap_j | 0.9722*** | 0.8189*** | 0.8858*** | 0.7661*** |
| | (0.024) | (0.048) | (0.028) | (0.046) |
| | 0.000 | 0.000 | 0.000 | 0.000 |
| lnpop_j | 0.8408*** | 0.7650*** | 0.8276*** | 0.7495*** |
| | (0.018) | (0.022) | (0.018) | (0.022) |
| | 0.000 | 0.000 | 0.000 | 0.000 |
| lndistw | -0.7735*** | -0.8046*** | -0.8114*** | -0.8125*** |
| | (0.046) | (0.049) | (0.046) | (0.046) |
| | 0.000 | 0.000 | 0.000 | 0.000 |
| **Frenchcol** | **1.4894*** ** | **0.2824** ** | **1.5635*** ** | **0.4355*** ** |
| | **(0.142)** | **(0.122)** | **(0.133)** | **(0.138)** |
| | **0.000** | **0.020** | **0.000** | **0.002** |
| **Britishcol** | **1.4714*** ** | **0.3956** ** | **1.5161*** ** | **0.6207*** ** |
| | **(0.163)** | **(0.169)** | **(0.165)** | **(0.158)** |
| | **0.000** | **0.019** | **0.000** | **0.000** |
| **Portuguesecol** | **3.7777*** ** | **2.3046*** ** | **3.7215*** ** | **2.4481*** ** |
| | **(0.503)** | **(0.456)** | **(0.483)** | **(0.418)** |
| | **0.000** | **0.000** | **0.000** | **0.000** |
| **Italiancol** | **2.1653*** ** | **1.1697*** ** | **2.2338*** ** | **1.2519*** ** |
| | **(0.370)** | **(0.276)** | **(0.251)** | **(0.145)** |
| | **0.000** | **0.000** | **0.000** | **0.000** |
| **Belgiancol** | **2.6624*** ** | **1.9362*** ** | **2.7165*** ** | **2.1917*** ** |
| | **(0.279)** | **(0.358)** | **(0.304)** | **(0.436)** |
| | **0.000** | **0.000** | **0.000** | **0.000** |
| **Spanishcol** | **3.2291*** ** | **2.0988*** ** | **3.2192*** ** | **2.2430*** ** |
| | **(0.392)** | **(0.310)** | **(0.282)** | **(0.359)** |
| | **0.000** | **0.000** | **0.000** | **0.000** |
| time dummies | YES | YES | YES | YES |
| oth. var. | YES | YES | YES | YES |
| Observations | 75,975 | 75,975 | 75,975 | 75,975 |
| R-squared | 0.7536 | | 0.7568 | |
| rmse | 1.753 | | 1.742 | . |
| F | 543.5 | | 568.3 | . |

**Table 4:** Comparison of the colonial history effect measured for each colonizer separately; robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; all specifications control for time dummies and the set of other variables influencing trade costs which was presented in Table 2

The results presented in Table 4 indicate that the colonial history effect on trade in the post-independence period does not differ substantially between former French and former British colonies. (1) OLS suggests that former French colonies export exp(1.4894) = 4.43 times more to France while former British colonies export exp(1.4714) = 4.36 times more to Britain compared to country pairs without a colonial history. (3) OLS suggests that former French colonies import exp(1.5635) = 4.78 times more from France while former British colonies import exp(1.5161) = 4.55 times more from Britain compared with country pairs without a colonial history. However, the estimation results suggest that the trade-promoting effect of

colonial history is significantly larger for other European colonizers. Colonial history seems to have promoted post-colonial trade flows between Portugal and (former) Portuguese colonies the most. The colonial history effect is also larger for Italian, Belgian and Spanish (former) colonies as compared with the French and British. For example OLS (1) and (3) suggest that former Belgian colonies export on average exp(2.6624) = 14.33 times more to Belgium and import on average exp(2.7165) = 15.13 times more from Belgium.

Estimating the indep, curcol and ACP dummies on the different trade directions has only little impact on the sizes and significance levels of the coefficient estimates. Exceptions are the (2) PMLE estimates for the Frenchcol and Britishcol variables which find a smaller colonial history effect at reduced levels of significance for (former) French colonies' exports to France.

### 5.4.3 The overall effect of the declaration of independence

The first approach to evaluate the effect of the declaration of independence is to measure the independence effect on African countries' total exports and imports in the post-colonial period. The overall independence effect is measured with the independent colony (indcol) dummies. indcol_i turns 1 for all observations in which former African colonies export to European and other African countries, starting the first year after the declaration of independence. indcol_j turns 1 for all observations in which former African colonies import from European and other African countries, again starting the first year after the declaration of independence. Additionally, the curcol dummies are included in the specifications to capture the effect of being in an ongoing colonial relationship. curcol_i_colony turns 1 for all observations in which African colonies' export to their European metropole prior to and including the year of independence while curcol_i_empire turns 1 for all observations in which the European metropole exports to their African colonies prior to and including the year of independence.

Table 2 in section 4.4.1. on page 45 and 46 presents the estimation results when indcol and curcol are measured on exports to European and other African countries. No significant effect of the curcol_i_colony dummy is found in the OLS and LSDV specifications. PMLE in contrast suggest a substantial positive effect of being in an ongoing colonial relationship. However, the significance level of the curcol coefficient estimates are low and the confidence intervals are very large. This result is independent of whether time dummies are included in the specification or not.

Turning to the coefficient estimates of the indcol_i dummy presented in Table 2, the (1) OLS specification shows a significant negative effect of independence on African countries' exports to European and other African countries when time dummies are excluded from the model. (1) OLS suggests that former African colonies export (exp(-0.4828)-1)*100 = 38.29% less than country pairs in which the exporter has either never been under colonial rule or is still in a colonial relationship. This negative effect of independence on former colonies' total exports to European and other African countries disappears when time dummies are included in the model. The PMLE and LSDV specifications do not find any significant effect of independence on former African colonies' total exports to European and other African countries at all.

In order to compare the overall independence effect on African countries' total exports with the independence effects on African countries' total imports, Table 5 reports the coefficient estimates for both.

| specification | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| method | OLS | PMLE | LSDV | OLS | PMLE | LSDV |
| dep. variable | lntrade | trade | lntrade | lntrade | trade | lntrade |
| | **INDEP + ACP EFFECTS ON EXPORTS** | | | **INDEP + ACP EFFECTS ON IMPORTS** | | |
| lngdpcap_i | 1.0952*** | 0.9942*** | 0.6563*** | 1.1024*** | 0.9429*** | 0.6449*** |
| | (0.030) | (0.056) | (0.024) | (0.023) | (0.046) | (0.023) |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| lnpop_i | 0.9230*** | 0.7392*** | 0.8060*** | 0.9092*** | 0.7328*** | 0.8986*** |
| | (0.019) | (0.025) | (0.062) | (0.018) | (0.025) | (0.062) |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| lngdpcap_j | 0.9645*** | 0.8219*** | 0.6473*** | 0.8761*** | 0.7661*** | 0.6606*** |
| | (0.024) | (0.049) | (0.019) | (0.028) | (0.046) | (0.019) |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| lnpop_j | 0.8350*** | 0.7622*** | 1.2432*** | 0.8216*** | 0.7469*** | 1.1596*** |
| | (0.018) | (0.022) | (0.054) | (0.018) | (0.022) | (0.055) |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| lndistw | -0.7685*** | -0.8073*** | | -0.8071*** | -0.8137*** | |
| | (0.046) | (0.049) | | (0.045) | (0.046) | |
| | 0.000 | 0.000 | | 0.000 | 0.000 | |
| **curcol_i_colony** | **-0.5291** | **1.2346*** | **-0.3267** | | | |
| | **(1.376)** | **(0.721)** | **(0.329)** | | | |
| | **0.701** | **0.087** | **0.320** | | | |
| **i_indcol** | **-0.1593** | **0.2306** | **0.1029** | | | |
| | **(0.106)** | **(0.188)** | **(0.091)** | | | |
| | **0.133** | **0.219** | **0.259** | | | |
| **curcol_j_empire** | | | | **-0.2674** | **-0.0706** | **0.2734** |
| | | | | **(1.129)** | **(0.688)** | **(0.192)** |
| | | | | **0.813** | **0.918** | **0.154** |
| **j_indcol** | | | | **-0.8661***** | **-0.7589***** | **0.1992***** |
| | | | | **(0.092)** | **(0.134)** | **(0.069)** |
| | | | | **0.000** | **0.000** | **0.004** |
| time dummies | YES | YES | YES | YES | YES | YES |
| oth. var. | YES | YES | YES | YES | YES | YES |
| Observations | 75,975 | 75,975 | 75,975 | 75,975 | 75,975 | 75,975 |
| R-squared | 0.7523 | | 0.8896 | 0.7556 | | 0.8897 |
| rmse | 1.758 | . | 1.200 | 1.746 | . | 1.200 |
| F | 587.6 | . | 1706 | 613.7 | . | 1706 |

**Table 5:** Comparison of the independence coefficient estimates when indcol, curcol and ACP effects are measured on former colonies' exports vs. imports; robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; all specifications control for time dummies and the total set of other variables presented in Table 2

According to specifications (4) to (6) the curcol dummy shows no significant effect when it turns 1 for African colonies' imports from their European metropole.

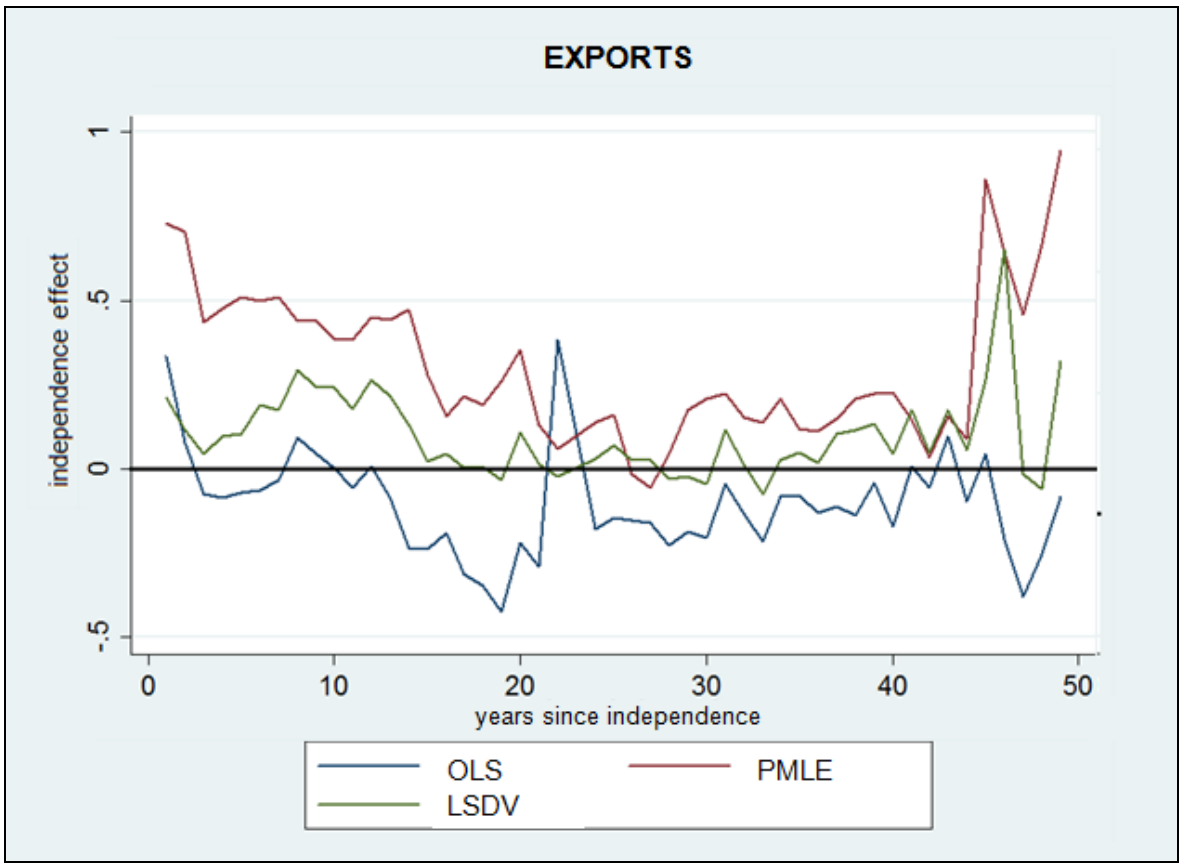
Turning to the i_indcol dummy, the OLS and PMLE coefficient estimates in specifications (4) and (5) report a strong negative effect of independence on former African colonies' total imports from European and other African countries. (4) OLS suggests that former African colonies import on average (exp(-0.8661)-1)*100 = 57.94% less than the other country pairs in the sample in which the importer has either never been under colonial rule or is still in a colonial relationship. The (5) PMLE estimation result is at a similar magnitude. According to this specification former African colonies import (exp(-0.7589)-1)*100 = 53.18% less from European and other African countries than country pairs which have

never been or still were under colonial rule in year t. Utilizing within variation only the coefficient estimates of LSDV indicate no negative effect of the declaration of independence on former African colonies' imports from European and other African countries in the post-colonial period.

