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Impact of the international trade agreements between the EU and African countries

Bachelor's Thesis

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Declaration

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3. I fully agree to my work being used for study and scientific purposes.

In Prague on 3.5.2023

Tomáš Svoboda

References

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Abstract

The international trade policy between the EU and African developing countries covers the negotiations of various agreements aiming to promote mutual trade flows. The goal seems to both exploit the economic potential and support local development, including poverty or inequality reduction. To gain the maximum utilization of the benefits of trade, agreements need to be optimized and set toward the right degree of integration. Therefore, this paper provides the ex-post analysis of trade agreements concluded during the period 1948-2021 to evaluate their impact on mutual trade volume. The Fixed effects and the Poisson pseudo maximum likelihood estimation methods are used in combination with two sets of dummy variables.

The results reveal the negative impact of the EU-African agreements across all depth levels in comparison to the general arrangements. Furthermore, the African continent shows a relative trade reduction among agreements containing too few and too many integration ratios emphasizing the necessity of finding the right balance. Disaggregating the effect into the African regions, West Africa seems to be the worst-performing area thus far. Finally, we have found strong evidence of trade diversion questioning the positive welfare of African nations. According to our findings, the renegotiation of several current agreements is advised to prevent undesirable results.

Abstrakt

Politika mezinárodního obchodu mezi Evropskou Unií a rozvojovými africkými zeměmi obsahuje vyjednávání mnoha dohod, které mají zvýšit vzájemné obchodní toky. Jejich cílem je jak využít možný ekonomický potenciál, tak i podpořit místní rozvoj včetně zmírnění chudoby a společenské nerovnosti. Pro maximální využití benefitů z obchodu, tyto dohody musí být optimalizovány a správně vyváženy. Proto tato práce provádí jejich ex-post analýzu za období 1948-2021. Pro odhady používáme metodu Fixních efektů a PPML v kombinaci s dvěma soubory binárních proměnných.

Výsledky ukazují negativní dopady dohod mezi EU a africkými zeměmi napříč všemi stupni integrace v porovnání se standardem. Afrika obecně navíc nese známky relativního úbytku obchodu také na velmi slabých a silných dohodách, což zdůrazňuje nutnost najít správnou míru integrace. Při rozložení efektu na jednotlivé regiony, nejhůře reaguje

Západní Afrika. Na závěr jsme také ukázali silný efekt obchodní diverze, který může omezit pozitivní dopady na africké země. Z našich výsledků plyne, že některé aktuální dohody je potřeba aktualizovat a správně vyvážit.

Keywords

International trade, FTA, custom union, gravity model, Africa, EU

Klíčová slova

Mezinárodní obchod, dohoda o volném obchodu, celní unie, gravitační model, Afrika, EU

Title

Impact of the international trade agreements between the EU and African countries

Název práce

Dopady obchodních dohod mezi EU a africkými zeměmi

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Contents

Introduction

In recent years, the African continent has emerged as an increasingly important trading partner for many countries around the world. Based on the UNCTAD, the African domestic market accounts for 2.9% of world production and 2.6% of world trade although almost 16.3% of the world population inhabits the continent, which opens significant opportunities of the domestic market. Moreover, Africa suffers from poverty, inequality, unemployment, and many other undesirable welfare indicators that can be positively affected by an increased amount of trade (Winters, McCulloch, and McKay, 2004).

After the protectionism era in the 1930s, the world has gradually begun to open up to international trade by reducing trade barriers. One of the methods seems to be entering the free trade agreements (FTA) or customs unions (CU) that intend to reduce policy-controlled barriers to enhance the flow of goods, services, capital, labor, etc (Baier *et al.*, 2008). Hence, many agreements have been negotiated between the EU and African nations during the recent decades that aim to deepen interconnectedness as well as support African development.

Access to a detailed analysis of the effects of trade policies is, therefore, important to policy-makers and other stakeholders during the decision-making process. The ex-post analysis of trade volume change resulting from agreement enforcement can enlighten possible drawbacks and areas for improvement as well as find pairs of countries where mutual trade should be promoted.

This thesis provides an extensive ex-post analysis of the trade agreements between the EU and African countries covering the period 1948-2021. Four research questions are defined indicating the impact of these treaties on mutual trade flows, the general impact of African agreements, the disaggregation of changes in trade into five African regions, and, last but not least, the presence of the trade creation and diversion effect. Therefore, it can be specified how the international trade policy of the EU toward developing African nations is fulfilled and whether anything should be renegotiated.

To estimate the impact, we use the Gravity model of trade, which is a common tool for trade evaluation across literature. Results from two different estimation methods, Fixed effects and PPML, are then presented as well as two different sets of dummy variable fixed effects approximating the multilateral resistance term. Furthermore, the overview of possible sources of bias is summarized to conclude with the correct

derivation of the final gravity equation. In addition, several depths of integration among the agreements are distinguished to measure the optimal settlement.

This thesis is organized as follows. The first chapter describes in detail the theoretical background of the Gravity model with the standard modeling errors, Chapter 2 summarizes existing literature regarding international trade history, trade agreements, trade creation & diversion, and African agreements specifications. Chapter 3 follows with the overview of current EU policies toward respective African regions backed by historical context. Proceeding with the practical part, the fourth chapter reveals the data preparation and definitions of individual variables used for the estimation, Chapter 5 connects the practical model with the theoretical background and provides the complete methodology. Finally, Chapter 6 presents the results gained from sixteen different models of estimation and the Conclusion finalizes this paper.

1. Gravity model

This chapter aims to introduce the gravity model – a work-horse for analyzing international trade, which is going to be frequently used in this thesis. After exploring the historical context and evolution of the model, the theoretical background together with the derivation of a general and structural equation is discussed. The third section focuses on an overview of the current methodology used for coefficient estimation linked to the theoretical part. A description of the standard processional mistakes made when building a model and the way how they should be addressed follows in the fourth section. The chapter ends by putting the model into the context of other methodologies evaluating trade policies.

1.1 Historical context

The original inspiration for the model dates back to July 5, 1687, when the law of universal gravitation was first published by Isaac Newton. His equation demonstrates a force acting *F* between any two points of mass which increases with their growing sizes *m1, m2* and decreases with the squared distances *r* of their centers, accompanied by the gravitational constant *G*.

$$F = G\frac{m_1 m_2}{r^2} \tag{1}$$

Inspired by the law of physics, authors started to notice similarities also in other fields of science. The first application of this kind was suggested by Ravenstein (1889) in his paper Law of migration, who investigated the gravitational interaction between migration trends of the 19th century. In the 1960s, searching for this pattern expanded into economics as well when researchers discovered an analogy of the gravitational laws in the behavior of subjects engaged in international trade. More specifically, they observed a positive impact on trade with the growing size of economies and a negative one with their mutual distance. This effect was first economically described by Tinbergen (1962) followed by several less influential papers, e.g. Pöyhönen (1963). All of them were connected by the concept that all nations place their goods on the common market which is then consumed based on mutual shares of world GDP. Even though the relationship seems to be extraordinarily stable and explains the trade flows relatively well, it was still accepted only as an empirical tool outside of the international trade mainstream.

The first microeconomic background was provided by Anderson (1979). His work seems to be formally correct, however, it was considered to be rather complex with somewhat limited assumptions (Bacchetta et al., 2012). He assumed that goods are imperfect substitutes produced by a specific country of origin while consumers have preferences defined over all products no matter the price, so-called the Armington assumption (Armington, 1969). The utility of consumers was then derived as a sum of the imported quantity of unique goods from each country multiplied by an index measuring the quality of its products, adjusted by constant elasticity. In any case, his results lay the foundation for further development and the later arrival of trade resistance. His gravity equation is stated as follows

$$M_{ijk} = \alpha_k Y_i^{\beta_k} Y_j^{\gamma_k} N_j^{\xi_k} N_j^{\varepsilon_k} d_{ij}^{\mu k} U_{ijk} \tag{2}$$

where M_{ijk} is a value of good k from country i to j, Y_i and Y_j stand for income in countries i and j respectively, N_i and N_j are the respective populations, d_{ij} is the distance between the pair of countries and finally, U_{ijk} represents the lognormally distributed error term.

Another theoretical model made by Bergstrand (1985) followed, where an old-trade connection between bilateral trade and factor endowment, the Hecksher-Olihn model, was made. However, it contains a very complicated price term that almost disabled empirical usage. Bergstrand (1989) reworked his initial contribution by adding a connection to the new theory and link to the recent Helpman-Krugman model (Helpman and Krugman, 1985), however, the price indices were kept without any change. In these models, differentiated goods are traded because consumers prefer variety rather than applying the previous Armington assumption.

The influential turnover in gravity model perception came in 1995 when the missing trade concept was introduced by Trefler (1995). Since the core theory models, e.g. Hecksher-Olihn, predict significantly higher trade flows than empirically observed, Trefler accredits this difference to “home bias”. Even though the reasoning by distance, national borders, and many others was appended even later, the idea to include trade impediments was emphasized. It turned out that the gravity model can explain this missing trade relatively well.

A highly important concept of the multilateral-trade-resistance term (MRT) was popularized mainly by Anderson and van Wincoop (2003) which is considered to bring

the originally weak microeconomic background to completeness. Instead of using the absolute costs, they emphasized the relative trade costs as a determinant of bilateral trade and incorporated the propensity of country *i* to export to country *j* concerning its overall resistance to exports, the other way around respectively. Moreover, using the expenditure system, the authors derived a practical way of estimation using cross-sectional data. This model as well as Eaton and Kortum (2002) helped to move toward the estimation methods based on a model structure which later allowed using the fixed effects. Theoretical equation

$$X_{ij} = \frac{Y_i Y_j}{Y} \left(\frac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma} \tag{3}$$

where X_{ij} denotes the trade flows between country *i* and *j*, Y stands for the world GDP, Y_i and Y_j indicate the GDP of the country *i* and *j* respectively, t_{ij} evaluates costs to import goods from *i* to *j*, Π_i and P_j indicate the MRTs in form of ease to market access and finally, σ is the elasticity of substitution.

Baldwin and Taglioni (2006) made another significant contribution by clarifying of three most common mistakes in previous research – gold, silver, and bronze medal errors. These errors are going to be discussed in detail in the next section. Furthermore, they managed to extend the previous model also for panel data usage.

The latest crucial movement of the gravity model was made in 2008 by three studies - Chaney (2008), Helpman et al. (2008), and Melitz and Ottaviano (2008). Interconnecting of the bilateral trade flows and the emerging heterogeneous firm theory influenced both estimation and interpretation of the gravity equation as well as its sophistication acknowledgment. Therefore, the gravity model evolved from empirical observation of similarities between physics and international trade into one of the most influential and broadly respected tools for analyzing, among others, international policies.

1.2 Microeconomic background

The model has come a long way before being used for core research mainly accompanied by the permanent building of microeconomic theory. Understanding the theoretical background is thus a necessary condition for correct and precise estimations. This section aims to provide a derivation of the structural gravity equation with respect to the microeconomic fundamentals. It is mainly based on a paper published by Baldwin and Taglioni (2006), who managed to simplify the previous equation from Anderson and

van Wincoop (2003) and extended it for panel data application. All the way along, we assume the market-clearing condition for an exporter and the spatial allocation of expenditures for an importing country. The derivation is accomplished in seven steps.

a) The expenditure share identity

Let us assume two countries, domestic *d* and origin *o*, where the value of goods flowing from *o* to *d* is measured. The process begins with the equation describing a domestic country's share of expenditures, one can imagine a "pie" that needs to be allocated, on a single-unit imported good from an origin exporter.

$$p_{od}x_{od} = share_{od}E_d \tag{4}$$

where x_{od} is the unit-good quantity of bilateral exports from country of origin *o* to domestic country *d*, p_{od} is the price of that good on the domestic market, E_d represents expenditures of the domestic country on tradable goods and $share_{od}$ stands for a share of these expenditures on a typical good variety of origin nation.

b) The expenditure function

The *share* variable of the previous equation can be further extended by deflating with a domestic country's price index to express the prices relatively.

$$share_{od} = \left(\frac{p_{od}}{P_d}\right)^{1-\sigma} \text{, where } P_d = \left(\sum_{k=1}^{R} n_k (p_{kd})^{1-\sigma}\right)^{1/1-\sigma}, \sigma > 0 \tag{5}$$

where $\frac{p_{od}}{P_d}$ expresses the relative real price, *R* is a number of countries the domestic nation imports from including the nation itself, n_k stands for a number of varieties of goods imported from *k*, and σ is the elasticity of substitution among possible symmetric varieties.

c) Adding the pass-through equation

The next equation refers to how the domestic price is calculated based on the original manufactured price. We assume the Dixit-Stiglitz monopolistic competition condition, therefore, the markup is, for simplicity, equal to 1.

$$p_{od} = \mu p_o \tau_{od} \tag{6}$$

where μ is the unit bilateral markup, p_o is a price of a good in the origin country and finally, τ_{od} are all costs of trade.

d) Aggregating across individual goods

By multiplying expenditures on a symmetric variety of goods by an amount that an origin country can offer, we obtain the total value V_{od} of bilateral trade from an origin nation to a domestic one.

$$V_{od} = n_o(p_o\tau_{od})^{1-\sigma} \frac{E_d}{P_d^{1-\sigma}} \tag{7}$$

e) General equilibrium in the exporting nation

Assuming the market clearing condition, an origin country has to sell its products either internationally or in its own domestic market. Therefore, the nation's total output is given as a sum of its all exports $Y_o = \sum_{d=1}^{R} V_{od}$. Using this relationship in the equation (7), we obtain

$$Y_o = n_o p_o^{1-\sigma} \sum_{d=1}^{R} (\tau_{od}^{1-\sigma} \frac{E_d}{P_d^{1-\sigma}}) \tag{8}$$

After solving for $n_o p_o^{1-\sigma}$, we get the following equation

$$n_o p_o^{1-\sigma} = \frac{Y_o}{\Omega_o} \qquad \text{, where } \Omega_o = \sum_{i=1}^{R} (\tau_{oi}^{1-\sigma} \frac{E_i}{P_i^{1-\sigma}}) \tag{9}$$

f) A first-pass gravity equation

Combining equations (9) and (7), we obtain the pre-version of gravity equation predicted also by Anderson and van Wincoop (2003) based on the microeconomic theory.

$$V_{od} = \tau_{od}^{1-\sigma} (\frac{Y_o E_d}{\Omega_o P_d^{1-\sigma}}) \tag{10}$$

Although Anderson and van Wincoop (2003) continue with further steps specifically only for cross-sectional data, this is probably the most relevant methodology for deriving the core of the gravitational equations. The important part is the variables *Ω* and *P* which refer to MRT usually labeled as openness of the world to nation's exports and openness of nation's imports from the world, respectively. The importance of this term refers to the fact that bilateral cost of trade between two countries are quantified relatively to costs with other countries. For instance, the MRT explains why there is a difference in bilateral trade flows between Australia and New Zealand surrounded by the Pacific Ocean, and similar pair of countries located next to other trading partners, e.g. Netherlands and Belgium. Assuming this factor being non-linear and dependent on other countries, it cannot be simply cut out and has to be approximated by a number of auxiliary variables.

Secondly, a different expression of the very basic and general gravity equation mentioned by Head and Mayer (2014) can be written as follows

$$X_{ij} = GS_i M_j \phi_{ij} \tag{11}$$

where X_{ij} is the standard bilateral trade value, S_i represents the capabilities of an exporting country i to supply its products, M_j describes a market condition related to trade promotion in a domestic importing country, φ_{ij} stands for the mutual accessibility mainly linked to trade costs and its respective elasticities and G is a gravitational constant.

One can notice the conceptual similarity between the two described equations. The reason is that they both capture the very basic theoretical core of the gravity model which is then extended by various authors in many different ways. Head and Mayer provide two categories of demand-side derivations, represented e.g. by Anderson (1979) or Bergstrand (1985) , and supply-side, e.g. Eaton and Kortum (2002) or Chaney (2008).

1.3 Estimation methods

This section provides an overview of estimating methods based on the previously deriver microeconomic theory. The obvious purpose in general is to find unbiased and consistent estimators of a desired explanatory variable while controlling for other variables which could affect bilateral trade values. Considering that both derived gravity equations are in a multiplicative form, it seems quite intuitive to take their natural logarithm which is then further proceeded more easily. Let us first use this method on the general gravity equation previously described by Head and Mayer (2014) obtaining a sum of natural logarithmic terms.

$$lnX_{ij} = lnG + lnS_i + lnM_j + ln\phi_{ij} \tag{12}$$

Furthermore, the same procedure can be used also on Anderson's and van Wincoop's (2003) structural gravity equation, simplified by Baldwin and Taglioni (2006) for better illustration, from the previous section

$$lnV_{od} = a_1 + a_2 lnY_o + a_3 lnE_d + a_4 ln\tau_{od} + a_5 ln\Omega_o + a_6 lnP_d + \varepsilon_{\mathrm{od}} \tag{13}$$

where a_1 is a constant, a_4=a_6=1-σ, and ε_{od} denotes the error term. Having the correct estimates, the coefficients in this form are simply interpreted as a percentage change of bilateral trade value while increasing the respective independent variable by one percent.

The first estimation method established by Tinbergen (1962) used simple OLS, however, it turned out this methodology produces biased results. Looking at the structural equation, the reason is very straightforward. It contains the MRT expressed as the variables Ω and P which cannot be observed in the real world since they are mostly interpreted as a nation's ability to export or import, respectively. Omitting and leaving them into the error term causes inconsistency, later described as the gold medal error, which is why they need to be treated differently. We provide several solutions aspiring to estimate the resistance term.

Going chronologically, the first attempts to approach the resistance terms resulted in a variable called "remoteness". There are several different variations introduced by researchers. For instance, Wei (1996) defined the resistance term as "log(GDP) – weighted average distance" and Helliwell (1998) came out with the formulations $REM1_n = \sum_i \frac{Dist_{ni}}{Y_i}$ and $REM2_n = (\sum_i \frac{Y_i}{Dist_{ni}})^{-1}$. However, neither of these variables was strongly underpinned by theory and, in case of the later, was problematic, e.g. disproportional evaluation of countries based on size. The most precise general expression of remoteness has shape

$$REM_i = (\sum_j \frac{dist_{ij}}{GDP_j / GDP_w}) \tag{14}$$

where $dist_{ij}$ is a distance between nations i and j, and GDP_w indicates the world global GDP (Bacchetta et al., 2012). Although even this equation is not theoretically correct, i.e. ignores other resistance factors than distance, it was often used by researchers and even further improved by Baier and Bergstrand (2009) who managed to create a non-linear equation with the remoteness term using the Taylor expansion.

The second approach, which is going to be used in this thesis, employs fixed effect estimation. The advantage of this method lies mainly in the relatively small amount of structural assumptions necessary for consistent results. The basic idea of the most influential kind of usage stated by Anderson and van Wincoop (2004) is to involve a dummy variable for exporting and importing countries to capture their specific fixed characteristics affecting exports or imports. The practical general logarithmic equation after controlling for countries' fixed effects thus looks like

$$lnX_{ij} = a_0 + a_1 I_i + a_2 I_j + a_3 lnt_{ij} + \varepsilon_{ij} \tag{15}$$

where I_j represents a country-specific dummy variable equals to 1 if it is a country j and 0 otherwise, I_i is a respective dummy for country i and lnt_{ij} stands for a logarithm of trade costs between these two countries. Moreover, the effects should be time-varying once we have panel data spanning over several time periods or industries. The solution is, therefore, adding a time dummy variable into the equation and extending it for respective periods.

$$lnX_{ijt} = a_0 + a_1 I_{it} + a_2 I_{jt} + a_3 lnt_{ijt} + a_4 I_t + u_{ijt} \tag{16}$$

where I_t denotes the time dummy variable, t is a specific time period, and I_{it}, I_{jt} are the country-specific fixed effects extended to vary across time. Since the time dummy is equal to 1 for its given period and 0 otherwise, we need to include exactly t-1 of these variables.

Finally, using the fixed effect method has its limitation mainly for larger data sets which is why, among other things, there are a few other methods of estimation. One of them is the original approach suggested by Anderson and van Wincoop (2003) which, however, uses the non-linear least squares method and is thus not broadly used anymore. This process is even further improved by Head and Mayer (2014) who constructed the iterated structural estimation called SILS. Other standard methods include Bonus Vetus OSL introduced by Baier and Bergstrand (2009), which attempts to linearize the model once again, or the Ratio-type estimation, however, diving into their content is outside the scope of this thesis.

1.4 Modeling errors

The fourth section of this chapter is devoted to exploring the most typical errors faced in the gravity model. We begin by addressing the most often mistake made by researchers across studies – so-called "medal errors", then the zero-variable issue is going to be explained, and finally, analyzing the FTA dummy can entail the endogeneity issue in our equation which needs to be taken care of.

1.4.1 Medals

One of the most common mistakes in Gravity model estimation is the "medal errors" defined by Baldwin and Taglioni (2006). The authors emphasize gold, silver, and bronze mistakes as potential reasons for bias and inconsistency as well as the solution of how to face them.

Beginning with the gold error, it is due to wrong dealing with the MRT included in the equation which then causes omitted variable error. To see the explanation more clearly, let us follow up on the previous structural gravity equation (10) while assuming the only determinant of trade costs is a mutual distance and proxying a nation's expenditures by its total product.

$$\underset{trade}{bilateral} = G\frac{Y_1 Y_2}{(dist_{12})^{elasticity-1}}, \text{ where } G = \frac{1}{\Omega_o}\frac{1}{P_d^{1-elasticity}} \quad (17)$$

Since the variable τ_{od} representing the cost of trade is included both in the gravity equation in form of distance and the resistance terms Ω and P, simply based on their definition, the estimates must be biased if the MRTs are not treated well. This is going to happen because of the correlation between the error term and the explanatory variable causing endogeneity. The element G denotes rather gravitational un-constant in our equation. There are two standard methods for dealing with this error - using country dummies, reaching 1 for a particular nation and zero otherwise, or pair dummies, reaching 1 for a given pair or countries and 0 otherwise (standard fixed effects). If being time-invariant, both of these methods are able to remove most of the bias, the cross-sectional part in particular. However, our policy variable will most likely be correlated with trade costs in different time periods, which can be mitigated by including also the time-varying version.

The silver medal error results from the wrong averaging of a dependent variable. Assuming a pair of countries, a standard way of measuring their bilateral trade is to take an average of both exports and both imports reported. The issue appears once the average of logarithms is taken rather than the logarithm of the averages. Moreover, the larger difference between a nation's exports and imports, so-called less balanced trade, the more serious the always positive bias is inducing coefficients to be overestimated. We can simply handle this issue by carefully averaging the bilateral trade variable, or avoiding averaging at all.

Finally, the bronze medal error is caused by incorrect deflation of trade flows. Considering the value of trade and the GDP proxies are measured in nominal values, they need to be deflated for further comparison. This is commonly done using the US dollar price index captured in this equation

$$\frac{V_{od}}{P_{USA}} = \tau_{od}^{1-\sigma} \left(\frac{GDP_o}{P_o^{GDP}} * \frac{GDP_d}{P_d^{GDP}}\right) \left\{\frac{P_d^{GDP}}{P_d^{1-\sigma}} * \frac{P_o^{GDP}}{\Omega_o} * \frac{1}{P_{USA}}\right\}, \text{ where} \qquad \tau_{od} = f(dist_{od}, other)$$

(18)

where $dist_{od}$ is a mutual distance between nations o and d, P_{USA} stands for the USA price index and P^{GDP} is a GDP deflator of a given nation. This procedure, however, will most likely result in estimates being biased caused by serial correlation. Standard correction is then incorporating time dummy variables into the equation.

To conclude, it is clear how to avoid the silver and bronze errors in our equation, the main challenge thus remains correct minimizing of the gold error bias.

1.4.2 Zero trade

Even though the theory behind the gravity equation indicates rather strictly positive values of trade, one can empirically see some countries do not trade with each other at all or only in one way in reality. This is especially clear once assuming disaggregated data for individual industries or even firms. This phenomenon raises an important question of how to handle zero trade values between pairs of countries undefined in a logarithmic gravity equation. There are overall three commonly used solutions trying to reduce a bias to a minimum. The first option is to trim these values off and simply treat them as a statistical error which solves the technicality, however, can eliminate important information these values are carrying. Therefore, this can be done only in a case when zero trade arises randomly as, for example, missing data or rounding errors. Recognizing the purpose of zero values may seem rather difficult, however, removing the structurally meaningful values would lead to inconsistent results.

Secondly, these zeros are even more often completely intentionally arisen as a consequence of, e.g., a nation's international policy or insignificance of trade partners leading to intentional trade omission carrying meaningful information. Other solutions thus can be adding a small constant to trade values before taking the logarithm or working with levels of trade rather than individual values. These methods, however, cannot be used together with OLS, where produce inconsistent estimators and need non-traditional handling. Researchers can employ the Tobit model, although it is being often questioned for the wrong explanation of missing trade issues and distorting the final interpretation (Bacchetta et al., 2012). By far more accurate is using the Poisson pseudo maximum likelihood estimator (PPML) for estimating the levels of trade mentioned in the third

method which is the most sufficient approach for this thesis. It works with the non-linear form of the gravity equation and, as Silva and Tenreyro (2006) suggest, even creates heteroskedasticity-robust estimates often desired for international trade data.

1.4.3 Endogeneity

At the very beginning of the gravity model evolution, researchers had assumed the FTA dummy variable to be exogeneous. As this assumption did not seem completely realistic, attempts to correct for this fact started to emerge, for example Trefler (1993) noticed the simultaneous determination of non-tariff barriers and imports in the US, Lee, and Swagel (1997) brought out the underestimation of the trade liberalization effect, or Magee (2003) showed that two similar-in-size democratic countries with already significant trade flows have higher probability of signing a trade agreement. However, all these papers used cross-sectional data with instrumental variables challenging the endogeneity.

On the other hand, Baier and Bergstrand (2007) suggest that rather panel data with country-and-time effects give the most plausible estimates, while disputing the previously used instrumental variables for the lack of them. They identified three causes of endogeneity – omitted variables, simultaneity, and measurement error. Considering the existence of factors affecting both trade volume and the likelihood of signing FTA, e.g. country's relative size or distance, the most crucial omitted variable bias is caused by those determinants that are unobservable, for example, some policy-related trade barriers. Hence, the correlation between those factors hidden in an error term and the FTA dummy variable may yield a bias. The authors claim that using panel data with fixed effects or first differencing is supposed to solve this issue. Secondly, simultaneity arises when dependent bilateral trade flows affect the explanatory dummy variable FTA, e.g. when lower trade flows than "natural" make governments sign FTA to promote it. The potential simultaneity bias, as well as measurement error bias, are, however, not a concern of this thesis since panel data from the official sources are used. To emphasize the necessity to correct for endogeneity, Baier and Bergstrand (2007) estimated the most likely downward bias of 75-85% caused by this issue – the real impact of an FTA thus erroneously seems to be lower if not corrected for endogeneity.