### 5.4.4 The independence effect over time

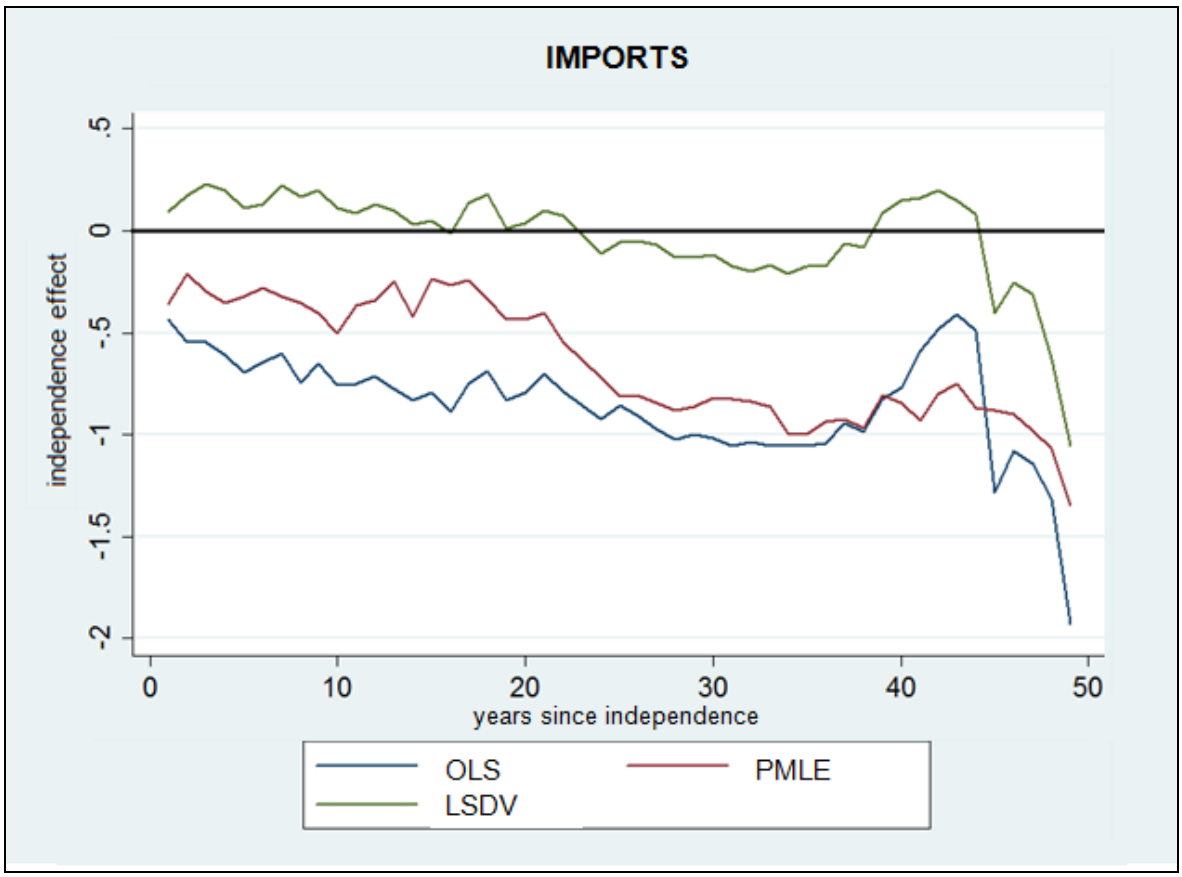
To investigate how the independence effect evolves over time and to check whether any functional form was spuriously imposed on the independence effect in course of the investigations so far, the independent colony variables (i_indcol, j_indcol) are broken up into a set of independence dummies that turn on for each number of years elapsed since the declaration of independence. The independence dummies indep1 to indep49 denote trade flows between former African colonies and other African and European countries starting the first year after the corresponding independence dates up to a maximum of 49 years after independence.

Graphs 5 and 6 picture how the effect of independence evolves over 49 years after African countries' declaration of independence from the European metropoles. The three lines in each Graph correspond to the coefficient estimates on the indep1 to indep49 dummy variables from the three different estimators OLS, PMLE and LSDV. Table 13 in the appendix on pages XXIII to XXV lists the coefficient estimates on the independence dummies with the corresponding significance levels.




**Graph 5:** Evolution of independence effect on former African colonies' exports

Graph 5 presents the coefficient estimates of the independence dummies on former African colonies' total exports to European and other African countries over 49 years after the declaration of independence. Consistent with the previous econometric results on the overall effect of independence, this analytical approach also suggests no significant negative effect of the declaration of independence on African countries' exports in the years 1962-2000. Rather, it indicates that independence has not influenced former African colonies' exports to European and other African countries in the long run. This is suggested by all three estimation methods applied. However, Graph 5 reveals three interesting developments. It is suggested that exports are positively influenced by independence in the first years. This positive effect reduces steadily in the first 10 to 15 years after the declaration of independence. In the following 30 years independence seems to have not exhibited any significant influence on trade. After 45 Years of independence the PMLE specification again suggests a significant, positive influence of independence on African countries' exports. The OLS and LSDV estimator do not find any delayed positive independence effect which is statistically significant.




**Graph 6:** Evolution of independence effect on former African colonies' imports

Graph 6 presents the development of the independence effect on former African colonies' total imports from European and other African countries over 49 years after the declaration of independence. Consistent with the estimates on the overall effect of independence in the previous section, the figure shows that independence negatively influenced African countries' imports from European and other African countries in the post-colonial era.

Considering within and between variation the OLS and Poisson estimates draw a similar picture. The significant negative effect of independence increases gradually over 40 years. Between 40 and 50 years after the declaration of independence the deteriorating effect of independence becomes stronger.

Utilizing within variation only the least LSDV specification method cannot find any independence effect on bilateral trade that is significantly different from zero in the first 40 years after independence. However, between 40 and 50 years after independence the coefficient estimates turn negative, suggesting a delayed, negative effect of the declaration of independence at high significance levels.

### 5.4.5 The independence effect differentiated for trade partners

The third approach to investigate the effect of independence on the development of bilateral trade between African and European countries is to explore whether the effect of African countries' independence differs across trade partners. This aims at identifying a potential redirection of trade between African and European countries in the post-colonial period. Accordingly, the independence dummy indcol is split up into 3 dummies. These dummies measure the independence effect on trade between former African colonies and a) former metropoles (= indcol_col), b) former siblings (= indcol_sib) and c) other European and African countries (= indcol_oth) separately. The variable indcol_col for example turns 1 for trade flows between former African colonies and the corresponding European metropoles for all years starting one year after the declaration of independence. Since the overall independence effect is measured on exports and imports individually, i_indcol_col measures the effect of independence on former African colonies' exports to the corresponding European metropole whereas j_indcol_col measures the effect of independence on former African colonies' imports from the corresponding European metropole. Indcol_sib and indcol_oth follow the same coding system. Table 6 presents the estimation results on the independence effect measured for the 3 types of trade partners separately.

| specification | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| method | OLS | PMLE | LSDV | OLS | PMLE | LSDV |
| dep. variable | lntrade | trade | lntrade | lntrade | trade | lntrade |
| | **INDEP + ACP EFFECTS ON EXPORTS** | | | **INDEP + ACP EFFECTS ON IMPORTS** | | |
| lngdpcap_i | 1.0967*** | 0.9947*** | 0.6587*** | 1.1010*** | 0.9361*** | 0.6451*** |
| | (0.030) | (0.056) | (0.024) | (0.023) | (0.046) | (0.023) |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| lnpop_i | 0.9205*** | 0.7390*** | 0.8148*** | 0.9064*** | 0.7301*** | 0.9088*** |
| | (0.019) | (0.025) | (0.062) | (0.018) | (0.025) | (0.062) |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| lngdpcap_j | 0.9650*** | 0.8230*** | 0.6478*** | 0.8767*** | 0.7676*** | 0.6645*** |
| | (0.024) | (0.049) | (0.019) | (0.028) | (0.045) | (0.019) |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| lnpop_j | 0.8377*** | 0.7626*** | 1.2503*** | 0.8241*** | 0.7479*** | 1.1737*** |
| | (0.018) | (0.022) | (0.054) | (0.018) | (0.022) | (0.055) |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| lndistw | -0.7671*** | -0.8067*** | | -0.8062*** | -0.8161*** | |
| | (0.046) | (0.049) | | (0.045) | (0.046) | |
| | 0.000 | 0.000 | | 0.000 | 0.000 | |
| curcol_i_colony | -0.7129 | 1.2073* | -0.4220 | | | |
| | (1.389) | (0.720) | (0.318) | | | |
| | 0.608 | 0.094 | 0.185 | | | |
| **i_indcol_col** | **-0.5278**** | **0.1803** | | | | |
| | **(0.240)** | **(0.285)** | | | | |
| | **0.028** | **0.527** | | | | |
| **i_indcol_sib** | **-0.8988** | **-1.8453***** | **-0.5181**** | | | |
| | **(0.659)** | **(0.465)** | **(0.250)** | | | |
| | **0.173** | **0.000** | **0.038** | | | |
| **i_indcol_oth** | **-0.1365** | **0.2504** | **0.1777*** | | | |
| | **(0.107)** | **(0.187)** | **(0.097)** | | | |
| | **0.202** | **0.181** | **0.068** | | | |
| curcol_j_empire | | | | -0.1049 | 0.0820 | 0.0805 |
| | | | | (1.156) | (0.701) | (0.181) |
| | | | | 0.928 | 0.907 | 0.657 |
| **j_indcol_col** | | | | **-0.5516**** | **-0.4770*** | |
| | | | | **(0.222)** | **(0.267)** | |
| | | | | **0.013** | **0.074** | |
| **j_indcol_sib** | | | | **-1.0039** | **-0.7521*** | **-0.8711***** |
| | | | | **(0.682)** | **(0.454)** | **(0.283)** |
| | | | | **0.141** | **0.097** | **0.002** |
| **j_indcol_oth** | | | | **-0.8715***** | **-0.8690***** | **0.2911***** |
| | | | | **(0.093)** | **(0.120)** | **(0.070)** |
| | | | | **0.000** | **0.000** | **0.000** |
| time dummies | YES | YES | YES | YES | YES | YES |
| oth. var. | YES | YES | YES | YES | YES | YES |
| Observations | 75,975 | 75,975 | 75,975 | 75,975 | 75,975 | 75,975 |
| R-squared | 0.7525 | | 0.8896 | 0.7557 | | 0.8897 |
| rmse | 1.757 | . | 1.200 | 1.746 | . | 1.200 |
| F | 567.3 | . | 1672 | 598.1 | . | 1673 |

**Table 6:** Independence effect differentiated for trade partners and measured on African countries' exports and imports separately; robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; all specifications control for time dummies and the total set of other variables presented in Table 2

The OLS specifications suggest that the declaration of independence decreases African countries' exports to and imports from former European metropoles at a similar magnitude. According to specifications (1) and (4), exports to metropoles decrease on average for (exp(-0.5278)-1)*100 = 41.01% while imports from the metropole decrease on average for (exp(-0.5516)-1)*100 = 42.40% over the post-colonial years. OLS (1) suggests that independence has no significant effect on

former African colonies' exports to and imports from siblings. Turning to former African colonies' trade with all other African and European countries, the independence effect differs between exports and imports. It is suggested that independence has no significant effect on African countries' exports to other African and European countries while independence significantly reduces imports from other African and European countries for (exp(-0.8715)-1)*100 = 58.17%.

The PMLE coefficient estimates draw a different picture. No highly significant independence effect is found on African countries' exports to and imports from former European metropoles in the post-colonial era. In contrast to OLS, PMLE suggests that independence significantly reduces exports to siblings for (exp(-1.8453)-1)*100 = 84.20% while import from siblings are less affected by independence, showing a coefficient estimate at the lowest level of significance. Exports to other African and European countries are not influenced by independence whereas imports from other African and European countries significantly deteriorated at a large magnitude. PMLE suggests that African countries' imports from other African and European countries have contracted for (exp(-0.8690)-1)*100 = 58.06% in a timeframe of 40 years after the declaration of independence.

Using only information on within variation, the LSDV specifications indicate a slight redirection of trade from siblings to other African and European countries for both, exports and imports, whereas for imports the independence effect is larger in magnitude and at a higher level of significance. The LSDV specifications (3) and (6) are unable to produce any independence coefficient estimates on trade flows between African-European country pairs with a colonial history. Concerning the other trade partners, it is suggested that exports to former siblings decrease for exp(-0.5181) = 40.43% while exports to other African and European countries increase for exp(0.1777) = 19.45%. However, the results are at reduced levels of significance. Turning to imports, after independence African countries' import exp(-0.8711) = 58.15% less from former siblings while imports from other African and European colonies increase for exp(0.2911) = 33.79% with both coefficient estimates being at the highest level of significance.

# 6 Conclusion

## 6.1 Discussion and comparison of results

### 6.1.1 The main trade determinants

Table 2 on page 45 and Table 11 in the appendix on pages XX to XXII give insights into which geographic and socioeconomic factors influenced post-colonial trade development between African and European countries in the years 1962 to 2000. Including an extensive set of trade-influential variables and controlling for a general evolution of trade the final specifications achieve a $R_2$ value of 0.7523 when estimated via OLS and 0.8896 when estimated via LSDV. Since in literature the $R_2$ values of OLS regressions explaining bilateral trade are typically found between 0.6 and 0.8 the estimation specification is regarded to be satisfactory in terms of explanation power.

Comparing OLS and PLME coefficient estimates the signs and magnitudes of the gravity variables' estimates are as expected. Income and population promote bilateral trade with values that approximate unity, while a 1% increase in distance reduces trade by roughly 0.8%. The LSDV estimation produces slightly lower results. which is plausible since the LSDV estimation considers within variation only.

All variables included in the variable set proved to somehow have affected bilateral trade development between African and European countries in the post-colonial period.

As anticipated, being landlocked reduced trade. However, OLS suggests the importers' landlockedness had a more trade-reducing effect while PMLE suggests the opposite. Contiguity increased trade in both OLS and Poisson specifications, although in PMLE the coefficient estimates are roughly one third lower in magnitude and at a lower significance level. This mirrors Silva and Tenreyro (2006), who find that OLS produces estimates on geographical and colonial tie variables that are larger than PMLE estimates.

The Africa dummy was anticipated to show a significant negative coefficient estimate. It was assumed that intracontinental European trade was significantly higher than intracontinental African and intercontinental African-European trade. Surprisingly, after controlling for time OLS suggests no significant Africa effect

while the PMLE specification even suggests a significant positive effect of the Africa dummy. One possible explanation is that Africa's puzzling coefficient estimate is driven by multicollinearity. It is very likely that the correlated lndistw and indcol variables absorb the negative effect of the Africa dummy to a large extend. A more detailed description of the Africa variable and the multicollinearity issue is given in the appendix on pages IX and X.

With regards to the variables representing sociocultural factors, a common language and a common legacy significantly promoted trade in the post-colonial period. Nevertheless, the influence of these two sociocultural factors on bilateral trade development was relatively low compared with influences of other variables included in the specifications. Having had the same colonizer was anticipated to positively have influenced bilateral trade development. This assumption is supported by the coefficient estimates of OLS, however, Poisson suggests that siblings did not trade significantly more than other country pairs in the years 1962-2000. Again, this outcome goes along with Silva and Tenreyro (2006), who find that OLS produces significantly larger estimates on geographic and colonial tie variables as PMLE does.

Turning to the variables representing economic factors, the common currency and trade agreement variables show the expected, highly significant trade-promoting effects in all three estimation methods applied. The coefficient estimates on the economic variables go along with other findings in literature, see Rose (2004) or Glick and Rose (2002). The ACP dummy was expected to show a significant positive effect on African countries' exports to Europe while it was regarded to show no effect on African countries' imports from Europe. Surprisingly, OLS finds not only the expected strong, trade-promoting effect of ACP on African countries' exports to Europe, it also suggests a significant positive effect of the ACP agreements on African countries' imports from Europe. Estimating the regression with PMLE the outcomes fit more to what was anticipated. Poisson suggests that ACP had a significant promoting effect for exports from Africa to European countries in the post-colonial period, while the ACP effects on African countries' imports from Europe are of lower magnitude and at reduced levels of significance. The results of the ACP dummies go along with findings of Lavallée and Lochard (2012).

### 6.1.2 Colonial history

Having a colonial history was expected to exhibit a strong positive influence on post-colonial trade development. The estimation results of both OLS and PMLE support this assumption. The OLS estimation suggests that in the years 1962-2000 bilateral trade between African-European country pairs with a former colonial relationship was roughly 6 times higher than trade between country pairs that have never been in a colonial relationship or have had independence dates prior to 1950. PMLE estimates that post-colonial trade between African-European country pairs with a colonial history was twice as high as trade between other country pairs. The estimates on the colonial history variable are consistent with the results of Head, Mayer, Ries (2010) who find that worldwide country pairs which once have been in a colonial relationship trade 3 times more compared with country pairs that have never been in a colony-colonizer relationship.

### 6.1.3 Differences in the colonial history effect

It was expected that the size of the colonial history effect is dependent on the identity of the metropole. Moreover, it was anticipated that the colonial history effect differs most between French and British colony-colonizer country pairs with a substantially larger magnitude for French colony-colonizer country pairs. This assumption based on historical accounts which suggest that the British and French followed very different colonial trade policies. While the British applied an indirect rule and supported free trade in their colonies, the French followed a direct rule and promoted trade protectionism. Surprisingly, the estimation results no significant difference in the magnitude of the colonial history effect between the French and the British. In the years 1962-2000 both the French and the British traded roughly 4.5 times more with African countries that once have been under their colonial rule than others. Nevertheless, the colonial history effect is found to be substantially larger for the other European colonizers included in the sample. It is suggested that former Portuguese, Spanish, Belgian and Italian colonies traded significantly more with their former colonizers in the post-colonial period as compared with the French and British.

However, this result has to be interpreted with caution. When looking at the sample composition it can be seen that the analysis includes data on 20 French, 15 British, 3 Portuguese, 3 Belgian, 2 Italian and 1 Spanish colony-colonizer country pairs. Given the relatively high number of country pairs, the coefficient estimates for the French and British colonial history dummies are quite reliable.

Given the small number of country pairs with Portuguese, Belgian, Italian and Spanish colony-colonizer relationship, the coefficient estimates of the history dummies might be substantially biased by country specific effects.

Moreover, it shall be mentioned that cross-country differences in the size of the colonial history effect cannot be interpreted to be due to superiorities or inferiorities of colonial legacies inherited from the different colonizers. With reference to de Sousa and Lochard (2010) and considering the non-random selection of African colonies by the European powers, differences in the size of the colonial history effect might also be caused by pre-colonial conditions.

### 6.1.4 The overall effect of the declaration of independence

It was assumed that the independence of African countries may have increased bilateral trade costs to former colonizers and siblings. As Lavallée and Lochard (2012) discuss in more detail, independence may have deteriorated business networks, put an end to trade agreements imposed on the colonies and led to a gradual retirement of business people who facilitated trade within the metropole. Therefore, it was anticipated that the declaration of independence exhibited a significant negative effect on trade between African and European countries in the years 1962-2000.

The independence effect was measured on exports and imports separately since trade policies differed systematically between exports to and imports from the colony as indicated in Bhattacharjea (2004). These differences could very likely have led to variations in the magnitude and significance level of the independence effect on African countries' exports and imports in the post-colonial period. Lavallée and Lochard argue that during colonization African countries mainly exported homogeneous primary products to their metropole while they imported manufactured goods from their metropole. Since imports are regarded to reflect the slowly changing preference patterns of a society according to Kleiman (1976), it was expected that imports may have been oriented less easily than exports after the declaration of independence.

Unexpectedly, no significant negative effect of independence was found on African countries' exports to former colonizers, siblings, European and other African countries after controlling for a general development of trade over time. This is suggested by all three estimators applied. Imports from the newly independent African countries in contrast proved to be negatively affected by independence in both OLS and PMLE specifications. One potential explanation for these estimation

result is that former colonies adopted import substitution measures after the declaration of independence in order to protect local economies and enhance local industrialization as it is suggested in Head, Mayer, Ries (2010) and Bruton (1998).

The curcol dummy was expected to be significantly positive for both, exports to and imports from the metropole since it was anticipated that trade flows were significantly higher between country pairs in ongoing colonial. The coefficient estimates on the current colony dummies were either insignificant or at very low levels of significance with large confidence intervals. This result is very likely due to imprecise estimation caused by a lack of colonial trade data. The sample incorporates very few observations with positive values on pre-independence trade. Only 204 observations ( = 0.15 % of the total number of observations included in the sample) incorporate positive trade values between African colonies and European colonizers prior to the declaration of independence.

### 6.1.5 The independence effect over time

Based on the findings of Head, Mayer, Ries (2010) and Lavallée and Lochard (2012), it was anticipated that African countries' exports to and imports from European and other African countries both eroded gradually over the post-colonial period.

Against this assumption the results suggest that independence did not have a significant long-term influence on African countries' exports to European and other African countries in the years 1962 to 2000. This outcome is in line with the results on the overall independence effect, indicating that there has been no redirection of African countries' exports after the declaration of independence.

Interestingly, it was found that independence exhibited a slight positive influence on export development in the first years after the declaration of independence. However, this positive short-run effect reduced gradually within 15 to 20 years after independence. This estimation result goes along with Head, Mayer, Ries (2010) who find that trade between former colonies and their metropoles tends to be slightly higher in the first ten years after independence. This outcome is also compatible with the findings of Lavallée and Lochard (2012) who suggest that independence has no immediate effect on trade with the former metropole and siblings.

With regards to the evolution of the independence effect on African countries' imports, the findings of the non-parametric specifications support the assumption that the independence events exhibited a gradual negative effect on bilateral trade

development. Over a time frame of 40 years the effect of independence on imports was gradually trade-eroding. The negative coefficient estimates on the independence dummies are at the highest significance level. This outcome is in line with Head, Mayer, Ries (2010) but it is in conflict with the findings of Lavallée and Lochard (2012), who find no significant impact of independence on former colonies' imports from the metropole and siblings over the first 15 years after independence.

Moreover, the results suggest that the deteriorating effect of independence has became more drastic between 40 and 50 years after independence. It has to be kept in mind that the coefficients of the independence effect after 40 and 50 years of the declaration of independence are estimated on data provided by a restricted number of country pairs with independence dates prior to 1960. These countries are Libya (1951), Sudan (1956), Morocco (1956), Tunesia (1956), Ghana (1957) and Guinea (1958). The results on the indep40-indep49 coefficient estimates are therefore very likely driven by specific effects of and events in the listed countries.

### 6.1.6 The independence effect differentiated for trade partners

The independence effect was also expected to vary between different types of trade partners. It was assumed that independence had the most trade-deteriorating effect on African countries' imports to and exports from the corresponding former European metropole. Moreover, it was expected that independence also negatively affected trade with other African siblings. These assumptions based on the results of Head, Mayer, Ries (2010) who find that trade between a colony and its metropole on average declines about 65% within 40 years after independence while trade between siblings falls as much as with the metropole. Increasing trade costs to former colonizers and siblings after the declaration of independence may have raised multilateral resistance indices which possibly made other countries more attractive trade partners. This assumption and the research results of Lavallée and Lochard (2012) suggested a redirection of exports and imports from former colonizers and siblings to other African and European countries.

The estimation results indicate that the effect of independence measured for each type of trade partners separately is higher in magnitude and proves to be more significant for African countries' import, which is consistent with preceding findings. The independence effect coefficient estimates on African countries' exports measured for each type of trade partners separately are to a large extend

insignificant. However, for imports the coefficient estimates are larger in magnitude and show high significance levels. However, the estimation results differ considerably between OLS and PMLE specifications.

OLS on the one hand suggests that the declaration of independence caused a reduction of African countries' exports to and imports from their former metropoles for about 40%. Moreover, OLS suggests independence significantly reduced imports from other African and European countries in the post-colonial period. All other coefficient estimates are not significantly different from zero. One possible explanation for the deterioration of trade between African countries and their former European metropoles after independence as suggested by OLS is delivered by Head, Mayer, Ries (2010). They argue that trade reductions between former colonies and metropoles may be due to the depreciation of trade-promoting capital.

PMLE on the other hand finds no significant effect of independence on African countries' exports to and only a marginal effect at a reduced level of significance on imports from the former metropoles in the years after independence. Rather, PMLE suggests independence caused a substantial reduction of African countries' exports to siblings for 84.2% and imports from other African and European colonies for 58.06%. One possible explanation for the deterioration of trade with former siblings is delivered by Lavallée and Lochard (2012). Independence may have put an end to trade arrangements which were imposed on colonies of the same metropole in the course of colonization.

Surprisingly and against the initial assumption of a trade redirection from former metropoles and siblings to other African and European countries, OLS and PMLE suggest that the declaration of independence exhibited the most trade deteriorating effect on imports from other African and European countries. An explanation for this finding is that after independence, deteriorated trading networks to former colonizers and siblings may have increased multilateral resistance terms for trade between African and European countries in total. Therefore, African countries' trade flows might rather have been redirected to other continents. Africa's imports of manufactured goods could have been redirected to Northern America or Asia. Both continents played a gradually increasing role in the international trading system at that time.

The coefficient estimates of the LSDV method suggest a development of trade that is more consistent with the initial assumption of trade substitution within African

and European countries. Utilizing within variation only, LSDV suggests that former African colonies' exports and imports were redirected from siblings to other African and European countries in the years 1962 to 2000. Unfortunately, LSDV is not able to estimate the independence effect on trade flows to and from former colonizers. This is very likely due to the relatively small number of observations on African-European country pairs with a colonial history combined with only little within variation of the indcol_col variable.

## 6.2 Summary on findings

It was found that the gravity variables income, population size and distance exhibited the expected strong effects on trade development as it is suggested in literature. Turning to other factors influencing trade costs, exporter's and importer's landlockedness significantly reduced whereas sharing a boarder significantly increased trade values. Common currency and ACP trade agreement both proved to have had a strong trade-promoting effect while the sociocultural variables common language and common legacy only marginally promoted trade in the post-colonial period. These results again comply with other findings in literature.

The magnitudes and significance levels of the colonial tie variables' coefficient estimates suggest that colonization and decolonization did strongly influence trade development between African and European countries in the years 1962-2000. The PMLE coefficient estimates on colonial tie variables are lower in magnitude as compared with OLS. This is due to an exaggeration of the role of geographical and colonial factors in OLS according to Silva an Tenreyro (2006).

Having had a common colonizer is suggested to be trade-creating at the highest level of significance in OLS estimations. PMLE suggests that trade between siblings is on average not higher as trade of other country pairs included in the sample. With respect to the variables in focus of this investigation, having a colonial history very strongly promoted bilateral trade between African-European county pairs in the post-colonial period while independence exhibited a gradual trade-reducing effect on African countries' imports over 40 years after the corresponding declaration of independence.

OLS results suggest that bilateral trade flows between African-European country pairs with a colonial history and independence dates after 1950 were on average about 6 times higher than trade flows between country pairs that have never been in a colonial relationship or have had independence dates prior to 1950. PMLE

suggests that African-European country pairs with a colonial history traded almost twice as much as other country pairs in the years 1962-2000. Both OLS and PMLE coefficient estimates on the AEcolony50 variable are highly significant. With respect to differences in the size of the colonial history effect according to the identity of the colonizer, the results suggest that the colonial history effect does not significantly differ between the French and the British as it was initially anticipated. The magnitudes of the colonial history coefficient estimates are substantially larger for Portuguese, Spanish, Belgian and Italian colony-colonizer country pairs. However, these differences in the magnitude of the colonial history effect have to be interpreted with caution, keeping the composition of the sample in mind.

The estimation results on the overall effect of independence suggest that African countries' exports to European and other African countries were not affected by the declaration of independence in the years 1962-2000. African countries' imports in contrast were negatively influenced by the declaration of independence at the highest level of significance. OLS suggests that independence reduced African countries' total imports from European and African countries for 57.94% while PMLE estimates an average of 53.18% import reduction over the post-independence period. This indicates that independence may have caused protectionism and import substitution in the newly independent African countries.

Investigating the evolution of the independence effect over time, the research results reveal that African countries' exports to European and other African countries were positively influenced by the declaration of independence in the first years. This positive effect reduced steadily within the first 10 to 15 years. In the following 30 years the declaration of independence did not exhibit any significant influence on African countries' exports to European and other African countries. With regards to imports, independence is suggested to have had a significant negative effect on African countries' imports from European and other African countries. This negative effect gradually increased over 40 years. 40 to 50 years after the declaration of independence the deteriorating effect became even stronger.

Further investigations on the independence effect differentiated for trade partners deliver substantially differing OLS and PMLE coefficient estimates. However, both estimation methods find a strong negative independence effect on African countries' imports from other African and European countries, with both estimators suggesting an average trade reduction of 58% in the years 1962-2000. Against the

initial assumption, OLS and Poisson cannot detect a redirection of trade flows from former colonizers and siblings to other African and European countries in the post-colonial period.

Utilizing within variation only, LSDV indicates a partial redirection of former African colonies' exports and imports from former siblings to other African and European countries. However, since only within variation is used to produce the coefficient estimates and the estimation results are at reduced levels of significance, the efficiency of this estimator is questioned.

## 6.3 Outlook

The focus of this paper lies on the investigation of the colonial history and independence effects on the development of bilateral trade using data on intra- and intercontinental trade flows between African and European countries in the post-colonial era. The research results are to a large extend compatible with the findings of Head, Mayer and Ries (2010) and Lavallée and Lochard (2012) who utilize trade data on former colonies from all over the world to investigate the influence of colonial history and independence on trade development.

This research gives first insights into how colonization and decolonization affected African-European post-colonial trade development. However, further research could complement the findings of the underlying study.

This study utilizes African and European trade flow data from the years 1962 to 2000 provided by NBER. Since a large proportion of African countries gained independence before 1962, the sample lacks on pre-independence trade data. Only 204 observations ( = 0.15% of the total sample) incorporate positive trade flow values between African colonies and European metropoles prior to the declaration of independence. One implication is that the current colony dummy capturing the effects of being in an ongoing colonial relationship can only be imprecisely measured. The lack of colonial trade data is very likely the reason for the insignificant coefficient estimates on the curcol dummy in all specifications applied. As another consequence the LSDV estimation method using within variation only is not very efficient when estimating the effects of the colonial tie variables.

For more accurate coefficient estimates it is suggested to add on pre-independence trade data to the NBER data base. The DOTS database for example may deliver colonial trade data on African countries prior to the year

1962. Lavallée and Lochard (2012) mention that DOTS incorporates pre-independence trade data for all former British colonies except for Botswana, Kiribati, Saint Lucia, Lesotho, Malawi, Swaziland and Tonga. Colonial trade data on African colonies ruled by the French may be obtained from official French authorities. For their 2012 paper "Independence and trade: the specific effects of French colonialism" Lavallée and Lochard (2012) complemented the DOTS database with bilateral trade data from following French sources:

- *Commerce extérieur des Etats d'Afrique et de Madagascar de 1949 à 1960*, Institut National de la Statistique et des Etudes Economiques (INSEE)
- *Annuaire statistique de l'Union Française d'Outre Mer*, Ministère de la France d'Outre-Mer (1938-1949)
- *Annuaire statistique des Territoires d'Outre Mer*, INSEE (1959, 1960, 1961)

The outcomes of this research do not indicate any substantial redirections of exports and imports between African and European countries in the years 1962-2000. However, it is possible that after the declaration of independence trade flows were redirected from former European metropoles, African siblings and other African and European countries to countries from other continents of the world such as Asia or America. This cannot be investigated in course of this research since the sample includes data on intra- and intercontinental trade flows between African and European countries only.