1.5 Other methodologies for trade analysis

We are going to conclude this chapter with an overview of other frequently used methodologies evaluating international trade policies to set the gravity equation into context. Sorting can be done using several categories, depending on whether we are interested in descriptive statistics or modeling, econometrics estimation or simulations, or ex-post or ex-ante analysis. Different procedures overlap in their scope of use, however, choosing the right combination of methods is crucial for the correctness of estimates and is done based on the research intention and question asked. This overview is inspired by Bacchetta et al. (2012).

The first category seeks to quantify several trade parameters allowing to trace consequences of particular policies by measuring comparison among different subjects or across-time evolution. These are indices describing a trade performance of a country by analyzing what, where, or how much it trades. The "what" indices focus mainly on a structure of trade with respect to a county's ability to produce given output by its natural or technical endowment, e.g. export diversification, revealed comparative advantage, or intra-industry trade. The "where" question is a direct link to the gravity model since it explores the country's trading partners and their suitability for welfare maximization. There are indices appearing in the gravity equation, e.g. geographical layout, common language and history, or infrastructure, in this group. Thirdly, the "how much" represents indices evaluating a country's trade openness and its integration into global chains, e.g. trade over GDP, the import content of exports, or offshoring. Moreover, there various indices providing a direct measurement of tariffs and non-tariff policies expressing mainly the country's overall restrictiveness. Concerning tariffs, a few metrics are trying to analyze the national distribution of tax burdens and find the most effective one, for instance, tariff profile, dispersion, or effective protection and tariff escalation. On the other hand, restrictions of trade caused by non-tariff measures can be empirically quantified by, for example, price gaps.

Another section contains partial and general equilibrium model families, which seem to be the currently most suitable tool for predicting the ex-ante consequences of trade policies using simulations. These models are mainly used for estimating the effects of considered trade policies, attempting to support or refute their future enforcement. The general equilibrium (GE) model is specified by its ability to capture linkages through the whole economy, and specifying constraints on production factors. The computable GE is

characterized by searching for the linkages in the economy, circular flow, and optimal behavior across all agents involved, e.g. households, government, or firms. On the other hand, the partial equilibrium model (PE) allows capturing the disaggregated effects and complicated mechanisms while requiring less-demanding timely data, for instance, the SMART model, or the Global simulation analysis of the industry-level trade policy model (GSIM) presented and simplified by Jammes and Olarreaga (2005). However, a choice between these two approaches highly depends on the research question.

Since the previous models capture mainly the trade effects on a country as a whole, this family of models attempts to analyze the distributional effects of policies, which means how these policies affect particular segments of the population. For example, lowering the tariffs and thus opening a country for higher trade activity can help export-oriented sectors while worsening the conditions in import-oriented ones. Therefore, these models tend to explore how inequality and poverty are influenced while changing trade policies, e.g., General equilibrium transmission of tariff changes suggested by Winters (2002), or the Simple model linking trade policy to household welfare by Porto (2005, 2006).

Finally, the specific statistical method for cause and effect evaluation of various policies called Synthetic Control Method (SCM) has been developed by Abadie and Gardeazabal (2003) and Abadie, Diamond and Hainmueller (2010). The main principle of this method is to take a weighted average of control groups for a comparison to a treatment group to answer a question what would have happened if a particular policy would/would not have been implemented (Abadie, 2021). In our case of FTAs, this method can be used for evaluating impacts of an FTA while comparing to weighted average of other countries that has not signed the treaty.

In conclusion, this thesis employed the gravity model estimation due to its correlation with research intention. Analysis of the impacts of the EU-Africa free trade agreements requires the ex-post econometrical evaluation of the benefits or losses of these two parties. In other words, we intend to analyze whether the EU is a suitable natural trading partner for African countries, given all the external parameters supporting or disturbing trade flows, and the other way around. Hence, this positive suitability would be expressed in form of an increase in mutual trade volume once barriers are removed indicating mutual enrichment provided all the control variables of the gravity equation.

2. Literature review

The second chapter of this thesis is dedicated to reviewing the current literature mainly connected with trade agreements. The first section introduces these agreements and their definition as well as their basic division. The second part focuses on a historical perspective of both the agreements and trade itself in form of the evolution of global economic integration. The third section specifies the key concepts for total welfare analysis – trade creation and diversion. Finally, the last part approaches the differences in trade agreement's effects signed by African countries accompanied by several local trading blocks overview.

2.1 Trade agreements

As the world becomes more and more globalized and interconnected, governments look for opportunities to engage in agreements to promote the nation's international trade. Before going deeper, several types of these agreements often appear in literature and thus need to be defined to understand correctly[1]. WTO denotes the Free trade agreement (FTA) as a treaty between two or more countries where trade barriers are completely or partially abolished while keeping its own tariffs on imports from non-members. On the other hand, the Customs union (CU) differs from FTA by applying common external tariffs on non-members. Preferential trade agreements (PTA) are understood by WTO as unilateral treaties offered by, usually developed, countries to promote their imports from particular partner nations by lowering their trade barriers. Finally, Regional trade agreements (RTA) are defined as reciprocal trade agreements between two or more partners that attempt to liberalize tariffs and services and contain FTAs and CUs. The very concept of regionalization is defined by WTO as any trade agreement that involves two or more countries but fewer than all members.

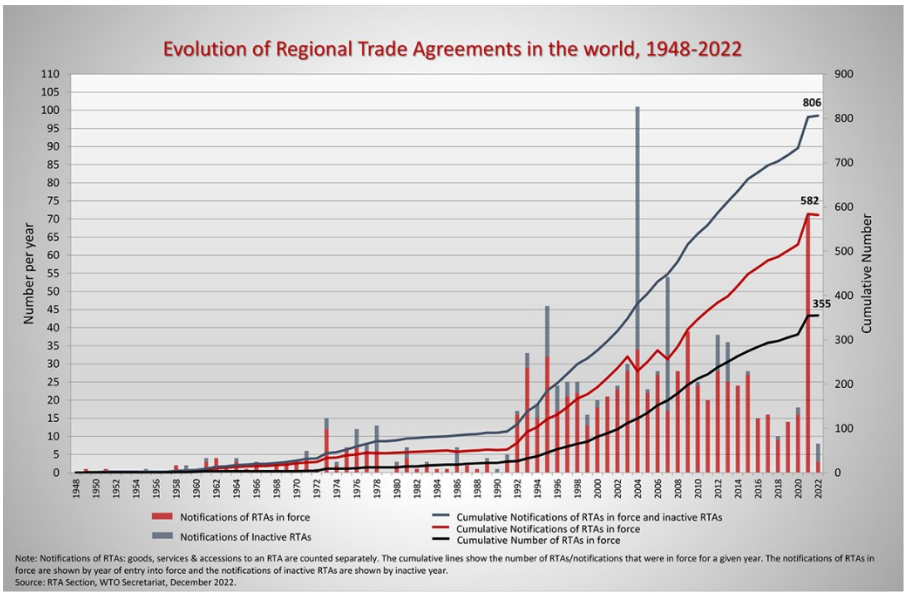
Furthermore, there are several criteria according to which these agreements can be divided. Firstly, WTO distinguishes unilateral and reciprocal agreements, the latter can be further extended to bilateral and multilateral based on a number of countries involved. Unilateral agreements are specific by lowering trade barriers but only in one direction, e.g. opening the developed markets to developing countries by lowering tariffs. Reciprocal agreements tend to liberalize trade on both sides between a pair of countries, several independent countries, or even the regions and economic unions. Secondly,

[1] The definitions taken over from the original GATT agreement (GATT, 1947)

agreements can be divided based on their relationship with non-members countries. While FTAs allow countries to keep their policies toward non-members countries, CUs require to undertake a common importing policy for all members. Another division can be done based on product scope, whether an agreement focuses on all or almost all parts of an economy or only particular sectors. To conclude, these agreements mutually overlap in scope and their understanding differs across various sources, therefore, the rate of economic integration they express is far more important.

Regional trade agreements in general have experienced steep growth since the mid-20th century following the former colonial trade. The following graph presents data indicating the increasing trend of trade liberalization and trade barriers reduction across the globe. That naturally rises questions of how the agreements became so widespread, what else should be considered for total welfare measuring and why is it efficient to sign this agreement at all. Figure 1 made by WTO (2022) covers the amount of RTAs per year worldwide across the whole time interval used for the estimation.

Figure 1 - Evolution of RTAs in the world



2.2 History of trade agreements

Although it cannot be spoken about officially written contracts until the beginning of the 18th century, a complete history of trade milestones is provided for better context and relevance since unofficial preferential treatment accompanied trade itself throughout history. Bernstein (2008) claims that trade has bound mankind since ancient times. First sources from Mesopotamia and the Indus Valley in Fertile Crescent date back to around

3000 BC, with Sumerians exploiting their water systems and the Persian Gulf. Around 2500 BC, the trade center moved to Egypt and the Red sea later followed by the Phoenicians. It did not take long for Egyptians to explore further, there is evidence about trade in the Indian Ocean since 2300 BC. As soon as the power shifted in favor of Greece and Persia, most of the trade took place in the Mediterranean, Aegean, and Black sea. Hence, the last centuries BC carry mostly the sign of trade between Greek city-states, Phoenicians routes through the Mediterranean, or the trading system in the Macedonian empire.

The important progress brought the Silk route that emerged around 130 BC under the Han dynasty. Rather than a single route, it expressed a trade connection between China and Europe, mainly the Romans at its origins, for both goods and ideas[2]. After the collapse of the Roman empire, the trade center in the Indian Ocean was highly controlled by Muslims, who established a system of both naval and overland routes mainly with India, Canton, or Malacca (present-day China and Malaysia). Later followed by the domination of China led by the Ming dynasty, this region kept close for Europeans until Vasco de Gama's voyage around the Cape of Good Hope in 1498 (Ravenstein and Sa, 2016). The 16th-century trade was strongly controlled by the Portuguese and Spaniards, who divided the world and their sphere of influence in half by the Tordesillas line – the Portuguese possessed the Indian Ocean while the Spaniards started to occupy the newly discovered lands of America by Columbus in 1492 (Quaglioni, 2018).

After the Dutch Revolt against Spain started in 1568, the Dutch colonies were slowly getting their independence and began the path to world power (Fitzmaurice, 2017). Next to the new modern agriculture or financial systems creating the nation's domination, the Dutch East India Company (VOC) was established in 1602. The VOC, highly supported by the government, possessed the trade monopoly in the Indian Ocean and the right to conclude local treaties[3], build forts and maintain armed forces. During the 17th century, the company completely seized several territories in present-day Indonesia and created a world monopoly on nutmeg and cinnamon (Loth, 1995). As the taste of consumers changed from luxury spices to tea, coffee, and cotton, the Netherlands and VOC were

[2] This connection shall be understood as an indirect chain of trading settlements transferring goods rather than merchants and ambassadors at its beginnings

[3] Enforced trade agreements governed by VOC's army force that are very different from modern bilateral treaties as FTAs

later replaced by England and the English East India Company (EIC), respectively, as world-trade leaders.

The first official bilateral trade agreement was the Methuen Treaty signed between England and Portugal in 1703. Portugal committed to importing English textiles without any tax charged while England did to importing Portuguese wine charging no higher tariffs than for those from France. Cardoso (2017) believes this treaty caused a substantial Portugal's dependency on England as well as contributed to England setting the path toward the Industrial Revolution. Another milestone meant the Cobden-Chevalier Treaty, the FTA signed between England and France in 1860. It reduced tariffs on several goods on both sides, e.g. French wine and brandy, or English coal and iron, and prefigured the following policy of Britain toward freer trade (Bairoch and Burke, 1989). Furthermore, Timini (2022) estimated the treaty to have a large, positive, and significant effect on trade flows.

On the wave of the Industrial Revolution, the global technology center of steel was slowly moved to the US at the beginning of the 20th century. The originally protectionist policy toward the US manufacturing sector switched to agriculture during the 1920s, which made congress react by implementing the Smooth-Hawley tariff act in 1930 targeting the entire tariff schedule (Irwin, 2017). Further raising of already high tariffs resulted in a wave of protectionism across Europe even worsening the consequences of the Great Depression, which is seen to be one of the pivotal causes of WWII (Madsen, 2001). The Imperial Preference signed in 1932 is also worth mentioning since it was a British response to the protectionist policies by implementing mutual tariff reductions throughout the Commonwealth.

After WWII comes the era of modern trade agreements, which mainly differ in their unification under common rules so that nations are requested to take other nations' welfare into account once signing an agreement. Before the war, the world found itself in strict protectionism and cold relations, accompanied by financial chaos resulting from the Great Depression, which is believed to be one of the main causes of the war (Bernstein, 2008). The turnover came in July 1944, when representatives of 44 nations signed the Bretton Woods agreement to create a new monetary system. The traditional gold standard used by most of the countries was replaced by establishing the US dollar as a world-leading currency, to which other nations redeemed their own currencies under a fixed exchange rate. This system was meant to stabilize the disorganized post-war financial

system (Cesarano, 2006). Another crucial result was the foundation of two new institutions – the International Monetary Fund (IMF), which maintains the financial stability and supervises exchange rates, and the World Bank, which funded the post-war reconstruction of Europe and reduces poverty. The third and last organization discussed to control international trade, the International Trade Organization (ITO), was later rejected by the US Congress for loss-of-sovereignty concerns and had to be compensated by a relatively weaker General Agreement on Tariffs and Trade (GATT). The system collapsed in 1971 under Nixon, when the US gold supply was no longer able to cover dollars in circulation (Lamoreaux and Shapiro, 2019).