It is therefore suggested to add on trade data between African countries and other countries of the world to investigate a potential redirection of African countries' trade flows after the declaration of independence on a global scope.

# 7 Bibliography

## 7.1 Books

Albertini, Rudolf von; Europäische Kolonialherrschaft 1880-1949, Atlantis Verlag, 1976

Cameron, Colin A.; Trivedi, Pravin K.; Microeconometrics Using Stata, Stata Press, 2009

Freund, Bill; The making of contemporary Africa, The development of African society since 1800, McMillan, 1988

Griffiths, William E.; Hill, Carter R.; Judge, George G.; Learning and Practicing Econometrics, John Wiley & Sons Inc., 1993

Kerbo, Herold R.; World Poverty, Global inequality and the modern world system, McGraw-Hill, 2006

Springhall, John; Decolonization since 1945, Palgrave, 2001

Thatcher, Paul; Students‘ Notes on the History of Africa in the 19th and 20th Centuries, Harlow UK, 1981

Wallerstein, Immanuel; Africa and the modern world, Africa World Press, 1986

## 7.2 Internet sources

CEPII; databases & models, http://www.cepii.fr/anglaisGraph/bdd/distances.htm, (recalled on 22.11.2013)

CIA World Fact Book; https://www.cia.gov/library/publications/the-world-factbook/fields/2088.html, (recalled on 12.11.2013)

Institute for digital research and education; Stata Web Books Regression with Stata Chapter 2 - Regression Diacnostics, http://www.ats.ucla.edu/stat/stata/webbooks/reg/chapter2/statareg2.htm, (recalled on 26.11.2013)

Princeton University; Data and Statistical Services, (15.08.2013), http://dss.princeton.edu/training/Panel101.pdf, (recalled on 26.11.2013)

Science Po; Department d'economies, A complete gravity data set, http://econ.sciences-po.fr/node/131, (recalled on 22.11.2013)

The Center of International Data at UC Davis; NBER-United Nations Trade Data, (Updated 30.01.2009), http://cid.econ.ucdavis.edu/data/undata/undata.html, (recalled on 12.06.2013)

United Nations Statistics Devision; Composition of macro geographical (continental) regions, geographical sub-regions, and selected economic and other groupings, http://unstats.un.org/unsd/methods/m49/m49regin.htm#europe, (recalled on 18.12.2013)

University of Nevad Las Vegas, history working material, decolonization, http://faculty.unlv.edu/pwerth/464.html, (recalled on 11.12.2013)

World Trade Organization; International Trade Statistics 2012, http://www.wto.org/english/res_e/statis_e/its2012_e/its2012_e.pdf, page 24, (recalled on 15.11.2013)

## 7.3 Papers

Anderson, James E.; A Theoretical Foundation for the Gravity Equation, The American Economic Review. Vol. 69, No. 1, March 1979, pp. 106-116

Anderson, James E.; Wincoop, Eric van; Gravity with Gravitas: A Solution to the Border Puzzle, American Economic Review 93 (1), 2003, pp. 170-192

Baldwin, Richard; Taglioni, Daria; Gravity for dummies and dummies for gravity equations, NBER working paper No. 12516, National Bureau of economic research, 2006

Bosker, Maartens; Garretsen, Harry; Economic GeoGraphy and Economic Development in Sub-Saharan Africa, CESifo Working Paper Series, No 2490, 2008

Eichengreen, Barry; Douglas A.; Irwin; The role of history in bilateral trade flows, NBER working paper 5565, 1996

Head, Keith; Mayer, Thierry.; and Ries, John; The Erosion of Colonial Trade Linkages after Independence, published in Journal of International Economics 81(1), 2010, pp. 1-14

Lavallée, Emmanuelle; Lochard, Julie; Independence and trade: the specific effects of French colonialism, Working Paper, 2012

Lochard, Julie; De Sousa, Jose; Trade and colonial status, Working paper SMART - LERECO N°10-12, 2010

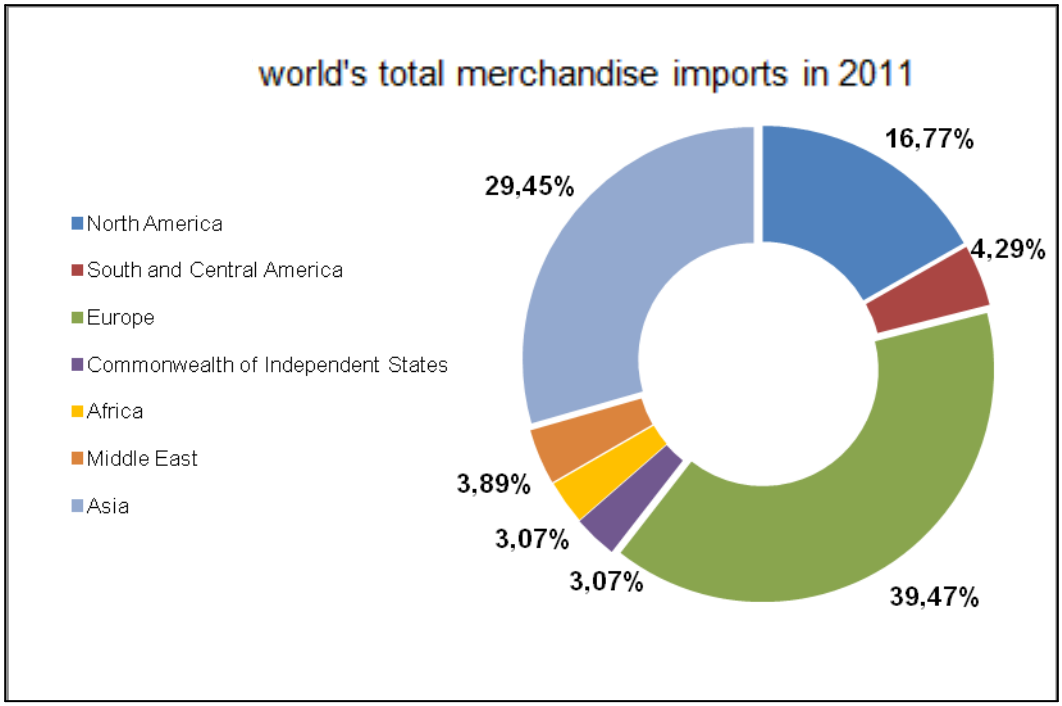
Sachs et al, J.; Ending Africa's poverty trap, Brookings Papers on Economic Activity 1, 2004, pp. 117-216

Silva, Santos; Tenreyro, Silvana; The log of gravity, The Review of Economics and Statistics, 88(4), 2006, pp. 641-658

# 8 Appendix table of contents

# 1 Further statistical data

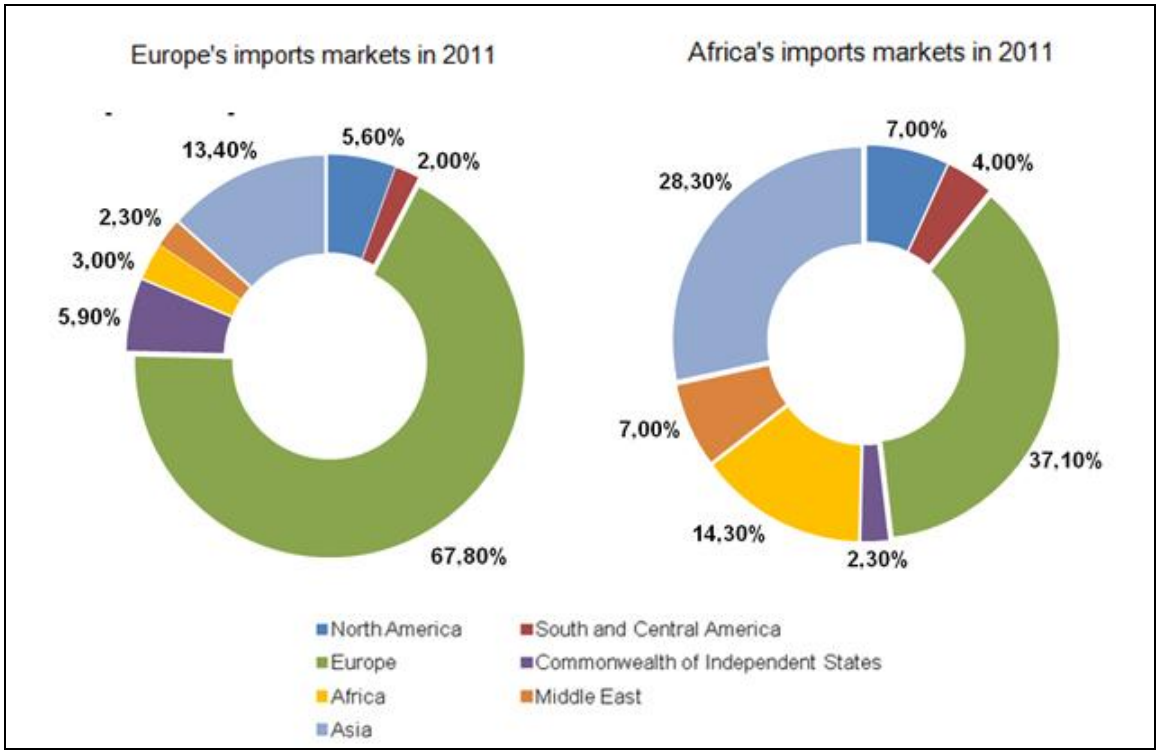
## 1.1 World's total imports 2011




**Graph 7**: World's total merchandise imports 2011 by destination markets

The figure shows the destination markets of the world's total imports of merchandise. Europe accounted for 39.47% of the world's total merchandise imports in 2011 while Africa's contribution to the world's imports was only 3.07%.

## 1.2 Europe's and Africa's import markets 2011

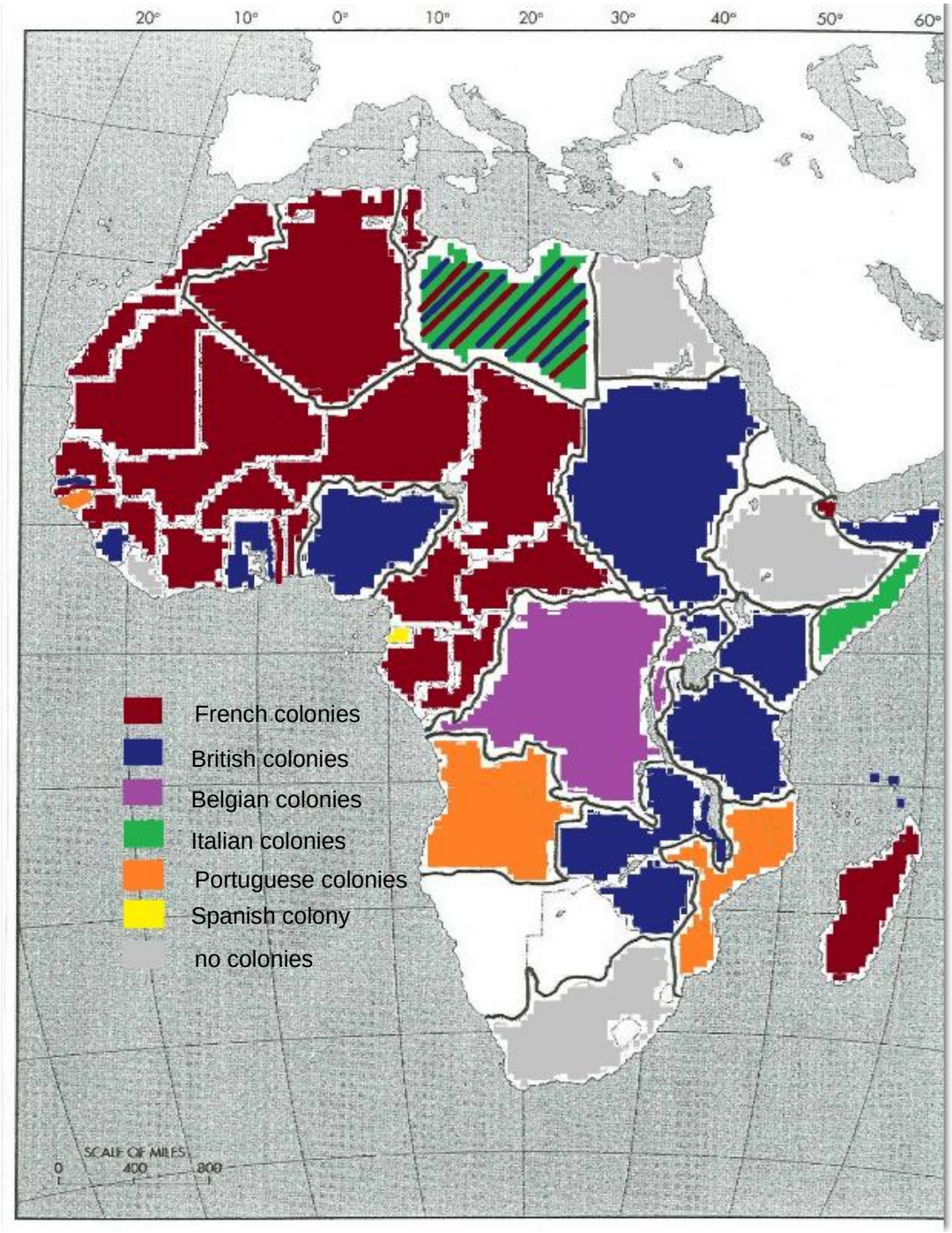



**Graph 8:** Share of Europe's and Africa's merchandise import markets in 2011

With regards to intracontinental trade, 67.80% of Europe's total merchandise imports originated from other European countries whereas only 14.30% of African countries' total merchandise imports came from other African countries.

Looking at intercontinental trade between Africa and Europe, 37.10% of Africa's merchandise imports 2011 were shipped from European countries while at the same time only 3.00% of Europe's imports originated from African countries.

## 2 Map of colonial Africa in 1950




**Graph 9:** Map of African colonies and other African countries in 1950

This figure shows the 45 African countries in scope of this investigation. 41 out of the 45 African countries have been colonies under European rule in the year 1950. The 4 countries painted in grey have either never been under colonial rule or have had independence dates prior to 1950.