The GATT treaty was signed in October 1947 by 23 countries with the main goal to boost economic prosperity by minimizing barriers to international trade. The crucial part of the agreement was the Most Favored Nation clause, under which should be all contracting parties treated equally without discrimination, and new trade concessions mutually agreed upon. Despite this equality, Article XXIV allowed nations to engage in voluntary and precisely defined FTAs or CUs. This was mainly promoted by Great Britain, which wanted to sacrifice the advantage of the Imperial preference only in exchange for gaining access to other important markets (Hudec, 1990). An important exception related to developing countries meant the Enabling clause signed in 1979 during the Tokyo Round, which enabled discrimination in engaging in trade agreements with developing nations and giving them preferential treatment, therefore, violating the Most Favored Nation clause (Park and Park, 2011). The clause is less strict than article XXIV since countries are not obliged to eliminate trade barriers to substantially all trade. However, Rajapatirana (1995) does not recommend using the Enabling treaty for the maximization of trade creation and minimization of trade diversion. The GATT meant the main international treaty supervising the creation of various trade agreements among nations until its replacement by the World trade organization (WTO) in 1995.

Carpenter (2009) marks further trade agreement evolution as 3 waves of regionalism. The first wave refers to the period after the GATT signature till 1986. A significant event was the formation of the European Coal and Steal Community (ECSC) in 1952 by the treaty of Paris, which tried to prevent any more conflicts between France and Germany through an economic collaboration of 6 countries. While the ESCS later came into the European Economic Community (EEC), renamed to European Community (EC) afterward, in 1958 through the Treaty of Rome, another economic block was formed as a

counterweight – the European Free Trade Association (EFTA). However, the EFTA turned out to be less successful than EC, therefore, all but two countries later joined the EC, which Baldwin (1993) explains by the domino theory of regionalism. Even though the EC did not comply with article XXIV of the GATT for its absence of the agricultural sector in tariff reductions, the matter of security made other states acknowledge it. The EC was later expanded and deepened multiple times, beginning with the accession of the UK, Ireland, and Denmark in 1973 and Greece in 1981.

There were also a couple of agreements built by developing countries, many of them affected by the upcoming decolonization movement. One of the most important is the Association of Southeast Asian Nations (ASEAN) signed in 1967 by five Asian countries, even though the trade policy will be added later. Concerning Latin America, several economic units were formed as well, for instance, the Central American Common Market (CACM) in 1961, the Andean Community in 1969, or Caribbean Community and Common Market (CARICOM) in 1973.

The second wave brought another enlargement of the EC when Portugal and Spain joined in 1986. Moreover, the project of a Single European Market for goods, services, capital, and labor was finalized in 1993, which resulted in the signing of the Maastricht Treaty and thus the establishment of the European Union (EU). The closer cooperation led to the response of the rest of the world in fear of less both pursuing GATT and openness by European nations. Hence, the US and Canada created the Canada-United States Free Trade Agreement (CUSFTA) in 1987, which turned into the North American Free Trade Agreement (NAFTA) in 1994 when Mexico joined. In Latin America, many bilateral agreements were discussed and an even larger custom union was created in 1991 by Brazil, Argentina, Uruguay, and Paraguay – MERCOSUR. The Asian countries reacted by establishing the Asia-Pacific Economic Cooperation (APEC) in 1989 and expansion of the ASEAN by free trade area in 1992. Finally, the second wave launched the Uruguay Round negotiations of GATT, which resulted in forming the World Trade Organization (WTO) in 1995 (Carpenter, 2009).

The third wave of regionalism follows after finishing the Uruguay Round and contains both establishing new agreements and extensions and the deepening of actual ones. Despite the withdrawal of the UK in 2020, the EU has grown to overall 27 members with Austria, Finland, and Sweden in 1995, the Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovakia, and Slovenia in 2004, Romania and

Bulgaria in 2007, and finally, Croatia in 2013. The trade liberalizing policy toward freer trade has been set also by China relatively recently as an instrument to integrate into the global economy and strengthen economic cooperation with other nations. China has begun negotiations of 24 FTAs, among which 16 are already in force including the influential China-ASEAN FTA (Chin and Stubbs, 2011). Moreover, the free trade zones around key ports and coastal areas have been created to facilitate foreign investment and further development.

2.3 Trade creation & diversion

There are various different concepts affecting total welfare from signing an FTA to consider, for instance, Limao (2006) models other than trade motives for signing an RTA, total welfare affecting Theory of Second-Best, or the welfare of consumers, e.g. product diversification, and quality, however, we stick to the trade creation and trade diversion concepts for their widespread usage and estimation suitability. Evaluation of a trade agreement's total welfare thus cannot be done without considering trade creation and diversion effects, which were first explained by Viner (1950) in his book The custom union issue. Trade creation represents the increased trade between member countries of the same trading block following the formation or expansion of this block. Hence, it reveals the size and magnitude of welfare positive effects that ensued from higher trade volume brought by trade barriers reduction while shifting consumption from higher-cost producers to lower-cost ones. In other words, forming a trading block, e.g. FTA or CU, decreases trade barriers between member countries and thus creates trade that would not have existed otherwise. On the other hand, trade diversion describes the decrease in trade between member and non-member countries after trade block formation. Even though there might exist a non-member country that produces some particular good relatively cheaply, a member country can prefer to import from other members, despite their higher relative prices, since these differences are erased by trade barriers reduction caused by trade block membership. Therefore, the trade blocks can divert trade away from more efficient producers outside the block and toward less efficient ones inside, which can cause serious welfare reduction mainly to consumers.

Quantifying the total welfare impact is rather ambiguous and depends on the magnitude of these two effects. Many scholars have designed a method for estimating these effects, however the most suitable for our thesis is Bacchetta et al. (2012) who

suggest that the estimation of ex-post trade creation and diversion can be accomplished using specific dummy variables inside the gravity equation. Let us be interested in the trade impacts caused by forming FTA between countries *i* and *j* where country *k* does not belong. Moreover, let us denote dummies *BothinFTA=1* if both countries in a pair are part of the FTA, and OneinFTA=1 if only the importer belongs to the FTA while the exporter does not. Then the augmented gravity equation

$$lnX_{ijt} = \beta_0 + \beta_1 I_{it} + \beta_2 I_{jt} + \beta_3 \ln(dist_{ij}) + \beta_4 cont_{ij} + \beta_5 lang_{ij} + \beta_6 ccol_{ij} + \beta_7 col_{ij} + \beta_8 landlock_{ij} + \beta_9 OneinFTA_{ijt} + \beta_{10} BothinFTA_{ijt} + \varepsilon_{ijt} \quad (19)$$

where I_{it} and I_{jt} are importer's and exporter's time-varying individual effects, $dist_{ij}$ is a mutual distance, $cont_{ij}$, $lang_{ij}$, $ccol_{ij}$, col_{ij}, $landlock_{ij}$ are respectively dummy variables for common borders, common language, common colonizer, one being colony of the other, being a landlocked country, and finally, ε_{ijt} represents an error term. Hence, trade creation arises when country *i* imports more from both *j* and *k* after FTA is signed, which means β_9 and β_{10} are positive and significant. Trade diversion is likely when a country *i* imports more from *j* and less from *k*, which is represented by positive and significant β_9 and negative significant β_{10}.

2.4 African agreements

Special attention is devoted to the RTAs forming among African countries. The most important agreements are the Economic Community of West African States (ECOWAS) signed in 1975, the Southern African Development Community (SADC) in 1992, the Common Market for Eastern and Southern Africa (COMESA), the West African Economic and Monetary Union (WAEMU), the Economic and Monetary Community of Central Africa (CEMAC) all signed in 1994, and finally, the East African Community (EAC) in 1999 (Candau, Guepie, and Schlick, 2019). There are also many other agreements signed in Africa, including the predecessors of the above-mentioned ones, one can generally observe a trend of building economic blocks according to the geographical parts of the continent. The most recent agreement from 2019 is worth mentioning as well – the African Continental Free Trade Area. This economic cooperation aims to unite all African countries into the biggest common continental market in the world, currently containing 55 countries.

Furthermore, Candau, Guepie, and Schlick (2019) examine the impact of RTAs on bilateral trade in Africa during 1955-2014. They found a strong overall effect on trade, however, decreasing over time. The overview of the total trade creation gained from RTAs per every African country during 1955-2014 can be found in Appendix 1.

Considering the impact of RTAs signed by African countries, Candau, Guepie, and Schlick (2019) also claim the resulting trade creation to be strong between 1955 and 1990. However, they showed almost no trade creation coming from the FTAs between 1990 and 2014 explained by the heterogeneity of both agreements and nations, which thus bear no effect. Moreover, the authors suggest that the hypothesis of Rodrik (2018), that FTAs are more about behind-the-border policies, e.g. investments or regulations, than the actual trade, does not hold for Africa. Also, Kohl, Brakman, and Garretsen (2016) claim that RTAs containing additional provisions often occurring in Africa, for instance, capital mobility, or regulation of labor and competition, significantly reduce trade. Neglecting to use the random effects estimation method, which seems less likely econometrically correct, Carrere (2004) found a strong positive effect of RTAs on African trade. Finally, Admassu (2020) argues that the performance of reciprocal agreements in Africa is higher relative to the non-reciprocal ones.

3. EU-Africa trade agreements

The third chapter summarizes the general trade relationship between African and European nations. Beginning with a brief historical overview in the first section, a successive summary of agreements is then presented. The second section divides the African continent into five geographical areas and regions for further exploration. Following sub-sections analyze current trade agreements between the EU and countries of that region, as well as a brief trade structure and statistics insight.

3.1 History of EU-Africa trade

Trade relations between Europe and Africa date back to the 5th century when camels started to be used for the trans-Saharan transfer of gold. These contacts between African rulers and mainly Arabic traders created links through the Mediterranean area, Western Asia, and the Indian Ocean, however, were later withheld for Europeans (Bortolot, 2003). It took until the 15th century when European sailors undertook discovery sea voyages around Africa and established contact with coastal settlements trading mostly ivory and gold in exchange for glasses and manufactured products. Bathily (1994) states that this relationship had been mutually beneficial until the advent of the European industrial revolution and a need for slaves, e.g. for trans-Atlantic sugar plantations, which lasted almost 400 years.

In 1884-1885, spreading colonialism led the world powers of that time, for instance, France, Britain, Germany, or Netherlands, to the Berlin Conference where the African continent was divided into spheres of influence. Building the narrow specialization of export-based cash crops and other primary production for the colonialist purpose predetermined difficulties in African countries' integration into the modern trading system (Gilpin and Gilpin, 2001). The division can be seen in Appendix 2.

The first modern adjustment of this trade relationship came in 1963 when the Yaoundé convention was signed, covering trade, financial and technical cooperation. The Associated African States and Madagascar[4] (AASM) - 18 former French, Belgian, and

[4] Burundi, the Federal Republic of Cameroon, the Central African Republic, the Republic of Chad, the Republic of the Congo, the Democratic Republic of the Congo, the Republic of Dahomey (current Benin), the Gabon Republic, the Republic of the Ivory Coast, the Republic of Madagascar, the Republic of Mali, the Islamic Republic of Mauritania, the Republic of Niger, the Republic of Rwanda, the Republic of Senegal, the Republic of Somalia, the Republic of Togo, the Republic of the Upper Volta (current Burkina Faso).

Italian colonies - were involved in creating an FTA with the EEC nations, that allowed them to export to the European Common Market, which was newly created by the Treaty of Rome in 1957. Whiteman (2012) emphasizes the importance of the part insisting that the interests of African countries should be taken into account for the first time. Moreover, African nations first participated in the Kennedy Round of Negotiations under GATT in 1964-1967, discussing trade relations toward them. However, it did not stand in their favor, e.g. unacceptable restrictions against textiles or tropical products, and thus caused protests leading to a non-reciprocal trade scheme establishment in 1968 (Oloruntoba, 2016). This scheme allowed exporting on the European market duty-free. The Yaoundé II agreement followed in 1970 and set further modifications on typical African products exported, e.g. cocoa, coffee, or bananas.

In 1971, the Generalized Scheme of Preferences (GSP) was first introduced. Since the preferential treatment of African countries is inconsistent with the Most Favored Nation principle of the GATT, the GSP is an exception for trade with developing countries. Extending its validity permanently by the Enabling clause in 1979, the GSP has been in force until now allowing developing countries to export without restrictions while protecting their products against the world market prices. The special arrangement for the least developed nations is the Everything But Arms (EBA) agreement providing duty and quota-free access to the European market for all products but arms and ammunition. With the UK joining the EEC in 1973, the former treaty is extended to developing countries from the African, Caribbean, and Pacific (ACP) regions leading to the Lomé Convention in 1975. The Lomé Convention, set in force till 2000, opened the EC market for all ACP countries in a non-reciprocal way allowing them to export duty-free and granting stronger market access. However, there was also some criticism that it actually empowers African economies, for instance, Sindzingre (2008) suggests that the treaty forced them to specialize in exporting raw materials which cannot bring sustainable development.

The Cotonou Agreement between the EU and 78 ACP countries was signed in 2000 as a successor of the previous Lomé convention. Bradley and Bradley (2010) summarize its main objectives to be ensuring security, promoting a stable and democratic political environment, eradicating poverty, and integrating the ACP into the world economy. The Cotonou Agreement also managed to transfer non-reciprocal trade preferences into reciprocal free trade agreements in combination with development-oriented Economic Partnership Agreements (EPA) (Faber and Orbie, 2009). These agreements are managed

reciprocally, however, ACP imports are usually protected by barriers in sensitive industries and control mechanisms. This asymmetrical bias is further obliged to be eliminated within a reasonable period (EU, 2000). Assuming to come into force for all regions in 2008, only the CARIFORUM EPA with the Caribbean nations was concluded, adding EPAs with other regions later or not even yet. Since the Cotonou treaty was due to expire in 2020, a new successor Post-Cotonou Agreement was negotiated on 15 April 2021, which currently waits on approval by all parties to enter into force. Wider topics are added into a concern of the agreements, for example, environment, sustainability, and human rights.

3.2 Trade agreements by regions

In this section, a closer exploration of the current trade agreements between the EU and African states is accomplished based on data from the European Commission. We used the division of the African continent into five sub-regions according to the United Nations (UN) – Western, Southern, Northern, Eastern, and Central Africa. For greater clarity, an overview of these regions rather than individual countries is going to be presented, as well as the impact per region later in the practical part taken into account. The following figure captures the division.

Figure 2 - UN division of African regions

3.2.1 Northern Africa

The northern Africa region contains countries Algeria, Egypt, Libya, Marocco, Sudan, Tunisia, and Western Sahara. Except for Sudan and Western Sahara, their geographical location bordering the Mediterranean Sea unites them, as well as a few other Middle Eastern nations, under the Southern Neighborhood. Hence, these countries are targeted by the European neighborhood policy (ENP) launched in 2004 which aims to bring stability, security, and prosperity to the closest regions. The policy has been lately upgraded into a renewed partnership with the Southern neighborhood in 2021, containing also the EU Trade Policy Review proposing a new investment initiative. Concerning the financial support of the nations, the EU has adopted a new strategy called the Neighborhood, Development, and International Cooperation Instrument (NDICI) for the years 2021-2027. Furthermore, the EU also cooperates with the influential Agadir Agreement joining Egypt, Tunisia, Marocco, and Jordan into the FTA in 2006, extended by Lebanon and Palestine in 2020.

The framework regulating the general relationship including trade conditions between the EU and Algeria was signed in 2002 in the EU-Algeria Association Agreement, which came into force later in 2005. The agreement aimed to liberalize mutual trade reciprocally. The important movement came in 2020 by creating the EU-Algeria FTA that abolished all tariffs except a few Algerian ones. Concerning the trade statistics, Algeria is the 28th biggest trading partner for the EU representing 0.7% of total trade in goods in 2020, the EU is Algeria's first partner with 46.7% in 2019. Algeria exports mainly fuel and mining products, on the other hand, the EU exports especially transport equipment.

The trade relationship between the EU and Egypt is handled by the EU-Egypt Association Agreement creating an FTA in 2004. Another enlargement came in 2010 focusing mainly on agriculture, and fisheries products. In 2013, a discussion about deepening the current FTA into a Deep and Comprehensive Free Trade Area (DCFTA) was conducted, however, ended up on hold. Egypt represents 0.7% of the EU's trade as the 29th largest partner in 2020 exporting mainly fuel and mining products, EU does 24.5% of Egypt's trade as the biggest partner covering mainly machinery and transport equipment.

Trade with Marocco has been mediated through the EU-Marocco Association Agreement signed in 1996 and entered into force in 2000. That was later deepened by the Agreement on additional liberalization of trade in agricultural products in 2012.

Moreover, the (DCFTA) was discussed in 2013, however, has been on hold up till now. In 2019, the Association Agreement was extended also to products originating in Western Sahara. Marocco is the 20th largest trading partner of the EU covering 1% of total trade in 2020, the EU is Moroccan biggest partner reaching 56% of trade, exporting mostly electrical machinery and transport equipment in both directions.

The EU-Tunisia Association Agreement signed in 1995 and came into force in 1998 regulates trade between these two subjects, creating an FTA with the arrangement of progressively opening the agriculture and fisheries markets. After a dispute settlement mechanism protocol came into force in 2011, the negotiations of DCFTA were launched later in 2015 to better integrate Tunisia into the EU common market. However, it was put on hold same as in previous cases. Tunisia is the EU's 35th largest partner with a 0.5% share in 2020 exporting mainly machinery and transport equipment, the EU is the biggest partner of Tunisia with 57.9% and the same dominated exports.

Trade between the EU and Libya is not adjusted by any agreement at the moment. Although there have been negotiations since 2008, they had to be suspended in 2011 due to local political instability. Libya stands as the 47th largest partner of the EU in 2020 with exports dominated by fuel and mining products, the EU does as the biggest partner covering 51% of trade with the same leading exported product.

Finally, the trade relationship with Sudan is currently modified only through the Everything But Arms agreement (EBA) designated for the least developed countries, however, the country usually does not comply with quality standards to export to the EU. Hence, the trade flows are minor with Sudan exporting mainly crude materials or animals, and importing machinery or transport equipment. Negotiations for the EPA as a part of Eastern and Southern Africa (ESA) have been stalled without further resumption.

In 2021, the EU retroactively evaluated the Euro-Mediterranean Association Agreements containing the Algerian, Egyptian, Moroccan, and Tunisian ones (European Commission *et al.*, 2021). The result showed the agreements have delivered their objectives, including a positive effect on trade, GDP, welfare, social indicators, consumers, and workers in both areas. Even though fewer new market access opportunities than expected were created, the growth of diversification and economic complexity is essential. In conclusion, these FTAs are evaluated as satisfactory in terms of achieving the objectives and playing an important role in the intra-Mediterranean trade.

The evaluation methodology is in accordance with the Better Regulation Toolbox (European Commission, 2021).

3.2.2 Western Africa

Western Africa region consists of Benin, Burkina Faso, Cape Verde, Cote d'Ivoire (Ivory Coast), The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Saint Helena, Ascension, Tristan de Cunha, Senegal, Sierra Leone, and Togo. Beginning with the islands Saint Helena, Ascension, and Tristan de Cunha, there are no trade agreements with the EU discussed or a significant trade volume. The 16 remaining countries are for policy-making purposes collectively referred to as West Africa and their connection with the EU is conducted both on an individual level and through the ECOWAS and WAEMU organizations, which unite 15 and 8 of them into regional economic blocks, respectively. West Africa is the largest trading partner in Sub-Saharan Africa for the EU with mutual trade flows reaching more than $47 million in 2020, as well as the most important investment destination. On the other hand, the EU absorbs 20% of West Africa's exports and 22% of its imports, exporting mainly fuels and machinery and importing oil, gas, and food products.

Trade between West Africa and the EU is treated by the reciprocal Economic Partnership Agreement (EPA) negotiated in 2014, however, it has still not been ratified and come into effect. The agreement aims to leverage trade and investment for sustainable development mostly through improving competitiveness, export performance, or industrialization of the West African countries. The core of the EPA is based on the Cotonou and later post-Cotonou principles carrying the pro-development approach, but also controlling mechanisms for achieving maximum positive benefit.

The exception is two countries that have already ratified their trade agreements in the so-called "stepping stone" EPAs. The Interim EPA between the EU and Ghana was concluded in 2016 and gives free access to the EU's market, emphasizing growth through trade, investment, and employment. The main objective for further development lies mainly in importing Ghana's agricultural products in exchange for equipment supporting growth. The second Interim EPA has been signed between the EU and Ivory Coast since 2016, bearing almost identical elements as the previous one. These agreements are only temporary and expected to be replaced once the EU-West Africa EPA will be accomplished.

In 2019, the impact study on the Interim agreements was made by the EU focusing primarily on how the ambient West Africa region is affected by the trade flow change. Even though the agreements allow both Ghana and Ivory Coast to use EU-origin products as a part of their own exports, the results show that the impact on intra-regional trade in certain products is relatively small and the trade volume with the adjacent countries remains almost the same. Moreover, the overall trade creation effect for Ivory Coast is estimated to be 2.5% (worth 3 million $US) across the ECOWAS countries, and trade diversion reaches 1.7%, generally affecting mainly Burkina Faso and Mali. Considering Ghana, the trade creation effect is about 3% (800 000 $US) accompanied by an even larger 4.7% diversion, influencing mainly its biggest trading partners Burkina Faso, Niger, and Togo.

3.2.3 Central Africa

The Central Africa region includes Angola, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of the Congo, Equatorial Guinea, Gabon, and Sao Tome and Principe. Keeping the agreement with Angola aside for the Southern Africa section since it officially requested to join SADC, the remaining countries are collectively denoted by the EU as the Central Africa region regulated by the EPA policy, similar to the Western African nations. Negotiations of the comprehensive EU-Central Africa EPA began in 2003, however, has been suspended in 2011 without any renewal so far and waits for approvals by all countries involved. The structure of Central Africa's trade with the EU mainly consists of oil, copper, fruits, or diamonds exported, and machinery, mechanical appliances, or pharmaceutical products imported.

Considering the individual nations, Chad, the Central African Republic, the DRC, and Sao Tome and Principe are part of the EU's program Everything but Arms scheme (EBA), which allows them to export to the EU market avoiding tariffs and quotas. Moreover, Congo exploits the Generalized scheme of preferences (GSP) removing the import duties for its exports into the EU market since 2008 as well. Since the GSP is meant only for vulnerable developing countries, Gabon and Equatorial Guinea are not eligible anymore according to the World Bank, and, therefore, remain without any formal trade benefits. Finally, Angola has requested to join the SADC EPA in 2020 analyzed in the South African section, as well as signed the EU-Angola Sustainable Investment Facilitation Agreement (SIFA) concluded in 2022, attempting to attract and expand sustainable investments between both parties.

Cameroon is currently the only Central African nation disposing of an Interim EPA signed in 2007 and then ratified in 2014 by all parties. While the EU common market is fully open for Cameroon's products, gradually removing duties and quotas over 15 years for 80% of imports is obliged by Cameroon in the opposite way, which takes into account the differences in the level of development. The main aims are enhancing market access, supply chain opportunities, access to imported intermediary goods, a platform for dialogue, and legal certainty. The agreement is a so-called "stepping stone" which allows both parties to adjust by adding, for instance, other services or investments. However, this treaty is only a temporary step toward deeper integration of the whole Central African region in a form of the mentioned EPA. In general, 48% of Cameroon's exports go to the EU, and 28% of imports came from. Finally, the impacts of this agreement have not been formally evaluated yet and thus its efficiency can be questioned.

3.2.4 Southern Africa

The Southern Africa region comprises Botswana, Eswatini, Lesotho, Namibia, and South Africa. With Mozambique in addition, these nations are members of the Southern African Development Community (SADC) whose trade relationship with the EU is currently governed by a regional EPA signed and ratified in 2016. Moreover, the process of accepting Angola is underway, waiting for the approval of all parties. The EPA is asymmetrically development-oriented, enabling the SADC countries to export to the EU market without any restrictions while allowing them to keep trade barriers for sensitive products and infant industries to be protected from world competition. It also pursues higher sustainability in terms of social and environmental matters. There is a significant amount of "safeguards" allowing a fast movement of trade barriers level in the agreement that can be activated once the EU's exports change to the extent they can threaten local production. The official evaluation of impacts has not been published yet and needs to be done in the future.

Taking into account current trade values, the EU is the largest trading partner for SADC nations reaching 23.5% of their exports in 2019, where they send mainly diamonds, but also e.g. Botswanan beef, Namibian fish, Eswatini sugar, Angolan oil, Mozambique aluminum, or South African wine. On the other hand, the EU exports especially machinery, electrical equipment, and pharmaceutical products.

Before the coming of a SADC-EU EPA agreement in 2016, South Africa had already possessed a Trade Development and Cooperation Agreement (TDCA) since 1999 that was later replaced. Hence, South Africa's emerging and fast-developing economy deserved a lot of preferential trade treatment in recent years, and the EU's funding attention, represented by wide-range activities investors significantly contributed to local industrialization and development. The TDCA is considered to increase mutual trade flows successfully by more than 120%, and FDI even five-fold. Therefore, South Africa represents the biggest trading partner in the African continent for the EU and the strongest economy as well, exporting diversified packs of both commodity-based and manufactured products.

3.2.5 Eastern Africa

The remaining African nations - Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mayotte, Mozambique, Réunion, Rwanda, Seychelles, Somalia, South Sudan, Uganda, Tanzania, Zambia, Zimbabwe - form the Eastern Africa region. These countries can be divided into three subgroups for the EU's policy-making purpose regarding trade – East African Community (EAC) members, Eastern and Southern Africa (ESA) members, and dependencies/other territories.

The EAC consists of Burundi, Kenya, Rwanda, Tanzania, Uganda, and, joining later in 2016, South Sudan. Trade partnership with these countries was negotiated in 2014 attempting to establish an overall regional comprehensive EPA, however, it has still not been approved by all parties up till now - although it has been signed by Rwanda, Kenya, and the EU, the rest of the countries are yet absent. The fundamental part of the agreement focuses on trade in goods and development cooperation with respect to the sustainable use of resources. Moreover, the treaty is supposed to be asymmetrical, completely opening the EU market while taking into account the level of development on the other side, an actual commitment is 82.6%. Assuming trade statistics, the EAC countries export mainly coffee, cut flowers, tea, or tobacco, on the other hand, the EU exports machinery and mechanical appliances or pharmaceutical products.

Secondly, there is an island Reunion, and an archipelago Mayotte both geographically falling under Africa, however, governed as the Departments of France. These territories do not have any trade agreement with the EU since they rank among the altogether nine

outermost regions (ORs)[5]. Therefore, these regions are an integral part of the EU and subject to the same laws and rules allowing them to export and import to the Common market without restrictions. However, they form only a minor mutual trade volume operating mainly with France.