# 3 Countries in scope of the research

## 3.1 African countries

| African countries with independence dates after 1950 | |
|---|---|
| 1. Algeria | 2. Malawi |
| 3. Angola | 4. Mali |
| 5. Benin | 6. Mauritania |
| 7. Burkina Faso | 8. Mauritius |
| 9. Burundi | 10. Morocco |
| 11. Cameroon | 12. Mozambique |
| 13. Cent.Afr.Rep | 14. Niger |
| 15. Chad | 16. Nigeria |
| 17. Congo | 18. Rwanda |
| 19. Cote Divoire | 20. Senegal |
| 21. Dem.Rp.Congo | 22. Seychelles |
| 23. Djibouti | 24. Sierra Leone |
| 25. Eq.Guinea | 26. Somalia |
| 27. Gabon | 28. Sudan |
| 29. Gambia | 30. Tanzania |
| 31. Ghana | 32. Togo |
| 33. Guinea | 34. Tunisia |
| 35. GuineaBissau | 36. Uganda |
| 37. Kenya | 38. Zambia |
| 39. Libya | 40. Zimbabwe |
| 41. Madagascar | |
| **African countries never under colonial rule or with early indep. dates** | |
| 42. Liberia | 43. Egypt |
| 44. South Africa | 45. Ethiopia |

**Table 7:** African countries included in the sample

## 3.2 European countries

| Relevant former European metropoles | |
|---|---|
| 1. Belgium-Lux | 2. Portugal |
| 3. France | 4. Spain |
| 5. Italy | 6. UK |
| **Other European countries** | |
| 7. Austria | 8. Ireland |
| 9. Denmark | 10. Malta |
| 11. Finland | 12. Norway |
| 13. Germany | 14. Netherlands |
| 15. Greece | 16. Sweden |
| 17. Iceland | 18. Switz.Liecht |

**Table 8:** European countries included in the sample

The sample of European countries excludes the countries of Eastern Europe. This is because intra-European trade bias caused by the Iron Curtain is desired to be kept out of the investigation. The United Nations Statistics Division's classification is used to identify which countries are associated to belong to Eastern Europe. With regards to trade flows from and to Germany, until the year 1989 only trade data reported from the Federal Republic of Germany is considered. The Baltic States are excluded from the sample due to a lack of reported trade flows.

## 3.3 Colonial relationships and independence dates

| African Country | col.Power | i-year |
|---|---|---|
| 1. Dem. Rep. Congo | BE | 1960 |
| 3. Burundi | BE | 1962 |
| 5. Rwanda | BE | 1962 |
| | | N = 3 |
| 8. Libya | FR | 1951 |
| 10. Morocco | FR | 1956 |
| 12. Tunesia | FR | 1956 |
| 14. Guinea | FR | 1958 |
| 16. Benin | FR | 1960 |
| 18. Burkina Faso | FR | 1960 |

| African Country | col.Power | i-year |
|---|---|---|
| 2. Libya | UK | 1951 |
| 4. Sudan | UK | 1956 |
| 6. Ghana | UK | 1957 |
| 7. Nigeria | UK | 1960 |
| 9. Somalia | UK | 1960 |
| 11. Sierra Leone | UK | 1961 |
| 13. Tanzania | UK | 1964 |
| 15. Uganda | UK | 1962 |
| 17. Kenya | UK | 1963 |
| 19. Malawi | UK | 1964 |

| | | |
|---|---|---|
| 20. Cote Divoire | FR | 1960 |
| 22. Gabon | FR | 1960 |
| 24. Cameroon | FR | 1960 |
| 26. Madagascar | FR | 1960 |
| 28. Mali | FR | 1960 |
| 30. Mauretania | FR | 1960 |
| 31. Niger | FR | 1960 |
| 33. Congo | FR | 1960 |
| 35. Senegal | FR | 1960 |
| 36. Togo | FR | 1960 |
| 38. Chad | FR | 1960 |
| 40. Centr. Afr. Rep. | FR | 1960 |
| 42. Algeria | FR | 1962 |
| 43. Djibouti | FR | 1977 |
| | | N = 20 |

| | | |
|---|---|---|
| 21. Zambia | UK | 1964 |
| 23. Gambia | UK | 1965 |
| 25. Mauritius | UK | 1968 |
| 27. Seychelles | UK | 1976 |
| 29. Zimbabwe | UK | 1980 |
| | | N = 15 |
| 32. Libya | IT | 1951 |
| 34. Somalia | IT | 1960 |
| | | N = 2 |
| 37. GuineaBissau | PT | 1974 |
| 39. Angola | PT | 1975 |
| 41. Mozambique | PT | 1975 |
| | | N = 3 |
| 44. Eq. Guinea | ES | 1968 |
| | | N = 1 |

**Table 9:** List of African countries, former colonizers and relevant independence dates

St. Helena as well as the French South Antarctic Territories including the Comoros are excluded from the analysis. While St. Helena has a unique history and is still under British rule, there is not sufficient data on the regressor variables for the French South Antarctic Territories. Ethiopia, Liberia, Egypt and South Africa are the 4 African countries included in the sample, which are not classified as former European colonies since they either have never been under colonial rule or they have had early independence dates: Ethiopia's independence dates back at least 2,000 years, which makes it one of the world's oldest independent countries. Liberia gained independence from the USA in 1847. South Africa and Egypt gained independence from the UK in 1910 and 1922.

## 3.4 Special cases

This research considers the two African countries Somalia and Libya as having had colonial relationships with more than one European metropole.

Somalia enters the analysis with colonial relationships to the European countries Italy and UK. This is because Somalia was formed out of the two colonies Italian Somaliland and British Somaliland after they declared independence in 1960.

Libya is included as having had three different metropoles: Italy, UK and France. This is because all three European countries have occupied Libya in the first half of the 20th century. From 1912-1943 Libya was under Italian rule. From 1943-1951 Libya was under French and British UN trusteeship. The British military administered the two provinces of Tripolitana and Cyrenaïca, while the French administered the province of Fezzan until Libya's declaration of independence in 1951.

# 4 Sample description

## 4.1 Panel characteristics

The panel consists of altogether 131,717 observations. The data was collected for the period 1962-2000 (=39 years) on 3,403 one-directional country pairs. One-directional means that each country pair enters the panel twice with two pair_ids. To exemplify: the African-European country pair Djibouti-France enters the panel with 39 observations on exports from Djibouti to France under the pair_id 983 and with 39 observations on exports from France to Djibouti under the pair_id 2438.

```
 pair_id:  1, 2, ..., 3403                                   n =        3403
    year:  1962, 1963, ..., 2000                             T =          39
           Delta(year) = 1 unit
           Span(year)  = 39 periods
           (pair_id*year uniquely identifies each observation)

Distribution of T_i:   min      5%     25%       50%       75%     95%      max
                        39      39      39        39        39      39       39

     Freq.   Percent     Cum.  |  Pattern
 ---------------------------------------------------------------------------
     3403    100.00   100.00   |  1111111111111111111111111111111111111111
 ---------------------------------------------------------------------------
     3403    100.00            |  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
```

**Graph 10:** Stata output on dataset description

Graph 10 might implicate that the underlying panels is balanced. It seems as if data is provided on all 3,403 country pairs in all 39 years. However, this implication is misleading. Due to missing and zero trade values between individual country pairs in certain years, the panel proves to be unbalanced when observations with missing and zero trade values are dropped.

```
 pair_id:  1, 2, ..., 3403                                   n =       3403
    year:  1962, 1963, ..., 2000                             T =         39
           Delta(year) = 1 unit
           Span(year)  = 39 periods
           (pair_id*year uniquely identifies each observation)

Distribution of T_i:   min      5%     25%       50%       75%      95%      max
                         1       1       9        24        39       39       39

     Freq.  Percent    Cum.  |  Pattern
------------------------------+-----------------------------------------------
      1022    30.03   30.03  |  111111111111111111111111111111111111111
        53     1.56   31.59  |  .111111111111111111111111111111111111111
        46     1.35   32.94  |  ...1111111111111111111111111111111111111
        19     0.56   33.50  |  ..........1..........................
        17     0.50   34.00  |  ................1.....................
        16     0.47   34.47  |  ................1.....................
        16     0.47   34.94  |  ...........1........................
        16     0.47   35.41  |  ........1...........................
        16     0.47   35.88  |  11111111111111...111.................
      2182    64.12  100.00  |  (other patterns)
------------------------------+-----------------------------------------------
      3403   100.00          |  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
```

**Graph 11:** Dataset description after dropping observations with missing and zero trade values

Graph 11 shows that 30.03% of the 3,403 one-directional country pairs do have observations with positive trade values over all 39 years. 1.56% of the 3,404 country pairs do have missing or zero trade values for the year 1962 but positive trade values for 1963-2000. 1.35% of the 3,403 country pairs do have missing values for the first three years of observation but positive trade values for the years 1965-2000 and so on.

## 4.2 Variable characteristics

Referring to the set of regressor variables included, the comlang variable in the underlying dataset equals the comlang_ethno variable of the CEPII database. Comlang_ethno is preferred to the comlang_off variable of CEPII, is because the comlang_ethno variable incorporates all the effects of comlang_off while it is less correlated to the other regressor variables incorporated in $x_{ij,t}$.

With regards to the trade agreements variables it shall be kept in mind the GATT, RTA and ACP have a different coding system as it is explained in Table 1 on the pages 31 and 32. The trade agreement dummies are adopted from the database which underlies Head, Mayer, Ries (2010). According to them, the RTA dummy is constructed from three main sources: Table 3 of Baier and Bergstrand (2007) supplemented with the WTO web site and qualitative information contained in Frankel (1997). Information about GATT membership comes from the WTO website. The ACP trade agreement dummies ACP_to_EU and EU_to_ACP capture the effects of preferential trade tariffs for exports from African to European

countries. The ACP dummy refers to a sequence of agreements which show a growing number of memberships over time. The preferential treatment of European imports from African countries is part of an ACP-EU development cooperation with the aim to provide technical and financial assistance to countries which were once under European rule. The time-varying list of African countries participating in the ACP agreement is provided in Table 10:

| trade agreement | Year | Relevant African countries included |
|---|---|---|
| Yaoundé I | 1963 | Benin, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Cote d'Ivoire, Democratic Republic Congo, Gabon, Madagascar, Mali, Mauritania, Niger, Rwanda, Senegal, Somalia, Togo |
| Yaoundé II | 1969 | Kenya, Tanzania, Uganda |
| Lomé I | 1975 | Ethiopia, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Malawi, Mauritius, Nigeria, Sierra Leone, Sudan, Zambia |
| Lomé II | 1979 | Djibouti |
| Lomé III | 1984 | Mozambique, Zimbabwe |
| Lomé IV | 1990 | Equatorial Guinea |
| Lomé IV revised | 1995 | Namibia, South Africa |

**Table 10:** List of African countries in scope participating in ACP trade agreements

It shall be noted that a common religion variable was included in the original set of trade-influential variables. However, the coefficient estimate on a common religion proved to be not significantly different from zero in specification models estimated by OLS, PMLE and LSDV, therefore it was excluded from the variable set.

Multicollinearity between covariates is an issue for the Africa variable. The Africa coefficient estimates are very likely distorted since Africa is correlated to several other trade-influencing variables included in $x_{ij,t}$. The variance inflation factor (VIF) test was conducted to quantify the severity of multicollinearity. Africa's post-estimation VIF value is 3.84. This is a rather high score which indicates that the magnitude of Africa's coefficient estimate is very much dependent on the sizes of other variables' coefficient estimates. The Stata *correlate* command reveals that the Africa variable shows rather strong positive correlation to distance (0.5741), e_indcol (0.3819) and i_indcol (0.3902) and a negative correlation to gdpcap_e (-0.3432), gdpcap_i(-0.3675) and RTA(-0.6726). The coefficient estimates on Africa therefore hav to be interpreted with caution.

## 4.3 Sample and variable variation

For the analysis it is important to quantify the relative importance of within and between variation, since the efficiency of the LSDV estimator depends on the within variation. The more within variation, the more efficient the LSDV estimator will be.

| Variable | | Mean | Std. Dev. | Min | Max | Observations |
|---|---|---|---|---|---|---|
| value | overall | 326068.6 | 2081138 | 1 | 5.14e+07 | N = 78612 |
| | between | | 1227841 | 1 | 2.23e+07 | n = 3403 |
| | within | | 1352685 | -2.07e+07 | 3.03e+07 | T-bar = 23.1008 |
| lntrade | overall | 7.978646 | 3.540646 | 0 | 17.75441 | N = 78612 |
| | between | | 3.602172 | 0 | 16.43258 | n = 3403 |
| | within | | 1.56664 | -2.211114 | 15.65948 | T-bar = 23.1008 |
| lngdpcap_e | overall | 6.851025 | 1.741456 | 3.50658 | 10.70794 | N = 129502 |
| | between | | 1.56049 | 4.680856 | 9.416081 | n = 3403 |
| | within | | .7565588 | 4.459301 | 8.919256 | T-bar = 38.0552 |
| lnpop_e | overall | 1.92034 | 1.428781 | -3.122606 | 4.826493 | N = 132717 |
| | between | | 1.404343 | -2.772024 | 4.363997 | n = 3403 |
| | within | | .2641943 | .7564138 | 2.767478 | T = 39 |
| lngdpcap_i | overall | 6.838936 | 1.743898 | 3.50658 | 10.70794 | N = 129516 |
| | between | | 1.562613 | 4.680856 | 9.416081 | n = 3403 |
| | within | | .7570354 | 4.447211 | 8.907166 | T-bar = 38.0594 |
| lnpop_i | overall | 1.898873 | 1.437941 | -3.122606 | 4.826493 | N = 132717 |
| | between | | 1.413676 | -2.772024 | 4.363997 | n = 3403 |
| | within | | .2641305 | .7349468 | 2.746011 | T = 39 |
| lndistw | overall | 8.144042 | .7064981 | 5.080959 | 9.352212 | N = 132717 |
| | between | | .7065993 | 5.080959 | 9.352212 | n = 3403 |
| | within | | 0 | 8.144042 | 8.144042 | T = 39 |
| landlocked_e | overall | .2077579 | .405704 | 0 | 1 | N = 132717 |
| | between | | .4057621 | 0 | 1 | n = 3403 |
| | within | | 0 | .2077579 | .2077579 | T = 39 |
| Landlocked_i | overall | .2083456 | .4061268 | 0 | 1 | N = 132717 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | between | | .4061849 | 0 | 1 | n = 3403 |
| | within | | 0 | .2083456 | .2083456 | T = 39 |
| contig | overall | .0617103 | .2406295 | 0 | 1 | N = 132717 |
| | between | | .2406639 | 0 | 1 | n = 3403 |
| | within | | 0 | .0617103 | .0617103 | T = 39 |
| Africa | overall | .9100793 | .2860691 | 0 | 1 | N = 132717 |
| | between | | .2861101 | 0 | 1 | n = 3403 |
| | within | | 0 | .9100793 | .9100793 | T = 39 |
| comlang | overall | .2368498 | .425151 | 0 | 1 | N = 132717 |
| | between | | .4252119 | 0 | 1 | n = 3403 |
| | within | | 0 | .2368498 | .2368498 | T = 39 |
| comleg | overall | .4381428 | .4961608 | 0 | 1 | N = 132717 |
| | between | | .4962319 | 0 | 1 | n = 3403 |
| | within | | 0 | .4381428 | .4381428 | T = 39 |
| comcol | overall | .1580958 | .3648322 | 0 | 1 | N = 132717 |
| | between | | .3648844 | 0 | 1 | n = 3403 |
| | within | | 0 | .1580958 | .1580958 | T = 39 |
| AEcolony50 | overall | .0258595 | .1587168 | 0 | 1 | N = 132717 |
| | between | | .1587395 | 0 | 1 | n = 3403 |
| | within | | 0 | .0258595 | .0258595 | T = 39 |
| e_indcol | overall | .5652479 | .4957263 | 0 | 1 | N = 132717 |
| | between | | .4673889 | 0 | 1 | n = 3403 |
| | within | | .1653927 | -.4091111 | 1.052427 | T = 39 |
| i_indcol | overall | .5714189 | .4948749 | 0 | 1 | N = 132717 |
| | between | | .4675276 | 0 | 1 | n = 3403 |
| | within | | .1624246 | -.4029401 | 1.058598 | T = 39 |
| curcol_e_ | overall | .0009343 | .0305525 | 0 | 1 | N = 132717 |
| colony | between | | .0172934 | 0 | .4871795 | n = 3403 |
| | within | | .0251888 | -.4862452 | .9752933 | T = 39 |
| curcol_e_ | overall | .0009343 | .0305525 | 0 | 1 | N = 132717 |
| metropole | between | | .0172934 | 0 | .4871795 | n = 3403 |
| | within | | .0251888 | -.4862452 | .9752933 | T = 39 |

| | | | | | | |
|---|---|---|---|---|---|---|
| indep3 | overall | .0130579 | .1135229 | 0 | 1 | N = 132717 |
| | between | | .0128202 | 0 | .025641 | n = 3403 |
| | within | | .1127969 | -.0125832 | .9874168 | T = 39 |
| indep24 | overall | .0149039 | .1211688 | 0 | 1 | N = 132717 |
| | between | | .012652 | 0 | .025641 | n = 3403 |
| | within | | .1205066 | -.0107371 | .9892629 | T = 39 |
| indep48 | overall | .0004069 | .0201673 | 0 | 1 | N = 132717 |
| | between | | .0032047 | 0 | .025641 | n = 3403 |
| | within | | .0199111 | -.0252341 | .9747659 | T = 39 |
| comcur | overall | .0544844 | .2269718 | 0 | 1 | N = 132717 |
| | between | | .1879848 | 0 | 1 | n = 3403 |
| | within | | .1272322 | -.9198746 | 1.003202 | T = 39 |
| GATT_both | overall | .5588131 | .4965308 | 0 | 1 | N = 132717 |
| | between | | .4211514 | 0 | 1 | n = 3403 |
| | within | | .2631067 | -.4155459 | 1.379326 | T = 39 |
| RTA | overall | .0830489 | .2759571 | 0 | 1 | N = 132717 |
| | between | | .2230498 | 0 | 1 | n = 3403 |
| | within | | .1625281 | -.8913101 | 1.057408 | T = 39 |
| ACP_to_eu | overall | .085558 | .2797113 | 0 | 1 | N = 132717 |
| | between | | .2257143 | 0 | .974359 | n = 3403 |
| | within | | .1652454 | -.888801 | .9317118 | T = 39 |
| eu_to_ACP | overall | .0857162 | .2799456 | 0 | 1 | N = 132717 |
| | between | | .225766 | 0 | .974359 | n = 3403 |
| | within | | .1655713 | -.8886428 | .9318701 | T = 39 |
| td1963 | overall | .025641 | .1580625 | 0 | 1 | N = 132717 |
| | between | | 0 | .025641 | .025641 | n = 3403 |
| | within | | .1580625 | 0 | 1 | T = 39 |
| td1988 | overall | .025641 | .1580625 | 0 | 1 | N = 132717 |
| | between | | 0 | .025641 | .025641 | n = 3403 |
| | within | | .1580625 | 0 | 1 | T = 39 |
| td1999 | overall | .025641 | .1580625 | 0 | 1 | N = 132717 |

| | | | | | |
|---|---|---|---|---|---|
| | between | 0 | .025641 | .025641 | n = 3403 |
| | within | .1580625 | 0 | 1 | T = 39 |

**Table 11:** Description of overall, within and between variation of all relevant variables

Table 11 shows that the trade flow in levels has between and within variation that is at a similar magnitude. For the trade flow variable measured in logs between variation prevails. The time invariant regressors comcol, AEcolony50, lndistw, landlocked_i, landlocked_j, contig, Africa, comlang, comlag do have zero within variation while the pair_id and time dummies do have zero between variation. The variables measuring independence effects show both within as well as between variation. With respect to the overall sample's variation there is clearly more variation between country pairs than within country pairs, which indicates that the within estimation using LSDV may suffer from a considerable loss of efficiency.

## 4.4 Conditional mean specification

The variable augmentation test is a commonly used test to check whether the conditional mean of the dependent variable is correctly specified. However, this test works for the OLS estimator while for the PMLE and LSDV estimator it is not applicable. An alternative and simpler test is provided by the Stata *linktest* command. The linktest is carried out for all three specification models considered in the analysis:

| Source | SS | df | MS | Number of obs = | 75975 |
|---|---|---|---|---|---|
| | | | | F( 2, 75972) = | . |
| Model | 712665.134 | 2 | 356332.567 | Prob > F = | 0.0000 |
| Residual | 234452.531 | 75972 | 3.08603869 | R-squared = | 0.7525 |
| | | | | Adj R-squared = | 0.7525 |
| Total | 947117.665 | 75974 | 12.4663393 | Root MSE = | 1.7567 |

| lnvalue | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| _hat | 1.057324 | .0088995 | 118.81 | 0.000 | 1.039881 | 1.074767 |
| _hatsq | -.0032687 | .0004934 | -6.62 | 0.000 | -.0042357 | -.0023016 |
| _cons | -.2190408 | .0376212 | -5.82 | 0.000 | -.2927781 | -.1453034 |

**Graph 12: L**inktest testing conditional mean of OLS specification

Poisson regression — Number of obs = 75975; LR chi2(2) = 1.43e+11; Prob > chi2 = 0.0000; Log likelihood = -2.483e+09; Pseudo R2 = 0.9665

| value | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| _hat | .9721055 | .0000414 | 2.4e+04 | 0.000 | .9720244 | .9721865 |
| _hatsq | .000965 | 1.43e-06 | 676.77 | 0.000 | .0009622 | .0009678 |
| _cons | .1975546 | .000297 | 665.15 | 0.000 | .1969725 | .1981367 |

**Graph 13:** Linktest testing conditional mean of PMLE specification

Linear regression, absorbing indicators — Number of obs = 75975; F( 2, 72622) = 27469.00; Prob > F = 0.0000; R-squared = 0.8897; Adj R-squared = 0.8846; Root MSE = 1.1994

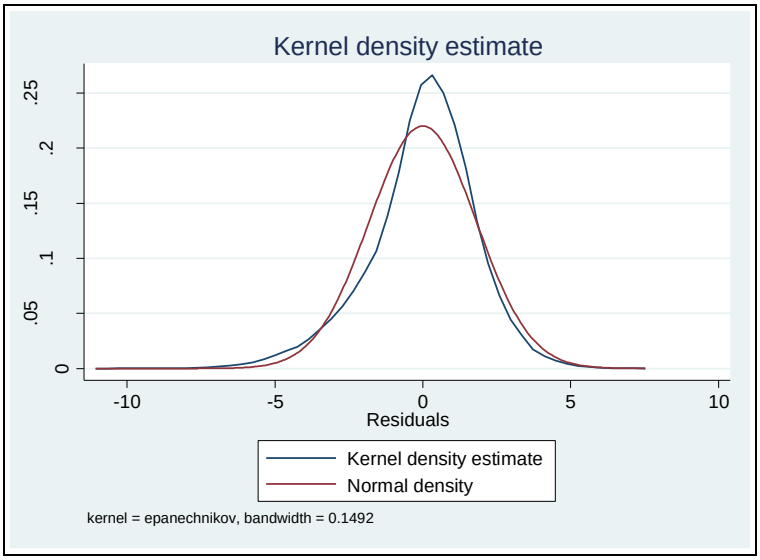
| lnvalue | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| _hat | 1.112977 | .0166448 | 66.87 | 0.000 | 1.080353 | 1.145601 |
| _hatsq | -.0068198 | .0009712 | -7.02 | 0.000 | -.0087233 | -.0049163 |
| _cons | -.4231929 | .0695345 | -6.09 | 0.000 | -.5594803 | -.2869055 |
| pair_id | F(3350, 72622) = | | 51.406 | 0.000 | (3351 categories) | |

**Graph 14:** Linktest testing conditional mean of LSDV specification

_hat proxies the conditional mean $x_{ij,t}$ which includes the entire set of regressor variables in the model specifications. _hatsq proxies the error term including all trade-influencing variables omitted from $x_{ij,t}$. The coefficient estimates and the t values of _hatsq suggest that the unobserved variables included in the error term do significantly affect bilateral trade. This implies that the conditional mean $x_{ij,t}$ does not include all variables influencing bilateral trade, some remain unobserved and are incorporated in $\varepsilon_{ij,t}$. As a consequence, the null hypothesis that the conditional mean is correctly specified has to be rejected. However, comparing the magnitudes of the _hat and _hatsq coefficient estimates and looking at the high $R_2$ scores, it is concluded that $x_{ij,t}$ incorporates a very large share of trade influencing variables. This suggests that the possibility of a bias in the coefficient estimates of the conditional mean due to omitted variables is rather small.

## 4.5 Normality of the error term

Normality of the error is not a precondition to obtain unbiased estimates of the regression coefficients. However, a normal distribution of $\varepsilon_{ij,t}$ assures that the p-values for the t-tests and F-test are valid. Moreover, normality of the error term is required for valid hypothesis testing. Kernel density estimates are used to test the normality of the residual after the regression.

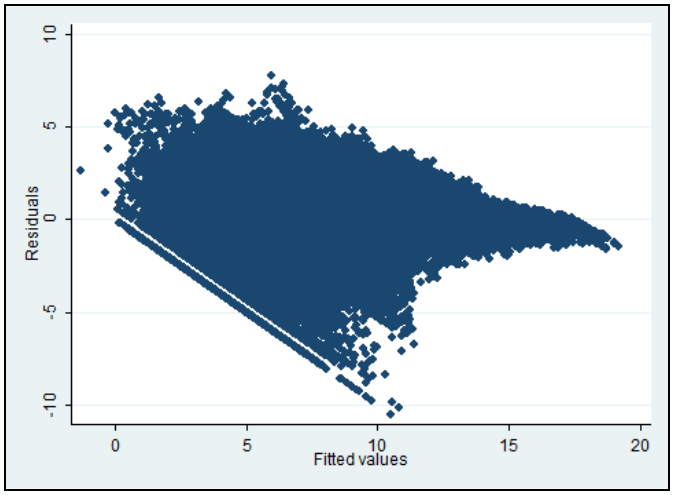



**Graph 15:** Kernel density plot of residuals from OLS estimation

It can be seen that the residuals are sensitive to non-normality in the middle range of the data as well as on the left tail. However, the residuals are close to a normal distribution.

## 4.6 Error correlation - heteroskedasticity

There are Graphical and non-Graphical methods to detect heteroscedasticity of the residuals. One Graphical way to test whether the residuals are heteroskedastic is to plot the residuals against the fitted (predicted) values by using the Stata *rvfplot* postestimation command as it is shown in Graph 16.




**Graph 16:** Residuals plotted against fitted values after OLS regression

If the residual variances were constant and therefore homoskedastic, the dots representing the residual estimates would be spread randomly across the Graph. However, Graph 6 shows clear patterns which indicate that the errors are somehow heteroskedastic. Therefore, further tests are computed. The *estat hettest* Stata command computes the Breusch-Pagan test. Graph 17 shows that this test strongly rejects the hypothesis that the residuals are homoskedastic.

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: lngdpcap_e lnpop_e lngdpcap_i lnpop_i lndistw landlocked_e landlocked_i contig Africa comlang
                    comleg comcol AEcolony50 curcol_e_colony e_indcol comcur rta gatt_both acp_to_eu

         chi2(19)      =  9965.07
         Prob > chi2   =    0.0000
```

**Graph 17:** Breusch-Pagan test on error variances

Another method to test homoskedasticity of the error terms is the White's test, which Stata computes via the *estat imtest* command:

Cameron & Trivedi's decomposition of IM-test

| Source | chi2 | df | p |
|---|---|---|---|
| Heteroskedasticity | 9572.55 | 179 | 0.0000 |
| Skewness | 2102.64 | 19 | 0.0000 |
| Kurtosis | 537.54 | 1 | 0.0000 |
| Total | 12212.73 | 199 | 0.0000 |

**Graph 18:** White's test on error variances

The White's test also strongly rejects the nullhypothesis of constant variance. The outcomes of all three test methods indicate that the error variance is severely heteroskedastic.

## 4.7 Error correlation - autocorrelation

To check for a serial correlation of the errors a first step is to correlate the dependent bilateral trade variable lntrade to its first-order lagged value L1.lntrade.

```
. correlate lnvalue L1.lnvalue
(obs=70620)
```

| | lnvalue | L. lnvalue |
|---|---|---|
| lnvalue | | |
| --. | 1.0000 | |
| L1. | 0.9551 | 1.0000 |

**Graph 19:** First order autocorrelation of trade variable lntrade

The first-order autocorrelation coefficient for lntrade suggests a very strong correlation of the bilateral trade flow value in period t to the bilateral trade flow value of the previous period t-1. This is a first hint that a serial correlation of the error term is quite likely.

To further investigate the serial correlation of the error term, the Stata post-estimation *predict uhat, residuals* command generates a residual variable and the following *forvalues* command leads to a calculation of the error autocorrelation at all lags. Graph 20 reveals that the errors show a very strong serial autocorrelation.