The remaining countries together with Sudan are members of the ESA, negotiating a regional EPA as well which, same as several times before, has not entered into force yet. Even though only one EPA for both ESA and EAC was the original intention, these blocks got separated in sense of trade in 2007. In the very same year, the Interim EPA between the EU and Comoros, Madagascar, Mauritius, Seychelles, Zambia, and Zimbabwe was concluded. This treaty was later signed only by Madagascar, Mauritius, Seychelles, and Zimbabwe in 2009 and came into force in 2012, with Comoros joining in 2019. The EPA generally supporting sustainable development focuses mainly on abolishing the EU's tariffs and quotas, a gradual liberalization of the African countries, development coordination, rules of origin, or trade defense. Furthermore, negotiations for deepening this Interim agreement were initiated in 2019. Finally, the ESA nations export to the EU especially sugar, coffee, fish, tobacco, copper, and crude oil, on the other hand, their imports are dominated by machinery and mechanical appliances, or pharmaceuticals.

[5] The EU's outermost regions consist of French Guiana, Guadeloupe, Martinique, Mayotte, Reunion Islands, Saint-Martin (France), the Azores, Madeira (Portugal), and the Canary Islands (Spain).

4. Data

The fourth chapter describes the data preparation for further Gravity model estimation. Consolidating variables from several different sources, specifically The Centre d'Études Prospectives et d'Informations Internationales (CEPII) database, The Design of Trade (DESTA) database, The United Nations (UN) database, and The World Bank (WDI) database, the final data set has been made. Overall, it covers information about every exporter-importer pair among 252 countries, leading to 63504 pairs in total, during a time range 1948-2021. Therefore, the resulting balanced panel data set contains almost 4.7 million rows uniquely defined by the country pair-year index, and 66 columns of all necessary variables. This chapter presents the selected variables for the estimation, the dummies expressing geographical location and level of trade integration, and, last but not least, the synthetic dummy variables description.

4.1 Variables selection

The core of the final data set comes from the CEPII which provides variables of several different categories for the gravity equation (Conte, M., P. Cotterlaz and T . Mayer, 2022). It utilizes the dynamics in the form of displaying how countries have changed over time, containing both past and present territories adjusted by variable *country_exist* reaching 1 if it does exist in a given year.

The first category in CEPII represents variables describing bilateral geographical distances among countries. The *distw_harmonic* has been chosen for the model denoting population-weighted harmonic mean distance between the most populated cities of each country. Head and Mayer (2010) show the formula for effective distance between countries *i* and *j* as

$$d_{ij} = \left(\sum_{k \in i} \frac{y_k}{y_i} \sum_{l \in j} \frac{y_l}{y_j} d_{kl}^{\theta}\right)^{\frac{1}{\theta}} \tag{20}$$

where y represents the economic activity, k, i are indices for cities, d_{kl} is the geographic distance between cities k and l, and Θ is the distance elasticity of trade flows. Moreover, the CEPII authors suggest approximating y with population shares, which are easily obtained, as well as using $\theta = -1$ since it corresponds more closely to empirical observations and thus results in harmonic mean. Furthermore, the model contains also a dummy variable *contig* reaching 1 if countries are neighbors.

Another CEPII category is the culture variables. We included the standard time zone in every country *gmt_offset_2020*, bilateral *comlang_ethno* intercepting if a pair shares a common language spoken by at least 9% of the population, *heg* containing 1 if a country is the current or former hegemon of destination, *col_dep_ever* reaching 1 if a country pair was ever in a colonial relationship, *sibling* and *sibling_ever* denoting if countries currently are or ever have been, in a sibling relationship, e.g. they share the same hegemon, respectively. Moreover, *comleg_pretrans* and *comleg_posttrans* show if countries share common legal origins before and after the USSR transition in 1991, respectively, *comrelig* determines the religious proximity of countries on a 0-1 scale, and, finally, *scaled_sci* is the Social Connectedness Index between countries defined by Bailey *et al.* (2018).

Among the Additional macroeconomic indicators, only the absolute population *pop* was selected since its logarithm is used in the model. Using of population variable, however, differs across papers, its incorporation is inspired by Bergstrand (1985). Trade facilitation variables contain *gatt*, *wto*, and *eu* variables indicating if a country is a member of GATT, WTO, and EU, respectively.

CEPII provides three sources of trade flows between a country pair which are then used as the dependent variable of the model. Measurements from the International Monetary Fund (IMF) have been employed since only them reach till 1948. The final variable used in the model is the value reported by exporter *tradeflow_imf_o* since the "squared" data set displays every pair twice in both domestic and origin relations. The other sources from COMTRADE and BACI cover shorter periods and thus contain a relatively higher amount of NAs. Finally, the GDP of countries since 1960 is obtained from the WDI database with the earliest years finalized by CEPII authors.

4.2 Levels of trade integration - depth

Variables measuring the desired effect of trade agreements are created using the DESTA and UN databases. DESTA captures the overview of all trade agreements as well as their depth on a 0-7 scale defined by Dür et al. (2014). Hence, the variable *depth* compares every agreement in 7 different categories that can be contained in PTAs and simply adds on a unit scale how many of them comply. The full_fta checks whether an agreement foresees its tariffs to be reduced to zero so that it is a full FTA, and the *standards, investments, services, procurement, competition, and iprs* indices go beyond

tariff reduction and investigate whether an agreement contains any substantive provisions and sections covering the standards, investments, services trade, public procurement, competition, and intellectual property rights, respectively. This variable is then further divided into 4 dummies reaching 1 if the *depth* is into the following ranges – *depth_0* for no trade agreements, *depth_1_2*, *depth_3_4*, and *depth_5_7* for valid agreements based on their respective interval strength. The drawback of this method is that some agreements in the data set acknowledged by WTO do not have assigned their strength at all, on the other hand, some country pairs are involved in more than one agreement leading to several depth indicators. The final *depth* is then taken as a maximum of all indices assigned to a country pair in a given year, which effectively removes all undesirable NAs.

4.3 Geographical location

The UN database provides us with a list of all countries and their respective geographical locations, expressed as both continental regions and sub-regions. Using the dummy variables capturing if a country belongs to Africa or a specific African region or not as a conversion method, the following geographical dummy variables that will be further used in Chapter 6 to answer the research questions have been defined. To distinguish the EU members, the previously presented *eu_o* and *eu_d* are used.

Variable *EU_Africa* captures if a pair consists of one EU member and one African state regardless of the trade direction, while One_two_African expresses if a pair contains at least one African nation. Furthermore, overall five dummy variables have been evolved indicating whether a combination of the EU member and a state from the particular African region as defined in Chapter 3 is present. For instance, dummy *EU_North* equals 1 suggests that the pair contains trade statistics between the EU member country and a country located in the North African region. Finally, the Imp_EU_Africa dummy reaches 1 if exactly one member of a pair is either from the EU or Africa and the other is not.

4.4 Synthetic dummy variables

Extending the model further, several synthetic variables had to be created, primarily to take care of the Medal errors described by Baldwin and Taglioni (2006). The first set of them contains *time dummies*. These are simple variables built for each year in the data set reaching 1 if the respective pair-year index matches, for example, a variable *year2000* is equal to 1 if and only if an observation takes place in the year 2000 and 0 otherwise. There are 74 of these variables.

Another two sets of dummies examine if a given country and country-pair take place in the observation. Variables *iso3_o* and *iso3_d* created for every country engaged in the data set assign 1 if a given exporter and importer, respectively, is the country expressed by the ISO-3 code. Furthermore, the *country_pair* dummy is equal to 1 if an observation contains a particular pair of countries stated by the variable. For example, the variable *KEN-NLD* reaches 1 for observations containing the Kenya-Netherlands pair statistics.

The last set of synthetic dummies is the *importer-time* and *exporter-time* variables. These are built as all combinations of exporting and importing countries with all the years and are defined to be 1 if a row contains the same combination. For instance, an exporter-year dummy *CZE_2000* is equal to 1 if and only if an observation contains the Czech Republic as an exporting country in the year 2000.

To conclude the chapter, the following table summarizes all variables used for the model estimation together with their basic description, source, and unit measurement. The vast majority of them come from the CEPII database, however, we provide reference to their original sources since CEPII completes several other sources into one gravity set. For more information see Conte, M. et al. (2022).

Table 1 - Gravity model variables overview

Variable	Description	Source	Unit
tradeflow_imf	Trade flows	IMF	Thousands US$
gdp	GDP	WDI	Thousands US$
distw_harmonic	Population-weighted distance	CEPII	Km
Region	Geographical location	UN	{0,1}
Subregion	Geographical location	UN	African regions
depth	Depth of trade integration	DESTA	{0,1,2,3,4,5,6,7}
contig	Countries are contiguous	CEPII	{0,1}
gmt_offset_2020	Time zones	TimeZoneDB	hours
comlang_ethno	Common language	CEPII GeoDist	{0,1}
heg	Hegemony of destination	Head et al. (2010)	{0,1}
col_dep_ever	Colonial or dependency relationship ever	Head et al. (2010)	{0,1}
sibling_ever	Sibling relationship ever	Head et al. (2010)	{0,1}
sibling	Current sibling relationship	Head et al. (2010)	{0,1}
comleg_pretrans	Common legal origins before 1991	LaPorta et al. (2008)	{0,1}
comleg_posttrans	Common legal origins after 1991	LaPorta et al. (2008)	{0,1}
comrelig	Religious proximity index	LaPorta et al. (1999)	[0,1]
scaled_sci_2021	Social Connectedness Index	Bailey et al. (2018)	[1,10^9]
pop	Population	WDI	Thousands units
gatt	GATT member	WTO	{0,1}
wto	WTO member	WTO	{0,1}
eu	EU member	EU	{0,1}

5. Methodology

The fifth chapter summarizes the methodology used to build the Gravity model estimation. The first section presents various descriptive statistics to better understand the data and the most important variables. The connection of practical results with the microeconomic background derived in Chapter 1 follows in the second section, which attempts to give a reasoning behind the variable selection and model structure. The third section reminds the MRT concept and adds several synthetic variables that are supposed to mitigate the omitted variable bias into the equation. Section 4 focuses on the model estimation, possible methods, and reasoning behind the Fixed effects and PPML selection. Finally, the fifth section brings up the most often mistakes that could distort coefficients and shows the strategies aiming to prevent those.

5.1 Descriptive statistics

This chapter begins with descriptive statistics. Table (2) presents the distribution of values of all relevant continuous numeric variables contained in the model. For the individual interpretation see Chapter 4 where their meaning and unit scale is introduced. Only the 'origin' versions of the unilateral variables are provided since descriptive statistics for the 'domestic' ones are identical. The range of values as well as the skewness of some variables can be clearly seen, for example, the left-skewed density function of the trade flows signaling most of the trade relationships take place only in a relatively small volume.

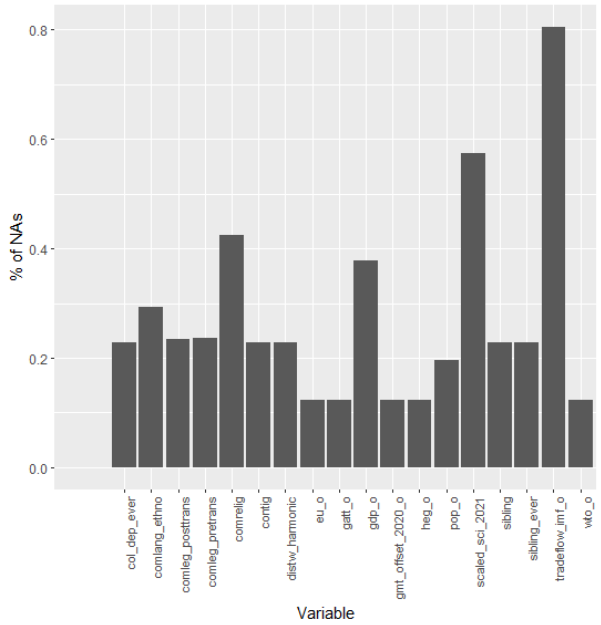
Table 2 - Descriptive statistics of numeric variables

STATISTIC	MIN	1ST Q	MEDIAN	MEAN	3RD Q	MAX	NAS
TRADEFLOW_IMF	0.001	108	1726	327985	22100	5.100e+08	3575319
GDP_O	8.825e+03	1.234e+06	6.614e+06	1.663e+08	4.405e+07	2.300e+10	1779624
DISTW_HARMONIC	0	4845	8223	8602	12181	19904	1071452
POP_O	3.2	301.0	3720.2	24073.8	13030.0	1412360.0	919548
SCALED_SCI_2021	48	642	1688	6.339e+05	6521	1.000e+09	2702843
COMRELIG	0.0	0.0	0.1	0.2	0.3	1.0	1999429

Furthermore, the issue of NAs contained in the data set is approached. The relatively wide time range comes at the expanse of a large number of not-available observations in the data since the further one goes in the past, the less accurate records and measurements are accessible, especially for pairs of developing countries. The following figure (2)

presents a percentage share of NAs contained in all model variables[6]. For the estimation purpose, we decided to keep them without any adjustments since both models can work with missing values. The alternative way could be to track observations mistakenly evaluated as NA instead of defined values, e.g. zero, however, this could have caused more confusion than possible benefits.