```
. forvalues j = 1/38 {
  2. quietly corr uhat L`j'.uhat
  3. display "Autocorrelation at lag `
  4. }
Autocorrelation at lag 1 =  0.827      Autocorrelation at lag 20 =  0.380
Autocorrelation at lag 2 =  0.772      Autocorrelation at lag 21 =  0.367
Autocorrelation at lag 3 =  0.731      Autocorrelation at lag 22 =  0.356
Autocorrelation at lag 4 =  0.695      Autocorrelation at lag 23 =  0.340
Autocorrelation at lag 5 =  0.663      Autocorrelation at lag 24 =  0.335
Autocorrelation at lag 6 =  0.635      Autocorrelation at lag 25 =  0.325
Autocorrelation at lag 7 =  0.607      Autocorrelation at lag 26 =  0.314
Autocorrelation at lag 8 =  0.579      Autocorrelation at lag 27 =  0.313
Autocorrelation at lag 9 =  0.553      Autocorrelation at lag 28 =  0.303
Autocorrelation at lag 10 =  0.532     Autocorrelation at lag 29 =  0.300
Autocorrelation at lag 11 =  0.504     Autocorrelation at lag 30 =  0.298
Autocorrelation at lag 12 =  0.485     Autocorrelation at lag 31 =  0.293
Autocorrelation at lag 13 =  0.463     Autocorrelation at lag 32 =  0.288
Autocorrelation at lag 14 =  0.450     Autocorrelation at lag 33 =  0.293
Autocorrelation at lag 15 =  0.439     Autocorrelation at lag 34 =  0.285
Autocorrelation at lag 16 =  0.427     Autocorrelation at lag 35 =  0.274
Autocorrelation at lag 17 =  0.414     Autocorrelation at lag 36 =  0.266
Autocorrelation at lag 18 =  0.398     Autocorrelation at lag 37 =  0.240
Autocorrelation at lag 19 =  0.389     Autocorrelation at lag 38 =  0.240
```

**Graph 20:** Autocorrelation of residuals in OLS regression

## 4.8 Error correlation - FE versus RE models

The presence of error correlation determines the suitability of different estimation methods. There are differences regarding the assumptions on the error correlation between fixed effects and random effects models. Both models rely on the individual-specific effects model, which formulates as follows for the dependent variable $y_{it}$:

(19) $y_{it} = \alpha_i + X'_{it}\beta + \varepsilon_{it}$

$\alpha_i$ is to be regarded as the individual-specific part of the error term and $\varepsilon_{it}$ is the idiosyncratic part of the error term. The FE model allows the regressors in $X'_{it}$ to be correlated with the individual-specific error term $\alpha_i$, permitting a limited form of endogeneity. However, $X'_{it}$ is not allowed to be correlated with the idiosyncratic $\varepsilon_{it}$ part of the error. The fixed effects estimator eliminates all time-invariant effects including $\alpha_i$ in the first stage of the regression. The attraction of the FE model is due to its consistent coefficient estimates of the time varying regressors.

In contrast to the FE model, the RE model assumes that both error components $\alpha_i$ and $\varepsilon_{it}$ are uncorrelated with the regressors in $X'_{it}$. The advantage of the RE model is that it yields estimates on all time-variant and time-invariant coefficients. The different assumption on the regressor-error correlation of the two models leads to

the simple rule that the RE model produces inconsistent estimates if the FE model is appropriate.

The Hausman test for fixed effects compares the FE and RE models to decide which one is to be preferred. Under the null hypothesis that $X'_{it}$ is uncorrelated to $\alpha_i$ both RE and FE estimators yield similar coefficient estimates on the time-variant regressors. If this holds, the RE model is to be preferred. Under the alternative RE estimates are inconsistent and the FE model is to be preferred. The Stata *hausman* command implements the conventional Hausman test:

```
. hausman fe re, sigmamore

                 ---- Coefficients ----
                 (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
                  fe           re         Difference          S.E.
-------------------------------------------------------------------------------
  lngdpcap_e    .5357194     .5957547      -.0600352       .0099452
     lnpop_e    .4669615     .7413215        -.27436       .0362742
  lngdpcap_i    .5466971     .5061992        .040498       .0094243
     lnpop_i    .9139021     .7530076       .1608945       .0345866
curcol_e_c~y   -.3221073    -.6099902       .2878829       .0341945
    e_indcol    .1055844    -.2640504       .3696348       .0317776
      comcur    .4234285     .4511771      -.0277486       .0139512
   gatt_both    .0446484     .0387666       .0058818        .006595
         rta    .3293265     .2934528       .0358737       .0080232
  acp_to_eu     .0872852     .0815675       .0057177       .0088083
-------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(10) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                           =     1051.01
                Prob>chi2 =      0.0000
```

**Graph 21:** Hausman test assuming RE estimator is fully efficient under null hypothesis

The Stata output of the Hausman test provides a side-by-side comparison of the FE and RE estimates. For the coefficient of the e_indcol regressor a test of RE against FE yields a t = 0.3696348/0.0317776 = 11.63 difference in the coefficient estimates, which is a statistically highly significant difference. The null hypothesis that the RE provides consistent estimates is strongly rejected since the overall statistic on chi2(10) shows p = 0.0000. It is concluded that the FE estimator is appropriate while the RE estimator delivers inconsistent estimates.

## 4.9 Log vs level bilateral trade flow variable

trade flow value, thousands of current US$

| | Percentiles | Smallest | | |
|---|---|---|---|---|
| 1% | 1 | 1 | | |
| 5% | 5 | 1 | | |
| 10% | 21 | 1 | Obs | 78612 |
| 25% | 301 | 1 | Sum of Wgt. | 78612 |
| 50% | 3294 | | Mean | 326068.6 |
| | | Largest | Std. Dev. | 2081138 |
| 75% | 30958 | 5.09e+07 | | |
| 90% | 274973 | 5.11e+07 | Variance | 4.33e+12 |
| 95% | 965775 | 5.14e+07 | Skewness | 12.53217 |
| 99% | 7862606 | 5.14e+07 | Kurtosis | 198.9928 |

log of trade flow value

| | Percentiles | Smallest | | |
|---|---|---|---|---|
| 1% | 0 | 0 | | |
| 5% | 1.609438 | 0 | | |
| 10% | 3.044523 | 0 | Obs | 78612 |
| 25% | 5.70711 | 0 | Sum of Wgt. | 78612 |
| 50% | 8.099858 | | Mean | 7.978646 |
| | | Largest | Std. Dev. | 3.540646 |
| 75% | 10.34039 | 17.74611 | | |
| 90% | 12.52443 | 17.74887 | Variance | 12.53617 |
| 95% | 13.78069 | 17.75426 | Skewness | -.10572 |
| 99% | 15.87763 | 17.75441 | Kurtosis | 2.731768 |

**Graph 22:** Detailed variable description on trade value in levels and trade value in logs

# 5 Further estimation results

## 5.1 Estimations with indcol, curcol, ACP on African countries' imports

Table 2 in section 4.4.1 presents the coefficient estimates of the entire variable set if the indcol, curcol and ACP dummies turn on for exports. Following Table presents the coefficient estimates for the total variable set when indcol turns 1 for former colonies' imports, curcol turns 1 for colonies' imports from their metropole and ACP turns 1 for African countries' imports from Europe.

| specification<br>method<br>dep. variable | (1)<br>OLS<br>lntrade | (2)<br>PMLE<br>trade | (3)<br>LSDV<br>lntrade | (4)<br>OLS<br>lntrade | (5)<br>PMLE<br>trade | (6)<br>LSDV<br>lntrade |
|---|---|---|---|---|---|---|
| | **MODEL EXCL. TIME DUMMIES** | | | **MODEL INCL. TIME DUMMIES** | | |
| lngdpcap_i | 0.8893***<br>(0.018)<br>0.000 | 0.6675***<br>(0.027)<br>0.000 | 0.5254***<br>(0.016)<br>0.000 | 1.1024***<br>(0.023)<br>0.000 | 0.9429***<br>(0.046)<br>0.000 | 0.6449***<br>(0.023)<br>0.000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| lnpop_i | 0.8709*** | 0.7096*** | 0.5315*** | 0.9092*** | 0.7328*** | 0.8986*** |
| | (0.019) | (0.025) | (0.045) | (0.018) | (0.025) | (0.062) |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| lngdpcap_j | 0.5827*** | 0.4445*** | 0.5550*** | 0.8761*** | 0.7661*** | 0.6606*** |
| | (0.020) | (0.024) | (0.015) | (0.028) | (0.046) | (0.019) |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| lnpop_j | 0.7648*** | 0.7217*** | 0.8439*** | 0.8216*** | 0.7469*** | 1.1596*** |
| | (0.018) | (0.021) | (0.045) | (0.018) | (0.022) | (0.055) |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| lndistw | -0.7789*** | -0.8684*** | | -0.8071*** | -0.8137*** | |
| | (0.048) | (0.045) | | (0.045) | (0.046) | |
| | 0.000 | 0.000 | | 0.000 | 0.000 | |
| landlocked_i | -0.3080*** | -0.5993*** | | -0.2120*** | -0.6450*** | |
| | (0.065) | (0.099) | | (0.064) | (0.100) | |
| | 0.000 | 0.000 | | 0.001 | 0.000 | |
| landlocked_j | -0.7366*** | -0.3253*** | | -0.6544*** | -0.3805*** | |
| | (0.063) | (0.112) | | (0.060) | (0.104) | |
| | 0.000 | 0.004 | | 0.000 | 0.000 | |
| contig | 0.6852*** | 0.2042*** | | 0.6691*** | 0.1461** | |
| | (0.120) | (0.062) | | (0.124) | (0.065) | |
| | 0.000 | 0.001 | | 0.000 | 0.024 | |
| Africa | -0.6309*** | 0.0437 | | 0.1186 | 0.7930*** | |
| | (0.103) | (0.114) | | (0.109) | (0.141) | |
| | 0.000 | 0.701 | | 0.278 | 0.000 | |
| comlang | 0.2493*** | 0.3322*** | | 0.2640*** | 0.3504*** | |
| | (0.073) | (0.068) | | (0.070) | (0.066) | |
| | 0.001 | 0.000 | | 0.000 | 0.000 | |
| comleg | 0.1186** | 0.1133** | | 0.2057*** | 0.1909*** | |
| | (0.059) | (0.047) | | (0.057) | (0.049) | |
| | 0.043 | 0.016 | | 0.000 | 0.000 | |
| comcol | 0.3083*** | -0.2739 | | 0.5759*** | 0.3228* | |
| | (0.117) | (0.170) | | (0.121) | (0.192) | |
| | 0.008 | 0.107 | | 0.000 | 0.093 | |
| **AEcolony50** | **2.0400*** ** | **0.7942*** ** | | **1.8100*** ** | **0.6326*** ** | |
| | **(0.114)** | **(0.146)** | | **(0.120)** | **(0.136)** | |
| | **0.000** | **0.000** | | **0.000** | **0.000** | |
| curcol_e_empire | -0.3742 | -0.0487 | 0.2768 | -0.2674 | -0.0706 | 0.2734 |
| | (1.020) | (0.689) | (0.193) | (1.129) | (0.688) | (0.192) |
| | 0.714 | 0.944 | 0.152 | 0.813 | 0.918 | 0.154 |
| **j_indcol** | **-1.1337*** ** | **-0.9188*** ** | **0.1958*** ** | **-0.8661*** ** | **-0.7589*** ** | **0.1992*** ** |
| | **(0.091)** | **(0.152)** | **(0.069)** | **(0.092)** | **(0.134)** | **(0.069)** |
| | **0.000** | **0.000** | **0.005** | **0.000** | **0.000** | **0.004** |
| comcur | 0.6062*** | 0.1362*** | 0.4121*** | 0.4825*** | 0.2478*** | 0.4596*** |
| | (0.138) | (0.034) | (0.047) | (0.140) | (0.047) | (0.048) |
| | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 | 0.000 |
| GATT_both | 0.0785 | 0.2487** | 0.0439** | 0.1797*** | 0.4672*** | 0.0785*** |
| | (0.052) | (0.110) | (0.021) | (0.052) | (0.106) | (0.021) |
| | 0.134 | 0.024 | 0.036 | 0.001 | 0.000 | 0.000 |
| RTA | 0.0290 | 0.2304*** | 0.3335*** | 0.0612 | 0.2293*** | 0.3748*** |
| | (0.078) | (0.072) | (0.020) | (0.074) | (0.069) | (0.021) |
| | 0.711 | 0.001 | 0.000 | 0.410 | 0.001 | 0.000 |
| eu_to_ACP | 0.4027*** | 0.0400 | 0.1132*** | 0.5662*** | 0.2430** | 0.1504*** |
| | (0.067) | (0.104) | (0.025) | (0.064) | (0.097) | (0.025) |
| | 0.000 | 0.702 | 0.000 | 0.000 | 0.012 | 0.000 |
| Time dummies | NO | NO | NO | YES | YES | YES |
| Observations | 75,975 | 75,975 | 75,975 | 75,975 | 75,975 | 75,975 |
| R-squared | 0.7422 | | 0.8890 | 0.7556 | | 0.8897 |
| rmse | 1.793 | . | 1.203 | 1.746 | . | 1.200 |
| F | 1679 | . | 7434 | 613.7 | . | 1706 |

**Table 12:** Estimation results on the whole set of variables determining postcolonial trade; indcol, curcol and ACP turn 1 for imports; robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Comparing the results of Table 11 with Table 2 presented in 4.4.1 it can be seen that the $R^2$ values of the corresponding models are roughly at the same level. Most of the coefficient estimates are roughly at the same magnitude. However, there are some differences.

Looking at the gravity variables the exporter's monadic effects are slightly higher and the importer' monadic effects are slightly lower in models that measure indcol, curcol and ACP on imports. According to OLS (4) in Table 2 a 1% increase in the exporter's income per capita has a, ceteris paribus, 1.0952% trade-promoting effect while a 1% increase in the importer's per capita income has a, ceteris paribus, 0.9645% trade promoting effect. Turning to the OLS (4) estimation results of Table 11 a 1% increase in the exporters income per capita has a, ceteris paribus, 1.1024% trade promoting effect while a 1% increase in the importer's per capita income has a, ceteris paribus, 0.8761% trade promoting effect.

With regards to the geographic variables, in comparison, the exporters landlockedness has a weaker negative effect and the importers landlockedness has a stronger negative effect when the dummies turn 1 for imports. The Africa dummy shows a less negative effect in the OLS (1) and no more significant effect in the PMLE (1) specifications when indcol, curcol and ACP turn 1 for imports rather than exports. Controlling for time the results are similar.

The estimates of the sociocultural variables comlang and comleg remain sTable regardless of the measurement direction of indcol, curcol and ACP. Common colonizer coefficient estimates presented in Table 2 and Table 11 paint a completely different picture when time dummies are excluded from the regression. When when controlling for time the estimation results are similar. The coefficient estimates on the economic variables common currency, GATT and RTA remain at the same level regardless of the measurement direction of the indcol, curcol and ACP dummies. However, the effect of the African-Caribbean-Pacific trade agreement changes. In the OLS specifications the positive effect reduces when the dummy turns 1 for African countries' imports from Europe. In the PMLE specifications it turns insignificant and in the LSDV specifications it shows only little trade-creating effect.

## 5.2 Indep1 to Indep49 coefficient estimates

Graphs 5 and 6 presented in section 4.4.4 picture the evolution of the independence effect over 49 years. The Graphs base on the coefficient estimates of the independence dummies indep1 to indep49 listed in following Table 13:

| specification<br>method<br>dep. variable | (1)<br>OLS<br>lntrade | (2)<br>PMLE<br>trade | (3)<br>LSDV<br>lntrade | (4)<br>OLS<br>lntrade | (5)<br>PMLE<br>trade | (6)<br>LSDV<br>lntrade |
|---|---|---|---|---|---|---|
| | **INDEP + ACP EFFECTS ON EXPORTS** | | | **INDEP + ACP EFFECTS ON IMPORTS** | | |
| indep1 | 0.3338** | 0.7283*** | 0.2110** | -0.4329*** | -0.3601 | 0.0930 |
| | (0.140) | (0.226) | (0.102) | (0.122) | (0.247) | (0.084) |
| | 0.017 | 0.001 | 0.039 | 0.000 | 0.145 | 0.267 |
| indep2 | 0.0800 | 0.7024*** | 0.1157 | -0.5482*** | -0.2103 | 0.1724*** |
| | (0.112) | (0.189) | (0.083) | (0.101) | (0.158) | (0.066) |
| | 0.474 | 0.000 | 0.163 | 0.000 | 0.182 | 0.009 |
| indep3 | -0.0740 | 0.4368** | 0.0448 | -0.5464*** | -0.2974** | 0.2292*** |
| | (0.113) | (0.177) | (0.081) | (0.100) | (0.147) | (0.064) |
| | 0.512 | 0.014 | 0.580 | 0.000 | 0.043 | 0.000 |
| indep4 | -0.0832 | 0.4762*** | 0.0973 | -0.6091*** | -0.3562** | 0.1978*** |
| | (0.111) | (0.175) | (0.079) | (0.099) | (0.141) | (0.063) |
| | 0.454 | 0.006 | 0.217 | 0.000 | 0.011 | 0.002 |
| indep5 | -0.0702 | 0.5101*** | 0.1037 | -0.6927*** | -0.3193** | 0.1136* |
| | (0.112) | (0.171) | (0.076) | (0.100) | (0.134) | (0.060) |
| | 0.532 | 0.003 | 0.172 | 0.000 | 0.017 | 0.058 |
| indep6 | -0.0642 | 0.4983*** | 0.1893*** | -0.6432*** | -0.2777** | 0.1335** |
| | (0.108) | (0.161) | (0.072) | (0.098) | (0.132) | (0.059) |
| | 0.553 | 0.002 | 0.008 | 0.000 | 0.035 | 0.024 |
| indep7 | -0.0326 | 0.5093*** | 0.1769** | -0.6042*** | -0.3242** | 0.2214*** |
| | (0.108) | (0.164) | (0.071) | (0.096) | (0.128) | (0.058) |
| | 0.763 | 0.002 | 0.013 | 0.000 | 0.012 | 0.000 |
| indep8 | 0.0927 | 0.4405*** | 0.2958*** | -0.7447*** | -0.3538*** | 0.1654*** |
| | (0.105) | (0.163) | (0.069) | (0.097) | (0.131) | (0.058) |
| | 0.377 | 0.007 | 0.000 | 0.000 | 0.007 | 0.004 |
| indep9 | 0.0475 | 0.4441*** | 0.2461*** | -0.6511*** | -0.4020*** | 0.2020*** |
| | (0.108) | (0.164) | (0.068) | (0.098) | (0.126) | (0.057) |
| | 0.659 | 0.007 | 0.000 | 0.000 | 0.001 | 0.000 |
| indep10 | 0.0034 | 0.3890** | 0.2434*** | -0.7565*** | -0.5025*** | 0.1145** |
| | (0.109) | (0.160) | (0.069) | (0.096) | (0.122) | (0.057) |
| | 0.975 | 0.015 | 0.000 | 0.000 | 0.000 | 0.045 |
| indep11 | -0.0550 | 0.3829** | 0.1808*** | -0.7526*** | -0.3661*** | 0.0843 |
| | (0.109) | (0.158) | (0.069) | (0.097) | (0.123) | (0.056) |
| | 0.615 | 0.015 | 0.009 | 0.000 | 0.003 | 0.131 |
| indep12 | 0.0084 | 0.4515*** | 0.2645*** | -0.7150*** | -0.3427*** | 0.1319** |
| | (0.109) | (0.162) | (0.067) | (0.097) | (0.131) | (0.055) |
| | 0.938 | 0.005 | 0.000 | 0.000 | 0.009 | 0.016 |
| indep13 | -0.0839 | 0.4436*** | 0.2177*** | -0.7728*** | -0.2505* | 0.1013* |
| | (0.111) | (0.162) | (0.067) | (0.099) | (0.144) | (0.056) |
| | 0.448 | 0.006 | 0.001 | 0.000 | 0.082 | 0.073 |
| indep14 | -0.2324** | 0.4730*** | 0.1326** | -0.8302*** | -0.4226*** | 0.0343 |
| | (0.111) | (0.169) | (0.067) | (0.097) | (0.127) | (0.055) |
| | 0.036 | 0.005 | 0.049 | 0.000 | 0.001 | 0.536 |
| indep15 | -0.2378** | 0.2814* | 0.0245 | -0.7937*** | -0.2360* | 0.0526 |
| | (0.110) | (0.162) | (0.068) | (0.097) | (0.137) | (0.056) |
| | 0.031 | 0.083 | 0.719 | 0.000 | 0.085 | 0.345 |
| indep16 | -0.1890* | 0.1588 | 0.0470 | -0.8846*** | -0.2652* | -0.0121 |
| | (0.111) | (0.162) | (0.067) | (0.099) | (0.144) | (0.056) |
| | 0.089 | 0.326 | 0.482 | 0.000 | 0.066 | 0.830 |

| | | | | | | |
|---|---|---|---|---|---|---|
| indep17 | -0.3104*** | 0.2160 | 0.0059 | -0.7530*** | -0.2423 | 0.1368** |
| | (0.117) | (0.166) | (0.071) | (0.100) | (0.152) | (0.057) |
| | 0.008 | 0.194 | 0.933 | 0.000 | 0.112 | 0.017 |
| indep18 | -0.3460*** | 0.1909 | 0.0070 | -0.6867*** | -0.3353** | 0.1781*** |
| | (0.118) | (0.165) | (0.071) | (0.100) | (0.140) | (0.057) |
| | 0.003 | 0.246 | 0.921 | 0.000 | 0.017 | 0.002 |
| indep19 | -0.4249*** | 0.2601 | -0.0338 | -0.8283*** | -0.4341*** | 0.0137 |
| | (0.115) | (0.163) | (0.071) | (0.098) | (0.133) | (0.058) |
| | 0.000 | 0.111 | 0.632 | 0.000 | 0.001 | 0.814 |
| indep20 | -0.2200* | 0.3548** | 0.1098 | -0.7913*** | -0.4350*** | 0.0397 |
| | (0.117) | (0.161) | (0.070) | (0.101) | (0.131) | (0.060) |
| | 0.059 | 0.028 | 0.118 | 0.000 | 0.001 | 0.508 |
| indep21 | -0.2891** | 0.1305 | 0.0156 | -0.6980*** | -0.3997*** | 0.1019* |
| | (0.115) | (0.147) | (0.072) | (0.097) | (0.128) | (0.058) |
| | 0.012 | 0.376 | 0.830 | 0.000 | 0.002 | 0.080 |
| indep22 | -0.3830*** | 0.0584 | -0.0208 | -0.7889*** | -0.5455*** | 0.0756 |
| | (0.119) | (0.149) | (0.073) | (0.100) | (0.130) | (0.059) |
| | 0.001 | 0.694 | 0.776 | 0.000 | 0.000 | 0.203 |
| indep24 | -0.1788 | 0.1394 | 0.0318 | -0.9224*** | -0.7192*** | -0.1089* |
| | (0.120) | (0.177) | (0.074) | (0.100) | (0.140) | (0.059) |
| | 0.136 | 0.431 | 0.668 | 0.000 | 0.000 | 0.066 |
| indep25 | -0.1444 | 0.1612 | 0.0702 | -0.8576*** | -0.8148*** | -0.0538 |
| | (0.119) | (0.180) | (0.072) | (0.099) | (0.149) | (0.058) |
| | 0.225 | 0.370 | 0.329 | 0.000 | 0.000 | 0.355 |
| indep26 | -0.1509 | -0.0125 | 0.0281 | -0.9058*** | -0.8082*** | -0.0491 |
| | (0.121) | (0.178) | (0.072) | (0.100) | (0.154) | (0.059) |
| | 0.212 | 0.944 | 0.698 | 0.000 | 0.000 | 0.407 |
| indep27 | -0.1608 | -0.0541 | 0.0276 | -0.9715*** | -0.8404*** | -0.0646 |
| | (0.117) | (0.175) | (0.071) | (0.099) | (0.150) | (0.058) |
| | 0.169 | 0.757 | 0.696 | 0.000 | 0.000 | 0.267 |
| indep28 | -0.2205* | 0.0458 | -0.0286 | -1.0213*** | -0.8786*** | -0.1326** |
| | (0.125) | (0.190) | (0.072) | (0.103) | (0.143) | (0.059) |
| | 0.077 | 0.810 | 0.692 | 0.000 | 0.000 | 0.024 |
| indep29 | -0.1849 | 0.1756 | -0.0209 | -0.9965*** | -0.8588*** | -0.1291** |
| | (0.126) | (0.202) | (0.075) | (0.104) | (0.146) | (0.062) |
| | 0.141 | 0.384 | 0.779 | 0.000 | 0.000 | 0.038 |
| indep30 | -0.2045 | 0.2073 | -0.0454 | -1.0145*** | -0.8182*** | -0.1178* |
| | (0.130) | (0.191) | (0.075) | (0.108) | (0.150) | (0.063) |
| | 0.116 | 0.278 | 0.545 | 0.000 | 0.000 | 0.062 |
| indep31 | -0.0443 | 0.2244 | 0.1145 | -1.0537*** | -0.8271*** | -0.1714*** |
| | (0.128) | (0.187) | (0.076) | (0.106) | (0.149) | (0.064) |
| | 0.730 | 0.229 | 0.132 | 0.000 | 0.000 | 0.007 |
| indep32 | -0.1331 | 0.1523 | 0.0128 | -1.0378*** | -0.8377*** | -0.1989*** |
| | (0.127) | (0.184) | (0.077) | (0.108) | (0.141) | (0.063) |
| | 0.293 | 0.408 | 0.869 | 0.000 | 0.000 | 0.002 |
| indep33 | -0.2164* | 0.1367 | -0.0743 | -1.0534*** | -0.8619*** | -0.1673*** |
| | (0.128) | (0.192) | (0.078) | (0.109) | (0.138) | (0.065) |
| | 0.092 | 0.477 | 0.338 | 0.000 | 0.000 | 0.010 |
| indep34 | -0.0823 | 0.2102 | 0.0249 | -1.0543*** | -0.9894*** | -0.2085*** |
| | (0.133) | (0.191) | (0.077) | (0.111) | (0.131) | (0.066) |
| | 0.537 | 0.271 | 0.747 | 0.000 | 0.000 | 0.002 |
| indep35 | -0.0769 | 0.1195 | 0.0478 | -1.0555*** | -0.9988*** | -0.1728*** |
| | (0.132) | (0.185) | (0.080) | (0.111) | (0.131) | (0.066) |
| | 0.559 | 0.517 | 0.549 | 0.000 | 0.000 | 0.009 |
| indep36 | -0.1283 | 0.1114 | 0.0179 | -1.0402*** | -0.9359*** | -0.1734** |
| | (0.133) | (0.187) | (0.082) | (0.113) | (0.133) | (0.069) |
| | 0.334 | 0.552 | 0.827 | 0.000 | 0.000 | 0.011 |
| indep37 | -0.1108 | 0.1501 | 0.1037 | -0.9426*** | -0.9238*** | -0.0636 |
| | (0.134) | (0.196) | (0.083) | (0.116) | (0.136) | (0.070) |
| | 0.408 | 0.444 | 0.213 | 0.000 | 0.000 | 0.363 |
| indep38 | -0.1372 | 0.2088 | 0.1154 | -0.9860*** | -0.9686*** | -0.0808 |
| | (0.134) | (0.201) | (0.086) | (0.116) | (0.133) | (0.072) |
| | 0.307 | 0.299 | 0.182 | 0.000 | 0.000 | 0.261 |

| | | | | | | |
|---|---|---|---|---|---|---|
| indep39 | -0.0385 | 0.2233 | 0.1338 | -0.8246*** | -0.8044*** | 0.0872 |
| | (0.139) | (0.217) | (0.093) | (0.121) | (0.133) | (0.076) |
| | 0.782 | 0.304 | 0.149 | 0.000 | 0.000 | 0.253 |
| indep40 | -0.1707 | 0.2269 | 0.0460 | -0.7662*** | -0.8408*** | 0.1479* |
| | (0.142) | (0.209) | (0.095) | (0.121) | (0.136) | (0.081) |
| | 0.229 | 0.278 | 0.627 | 0.000 | 0.000 | 0.067 |
| indep41 | 0.0089 | 0.1454 | 0.1740 | -0.5908*** | -0.9281*** | 0.1632 |
| | (0.165) | (0.213) | (0.110) | (0.144) | (0.145) | (0.101) |
| | 0.957 | 0.494 | 0.113 | 0.000 | 0.000 | 0.106 |
| indep42 | -0.0551 | 0.0329 | 0.0491 | -0.4854*** | -0.7989*** | 0.1977** |
| | (0.159) | (0.227) | (0.115) | (0.148) | (0.130) | (0.099) |
| | 0.730 | 0.885 | 0.668 | 0.001 | 0.000 | 0.046 |
| indep43 | 0.0983 | 0.1552 | 0.1758 | -0.4080*** | -0.7501*** | 0.1495 |
| | (0.164) | (0.227) | (0.117) | (0.152) | (0.137) | (0.110) |
| | 0.548 | 0.494 | 0.134 | 0.007 | 0.000 | 0.175 |
| indep44 | -0.0945 | 0.0907 | 0.0550 | -0.4902*** | -0.8661*** | 0.0841 |
| | (0.178) | (0.261) | (0.125) | (0.164) | (0.141) | (0.114) |
| | 0.595 | 0.728 | 0.660 | 0.003 | 0.000 | 0.461 |
| indep45 | 0.0470 | 0.8608*** | 0.2657 | -1.2823*** | -0.8785*** | -0.4001** |
| | (0.453) | (0.305) | (0.400) | (0.359) | (0.215) | (0.181) |
| | 0.917 | 0.005 | 0.506 | 0.000 | 0.000 | 0.027 |
| indep46 | -0.2069 | 0.6437** | 0.6535* | -1.0783*** | -0.8985*** | -0.2527 |
| | (0.333) | (0.303) | (0.334) | (0.367) | (0.221) | (0.225) |
| | 0.535 | 0.033 | 0.051 | 0.003 | 0.000 | 0.262 |
| indep47 | -0.3789 | 0.4571 | -0.0142 | -1.1440*** | -0.9778*** | -0.3108* |
| | (0.411) | (0.313) | (0.345) | (0.309) | (0.214) | (0.181) |
| | 0.357 | 0.145 | 0.967 | 0.000 | 0.000 | 0.085 |
| indep48 | -0.2522 | 0.6676** | -0.0575 | -1.3172*** | -1.0637*** | -0.6260*** |
| | (0.427) | (0.304) | (0.349) | (0.320) | (0.239) | (0.207) |
| | 0.555 | 0.028 | 0.869 | 0.000 | 0.000 | 0.003 |
| indep49 | -0.0824 | 0.9445*** | 0.3222 | -1.9294*** | -1.3432*** | -1.0538*** |
| | (0.499) | (0.316) | (0.320) | (0.452) | (0.239) | (0.288) |
| | 0.869 | 0.003 | | 0.000 | 0.000 | 0.000 |
| time dummies | YES | YES | YES | YES | YES | YES |
| oth. var. | YES | YES | YES | YES | YES | YES |
| Observations | 75,975 | 75,975 | 75,975 | 75,975 | 75,975 | 75,975 |
| R-squared | 0.7528 | | 0.8898 | 0.7556 | | 0.8899 |
| rmse | 1.757 | | 1.199 | 1.747 | | 1.199 |
| F | 342.8 | | 874.3 | 344.9 | | 865.0 |

**Table 13:** Coefficient estimates underlying Graph 5 and 6 analyzing the independence effect on former colonies' exports and imports over time; robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; all specifications control for time dummies and the total set of other variables presented in Table 2