Figure 3 - Percentage share of NAs for every variable



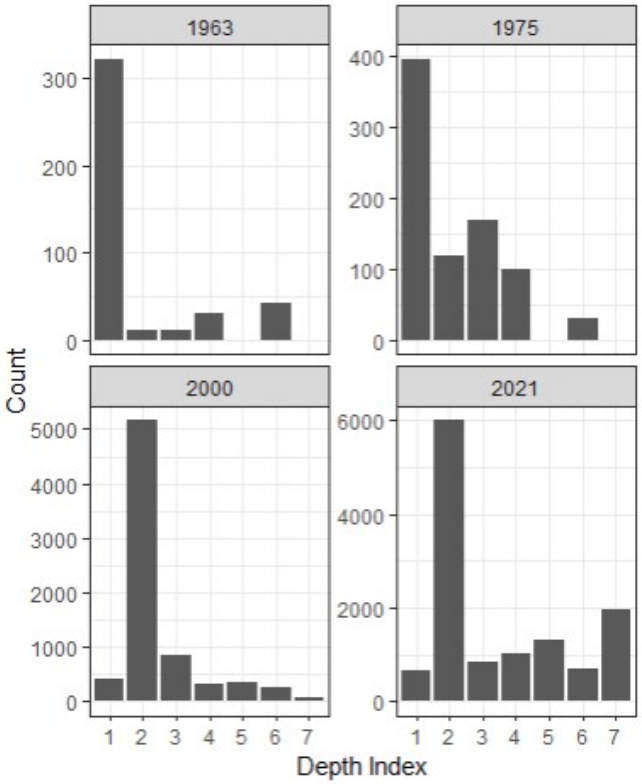
Finally, the distribution of trade agreements depth is considered. Graph (4) shows the number of trade agreements assigned to the respective depth indices in four different years 1963, 1975, 2000, and 2021. These years are intentionally chosen as milestones when the Yaoundé I, Lomé, and Cotonou conventions were signed followed by the most recent situation, respectively. Moreover, the depth index of 0, which means either very weak or no agreement at all based on the definition by Dür et al. (2014)[7], has also been removed from the graphs so that the results are not skewed[8]. Noticing the changing scale of y-axis counts, the graph also captures an increasing number of trade agreements in time as well as their deepening and thus growing overall integration worldwide.

[6] Measures how many percent of all observations are NAs per given variable, defined as sum of NAs in a given column divided by total number of rows in the data set

[7] Trade agreements of depth 0 do not comply with any of the seven categories (zero tariffs reduction trend, standards, investments, services trade, public procurement, competition, and intellectual property rights) and have, therefore, almost no effect on trade. For more information see definitions in the second section of Chapter 4

[8] The *depth_0* index accounts for the following number of agreements – 1963: 63086; 1975: 62690; 2000: 56048; 2021: 50988

Figure 4 - Distribution of trade agreements across depth indexes



5.2 Microeconomic connection

This section follows the microeconomic derivation of the Gravity model in the first chapter and provides a connection with the practical estimation. The derivation itself is done for cross-sectional data based on the literature, however, is later extended to comply with panel data used for the estimations. We ended up the derivation with two versions of the Gravity model, one presented by Baldwin and Taglioni (2006) as

$$V_{od} = \tau_{od}^{1-\sigma} \left(\frac{Y_o E_d}{\Omega_o P_d^{1-\sigma}}\right) \tag{21}$$

where V_{od} is the total value of bilateral trade, τ_{od} represents all costs of trade, Y_o measures the total output of an origin nation, E_d describes expenditures of the domestic country on tradable goods, σ is the elasticity of substitution and, finally, Ω_o and P_d refer to the MRT firstly introduced by Anderson and van Wincoop (2003). The other version summarized by Head and Mayer (2014) as

$$X_{ij} = GS_i M_j \phi_{ij} \tag{22}$$

where X_{ij} stands for the standard bilateral trade value, S_i shows the capabilities of an

exporting country i to supply its products, M_j is a market condition related to trade promotion in a domestic importing country, φ_{ij} demonstrates the mutual accessibility mainly linked to trade costs and its respective elasticities and G is the gravitational "un-constant".

Based on their multiplicative form, taking a logarithm is a standard procedure in the literature. Considering (21), we obtain the following gravity equation[9]

$$lnV_{od} = a_1 + a_2 lnY_o + a_3 lnE_d + a_4 ln\tau_{od} + a_5 ln\Omega_o + a_6 lnP_d + \varepsilon_{od} \qquad (23)$$

Linking the theoretical equations to the variables of our final models, bilateral trade flows *tradeflow_imf_o* represents V_{od}, moreover, Y_o and E_d are proxied by GDPs of countries *gdp_o* and *gdp_d* and, as Bergstrand (1985) suggests, also by populations *pop_o* and *pop_d*.

Trade costs τ_{od} are typically estimated using several variables that differ across the literature. For example, Bacchetta et al. (2012) assume bilateral distance, common border, language and colonizer, colonial relationship, and a dummy capturing if countries are landlocked. Moreover, Anderson and van Wincoop (2003) add several border effect parameters, including, e.g., cultural variables or institutional proximity, to the equation to explain the empirically observed overestimation of trade flows between neighboring countries. Therefore, accept of the mutual distance *distw_harmonic*, the dummy variable *contig*, reflecting the contiguity of a country pair, has been added to the model, as well as a set of cultural variables describing time zone, colonial and hegemonic relationship, common language, and legal system, religious proximity, and social connectedness[10]. Furthermore, trade costs τ_{od} have been extended in our model also by the trade facilitation variables reflecting if a country is part of the EU, GATT, or WTO. This approach was employed by several research papers, for instance, Helpman, Melitz, and Rubinstein (2008). Hence, the trade costs τ from equation (23) can be written as follows

$$\tau_{od} = d_{od}^{\beta_1} * \exp(\beta_2 contig + \beta_3 culture\_vars + \beta_4 trade\_facilitation) \qquad (24)$$

The crucial issue raised by Anderson and van Wincoop (2003) is the Multilateral Resistance Term (MRT) expressed as Ω_o and P_d in equation (23). Since these variables

[9] Baldwin and Taglioni (2006) are based on the work of Anderson and van Wincoop (2003), whose logarithmic equation has the following form:

$$\ln X_{ij} = a_o + a_1 lnY_i + a_2 lnY_j + a_3 lnt_{ij} + a_4 ln\Pi_i + a_5 lnP_j + \varepsilon_{ij}$$

, where the meaning is analogical.

[10] See Chapter 4, section 1 - Variables selection - for a closer description of these variables

are not observable in the real world, some form of their estimation or mitigation of their effect has to be included to avoid biased results. In the next section, the method selected to reduce the MRT significance will be introduced, we denote it as *synthetic_variables* at this moment simply for notation purposes.

To conclude this section, the microeconomic theory results in the following equation

$$\ln(tradeflow\_imf\_o) = \beta_0 + \beta_1 \ln(gdp\_o) + \beta_2 \ln(gdp\_d) + \beta_3 \ln(pop\_o) + \beta_4 \ln(pop\_d) + \beta_5 \ln(distw\_harmonic) + \beta_6 contig + \beta_7 culture\_vars + \beta_8 trade\_facilitation + \beta_9 synthetic\_variables + \varepsilon_{od} \quad (25)$$

5.3 Multilateral resistance term

The third section focuses on a way of dealing with the MRT derived in the equation above as Ω_o and P_d. As Baldwin and Taglioni (2006) claim, neglecting this concept would certainly lead to biased results as proved in the Medal errors definition. The literature offers many ways how to approximate this unobservable term, for more details recall the third section of Chapter 1. Later on, we will focus mainly on the most suitable ways given the research questions regarding coefficients of a bilateral variable – trade agreements.

The first method consists of replacing the MRT indexes in equation (23) with importer and exporter dummies as suggested by Anderson and van Wincoop (2004). Since this paper focused rather on the cross-sectional data, the time dimension should be added to these dummies so that they are able to capture also the time-varying unobserved characteristics of the exporters and importers such as booms or slowdowns in their economy. These dummy variables reach 1 if an observation contains a given exporter/importer in a given year and 0 otherwise. Furthermore, the pair dummy being 1 for a given country pair is added to the equation to prevent pair-specific effects. Concerning the literature, these variables were used, for instance, by Head and Mayer (2014) or Baier and Bergstrand (2007). Expanding the equation (25), the synthetic variables can be evolved into

$$\beta_9 synthetic\_variables = \delta_1 D_{ot} + \delta_2 D_{dt} + \delta_2 D_{od} \quad (26)$$

where D_{ot} is an exporter-time dummy, D_{dt} is an importer-time dummy, D_{od} is a pair dummy, and indexes *o*,*d*, and *t* represent a country of origin, domestic country, and year, respectively.

The other approach is to include country-specific as well as time-dummy variables in the gravity equation as proposed by Baldwin and Taglioni (2006). This approach helps to capture the unobserved heterogeneity caused by specific characteristics of countries and changes in time. The exporter dummy reaches 1 if an observation contains a given exporter and zero otherwise, analogically the importer dummy, and the time dummy is created in the same way by indicating when an observation contains a given year. Similarly, we can rewrite the synthetic variables as follows

$$\beta_9 synthetic\_variables = \delta_1 D_o + \delta_2 D_d + \delta_3 D_t \quad (27)$$

where D_o is an exporter dummy, D_d is an importer dummy, and D_t is a time dummy. In conclusion, both methods will be used in this thesis to approximate the MRT in the final gravity equation, and compared in the end.

5.4 Model selection

While estimating the Gravity model, it can be done using cross-sectional or panel data. For example, the cross-sectional data were used by Anderson and van Wincoop (2003) and Baier and Bergstrand (2007). Their main advantage lies in simplicity, data accessibility, or focus on contemporary factors. Modern approaches as well as this thesis, however, give preference to the panel data since it is more efficient in controlling for unobserved heterogeneity and is able to capture dynamic relationships, as claimed, for instance, by Arellano and Bover (1995).

Once the theoretical equation is prepared, the issue of the estimation method follows. Their closer specification and successive evolution are presented in the third section of Chapter 1, hence, only a brief summary is provided here. It can be done, among others, with standard Ordinary Least Squares (OLS), Fixed effects, Random effects, Tobit, Double demeaning (DDM), Tetrads, Structural Iterated Least Squares (SILS), Poisson Pseudo Maximum Likelihood (PPML), Negative Binomial Pseudo Maximum Likelihood (NBPML), Gamma Pseudo Maximum Likelihood (GPML), and Nonlinear Least Squares (NLS). Some of them are more or less criticized, for example, Anderson and van Wincoop (2003) show the biasedness of standard OLS by introducing the MRT, Head and Mayer (2014) claim that NLLS suffers from several limitations such as inconsistency, instability, and sensitivity to initial parameter values, and Bacchetta et al. (2012) argue That Tobit model assumes homoscedastic error which is unlikely in reality. In general, all of these

methods can be met across the literature, however, this thesis will focus on probably the two most popular ones – Fixed effects and PPML.

5.4.1 Fixed effects

The fixed effects estimation method is a popular and widely used method in panel data analysis due to its ability to control for unobserved heterogeneity, that might affect bilateral trade flows, and identify causal effects. It is used, for example, by Anderson and van Wincoop (2004) or Head and Mayer (2014).

This method can be employed only if the research interest lies in coefficients of time-varying variables, trade agreements in our case. According to Wooldridge (2015), the fixed effects use time-demeaned data to eliminate the unobserved effect, which is constructed by subtracting the over-time averages from the original equation[11]. This procedure naturally removes also the time-invariant variables. Furthermore, the important part that has to be checked is the fixed effects assumptions. Wooldridge (2015) defines altogether 7 assumptions – linearity in parameters, random sample in cross-sectional dimension, no perfect collinearity, zero conditional mean, homoskedasticity, no serial correlation, and normality. These conditions ensure coefficients are unbiased and efficient, so-called BLUE.

There are also several papers that use the Random effects estimation method based on quasi-demeaned data procedure instead. Selection between these methods can be conducted using the Hausman test, however, this thesis directly employs the fixed effects based on its wider application in the literature. An important comparison of around 115 research papers concerning this selection was performed by Cardamone (2007), who concluded that the majority give preference to fixed effects.

The final equation using the fixed effects method and the pair, exporter-time and importer-time synthetic dummies[12], therefore, has the following shape

$$\ln(tradeflow\_imf\_o) = \beta_0 + \beta_1 \ln(gdp\_o) + \beta_2 \ln(gdp\_d) + \beta_3 \ln(pop\_o) + \beta_4 \ln(pop\_d) + \beta_5 \ln(distw\_harmonic) + \beta_6 contig + \beta_7 culture\_vars + \beta_8 trade\_facilitation + \delta_1 D_{ot} + \delta_2 D_{dt} + \delta_3 D_{od} + \varepsilon_{od} \quad (28)$$

[11] For a detailed explanation see Wooldridge (2015)

[12] Analogically for the country-pair and time dummies, as defined in the third section of this chapter

5.4.2 PPML

Another widely used method for gravity model estimation is the Poisson Pseudo Maximum Likelihood (PPML). While the fixed effects cannot work with zero trade since the logarithm of zero is not defined, which can cause bias and will be further examined later in this chapter, one of the main strengths of PPML is probably its ability to process them. The reason is that the dependent variable is no longer in logarithmic form in this case. Moreover, Santos Silva and Tenreyro (2006) claim that, unlike the OLS, the PPML is able to estimate the non-linear form of the gravity model and to control for heteroskedasticity by under-weighting outlying observations.

The equation (29) depicts the PPML gravity equation, controlling for the country-specific and time effects

$$\text{tradeflow\_imf\_o} = \exp[\beta_0 + \beta_1 \ln(gdp\_o) + \beta_2 \ln(gdp\_d) + \beta_3 \ln(pop\_o) + \beta_4 \ln(pop\_d) + \beta_5 \ln(distw\_harmonic) + \beta_6 contig + \beta_7 culture\_vars + \beta_8 trade\_facilitation + \delta_1 D_o + \delta_2 D_d + \delta_3 D_t] * \varepsilon_{od} \quad (29)$$

5.5 Bias prevention

This section attempts to recall the most often mistakes researchers do while estimating the gravity model. Their prevention that aims to mitigate possible bias is then presented.

5.5.1 Medals

The medal errors indicating the most frequent mistakes researchers do, as defined by Baldwin and Taglioni (2006), are closely described in the fourth section of Chapter 1. There are altogether 3 types of them – the gold, silver, and bronze errors.

The gold medal arises from mistakenly ignoring the MRT expressed in (21) as Ω_o and P_d and, therefore, causing the omitted variable bias. The MRT term can be either proxied or eliminated by an estimation method in several different ways, however, this paper follows the solution proposed by the authors, who advise including either country effects or pair effects in combination with a time dummy. Furthermore, Baier and Bergstrand (2009) came up with the importer-year and exporter-year dummy variables as an MRT proxy and argued this approach can improve the accuracy of model predictions and lead to more reliable estimates of the trade policies effects even more than the previous method. Since both procedures are involved in our models, the gold medal error has been safely avoided.

The silver medal resulting from taking an average of logarithms instead of the other way around has been bypassed by using only trade flows reported by the origin country and thus not taking logarithms at all.

The bronze medal coming out from incorrect deflation of trade flows can be simply treated by including a time dummy as shown again by Baldwin and Taglioni (2006). Since the gold medal has been taken care of, this mistake is covered as well. To conclude, all of the possible medal bias has been apparently eliminated.

5.5.2 Zero trade

This issue arises once trade flows between two countries are reported to be zero. Assuming the logarithmic form of a dependent variable in the Fixed effects models, this expression is then not defined. Omitting these observations once they carry meaningful information, for example, a trade embargo, can lead to inconsistent results. Three possible solutions are summarized by Bacchetta et al. (2012) in the fourth section of Chapter 1.

Searching through the whole data set, the *tradeflow_imf_o* does not contain any 0. These can be also hidden inside the NAs, however, their distinguishing seems to be relatively difficult to process. It goes hand in hand with the theory, indicating rather strictly positive values, and can be mainly caused by utilizing the aggregated data. Hence, it can be concluded that the zero trade bias has been trivially avoided.

5.5.3 Endogeneity

The endogeneity issue arises primarily from three sources – omitted variables, simultaneity, and measurement error (Baier and Bergstrand, 2007)[13]. Since the data from official sources are used, the latter two are not a concern of this thesis, however, the omitted variables issue still needs to be mitigated. Solutions differ across the literature, for example, one can use the instrument variables, the Generalized Method of Moments (GMM) estimation, or the Two-Stage Least Squares (2SLS) estimation. This thesis, however, is inspired by Baier and Bergstrand (2007) who suggest using panel data with country and time effects, as well as the fixed effects estimation method. Furthermore, a relatively large number of cultural and other control variables is included in the equation, which can further lower the unobservable effects.

[13] For more details see the fourth section od Chapter 1

5.5.4 Heteroskedasticity

While the PPML estimation method is heteroskedasticity resistant, the Fixed effects assume the homoskedasticity of disturbances, and its violation can lead to a biased variance of estimates and thus inefficient results. Therefore, Bacchetta et al. (2012) argue that the bias can be mitigated by using panel data and systematically implementing robust standard errors. This thesis utilizes White's heteroskedasticity-robust standard errors due to its log-log nonlinear specification.

To conclude this chapter, we believe the Gravity equation is precisely prepared for an estimation and all possible issues have been prevented. The next chapter presents the results and their interpretations.

6. Results

The sixth chapter finalizes the previously described general gravity equation by bringing up the model estimation results. The overall topic is divided into 4 research questions defined by a specific set of 'trade agreements' dummy variables, which will be presented in the following sections and added to the final equations (28) and (29). Hence, the intention is always specified for each question, then the table with results is provided and implications revealed.

As specified in Chapter 5, overall four columns of coefficients are estimated for each research question employing the combinations of Fixed effects and PPML methods as well as two different sets of synthetic variables, the overview is provided in Table (3). The models have been built up in R, however, the final estimation is replicated in STATA due to its higher technical suitability.

Table 3 - Estimation results' column description

	(1)	(2)	(3)	(4)
Fixed effects	✓		✓	
PPML		✓		✓
C/T effects	✓	✓		
E-Y/I-Y/P effects			✓	✓

* C/T: Country and time effects; E-Y/I-Y/P: Exporter-year, importer-year and pair effects

6.1 EU-Africa agreements impact

The first research question attempts to predict the impact of trade agreements concluded between the EU member states and African countries in comparison to the general agreements effect. Therefore, dummies *EU_Africa*, *Depth_1_2*, *Depth_3_4*, *Depth_5_7*, and their combinations[14] are implemented into the final equation measuring the desired output. Single *depth* coefficients indicate the general effect of trade agreements while their combinations with *EU_Africa* measure how it differs specifically for EU-African pairs.

Results are shown in Table (4) exposing all variables of the respective gravity equation as rows and the estimation methods as columns, for numbers conversion, see Table (3). To interpret the values of the coefficients, we need to distinguish between

[14] All of the 'trade agreements' dummy variables are displayed in Table (4) or the model's specification R code file "Final_gravity_models.R". Variable 'Depth_0' is intentionally omitted due to perfect collinearity issue.

logarithmic and dummy variables. The logarithmic variables can be read directly as the log-log elasticity percentage change[15], for example, increasing the GDP of exporting country by 1% would lead to a 0.78% growth in trade volume, which is significant and within the expected range. On the other hand, the log-level coefficients of dummy variables need to be transformed using the formula '$\text{elasticity} = \exp(\beta) - 1$' in other to interpret them as elasticities. Taking column 1 as an example, relatively weak trade agreements[16] with strengths 1 or 2 increase trade volume by 33.6% in general, however, these agreements concluded specifically between the EU and African states reduce this growth by 51.8%. The total effect of EU-African agreements on mutual trade flows is, therefore, -18.2%[17]. The medium-strong agreements with depth 3 or 4 and the strong ones reaching 5-7 increase the overall trade flows by 51.2% and 16.2%, respectively.

Since the estimates of *depth* and *EU_Africa* combinations are mainly statistically significant and negative, it can be concluded that the EU-African trade agreements lower the otherwise positive effect across all depths. Furthermore, this negative impact is even stronger than the positive one in several cases, especially for weaker treaties *depth_1_2*, hence, some agreements are in fact regressive and decline the overall trade.

The reasoning behind this impact can be, for instance, asymmetrical provisions that favor the EU business and make it difficult for African countries to compete, or a lack of infrastructure in African states make it harder to fully take advantage of these agreements. To conclude, it seems favorable to deepen the trade relations to mitigate the current negative effects, to straighten the degree of asymmetry, and to focus on their overall further redesign.

[15] Logarithmic variables begin with 'ln'; coefficients are interpreted using the formula: $\%\Delta y = \beta_1 \%\Delta x$

[16] For a definition of *depth* variables see the second section of Chapter 4

[17] [exp(0.29)-1] + [exp(-0.73)-1] = -18.2%

Table 4 - Estimation results 1

	Dependent variable: ln_tradeflow_imf_o			
VARIABLES	(1) FE	(2) PPML	(3) FE	(4) PPML
ln_GDP_o	0.785***	0.705***		
	(0.0198)	(0.0442)		
ln_GDP_d	0.638***	0.547***		
	(0.0171)	(0.0323)		
ln_distw	-1.368***	-0.696***	0.415	
	(0.0202)	(0.0298)	(1.337)	
contig	0.561***	0.413***		
	(0.0888)	(0.0570)		
ln_pop_o	-0.628***	-0.314***		
	(0.0472)	(0.0850)		
ln_pop_d	0.108***	-0.0686		
	(0.0414)	(0.0831)		
gatt_o	0.102***	0.461***		
	(0.0370)	(0.131)		
gatt_d	0.0493	0.414***		
	(0.0320)	(0.0668)		
wto_o	0.0529	0.0348		
	(0.0387)	(0.0537)		
wto_d	0.158***	0.0801**		
	(0.0300)	(0.0399)		
eu_o	0.214***	0.269***		
	(0.0287)	(0.0398)		
eu_d	-0.168***	0.197***		
	(0.0378)	(0.0396)		
gmt_offset_2020_o	-	-	-	-
gmt_offset_2020_d	-	-	-	-
comlang_ethno	0.171***	0.0307		
	(0.0408)	(0.0642)		
heg_o	1.208***	0.0658		
	(0.116)	(0.121)		
heg_d	1.470***	-0.113		
	(0.137)	(0.168)		
col_dep_ever	-	-	-	-
sibling	0.167***	-0.325***	0.467**	-0.288
	(0.0626)	(0.106)	(0.182)	(0.296)
sibling_ever	0.566***	0.257***		
	(0.0431)	(0.0790)		
comleg_pretrans	0.615***	-0.0518		
	(0.0400)	(0.0827)		
comleg_posttrans	-0.382***	0.236***		
	(0.0392)	(0.0689)		
comrelig	0.211***	0.190**		
	(0.0489)	(0.0809)		
scaled_sci_2021	2.51e-07***	8.27e-07***		
	(8.13e-08)	(1.89e-07)		
eu_africa	0.523***	0.709***	0.00274	0.0135
	(0.0570)	(0.126)	(0.0490)	(0.0856)
depth_1_2	0.293***	0.101	0.142***	0.119***
	(0.0351)	(0.0650)	(0.0299)	(0.0324)
depth_1_2eu_africa	-0.730***	-0.597***	-0.436***	-0.482***
	(0.0664)	(0.152)	(0.0581)	(0.0798)
depth_3_4	0.664***	0.393***	0.312***	0.106***
	(0.0425)	(0.0522)	(0.0315)	(0.0278)
depth_3_4eu_africa	-0.547***	-0.454***	-0.206***	-0.256***
	(0.0656)	(0.133)	(0.0520)	(0.0745)
depth_5_7	0.401***	0.471***	0.371***	0.146***
	(0.0338)	(0.0502)	(0.0278)	(0.0273)
depth_5_7eu_africa	-0.402***	-0.771***	-0.631***	-0.490***
	(0.146)	(0.148)	(0.146)	(0.128)
Constant	-0.838	-2.083	4.264	16.13***
	(0.697)	(1.425)	(11.48)	(0.0226)
iso3_o	Yes	Yes	No	No
iso3_d	Yes	Yes	No	No
year	Yes	Yes	No	No
country_pair	No	No	Yes	Yes
exp_year	No	No	Yes	Yes
imp_year	No	No	Yes	Yes
Observations	661,058	661,058	659,728	659,728
R-squared	0.705		0.862	
Adjusted R^2	0.705		0.852	
Pseudo R-squared		0.990		0.990

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

6.2 General impact of African agreements

The second research question widens the previous concept by inspecting the general effect of trade agreements with African states regardless of the pair counterpart. This section, therefore, provides an opportunity to evaluate the role of Africa in Section 1 results and evaluate how the continent reacts to global support in terms of trade in general. Concerning the 'trade agreements' dummy variables, *One_two_African* reflecting if at least one country is African, *depth* as in the previous section, and their combinations are added to the final equation.

The results are presented in Table (5). Using column 1 as an example once again, the agreements with depth 1 or 2 generally significantly increase trade by 28.4%, which is then slightly reduced by the presence of African countries by 13.9%, however, the reduction is only weakly statistically significant. To sum up, these agreements enhance trade flows by 14.5%[18]. The agreements *depth_3_4* and *depth_5_7* analogically increase the overall trade by 11.5% and 6.3%, however, not significantly in the second case.

Taking into account the statistically significant coefficients especially, one can observe a rather uncertain effect of *depth_1_2* overall trade change, which is probably close to zero. Moreover, the effect for African countries seems to be negative. On the other hand, the African agreements with *depth_3_4* tend to significantly intensify the otherwise strong positive effect and thus have a significant impact on trade. Finally, the *depth_5_7* agreements are likely to significantly reduce their otherwise positive effects in African cases resulting in a neutral overall effect.

These results emphasize the importance of the right level of integration. The relatively weak agreements 1 and 2 show signs of trade reduction in comparison to standard impact, which correlates with Section 1 and reveals the African "barriers" to trade agreements utilization on weaker levels of integration. On the other hand, the African continent reveals a strongly positive acceptance of medium-strong treaties that should be further exploited and points out the EU as the possible cause of the previous mutual trade reduction. The relative decline of the strongest agreements 5-7 can be understood as a cost of excessive openness that can even harm the local countries and should be taken care of. Hence, it does not seem desirable to force the strong integration through difficult negotiations since the African nations are not developed enough to thrive from them.

[18] [exp(0.25)-1] + [exp(-0.15)-1]

Table 5 - Estimation results 2

	Dependent variable: ln_tradeflow_imf_o			
VARIABLES	(1) FE	(2) PPML	(3) FE	(4) PPML
ln_GDP_o	0.788***	0.708***		
	(0.0200)	(0.0436)		
ln_GDP_d	0.642***	0.554***		
	(0.0172)	(0.0321)		
ln_distw	-1.365***	-0.700***	0.385	
	(0.0203)	(0.0298)	(1.354)	
contig	0.529***	0.405***		
	(0.0879)	(0.0568)		
ln_pop_o	-0.605***	-0.316***		
	(0.0473)	(0.0850)		
ln_pop_d	0.121***	-0.0814		
	(0.0418)	(0.0837)		
gatt_o	0.103***	0.462***		
	(0.0372)	(0.135)		
gatt_d	0.0474	0.413***		
	(0.0320)	(0.0701)		
wto_o	0.0522	0.0586		
	(0.0386)	(0.0525)		
wto_d	0.155***	0.0949**		
	(0.0298)	(0.0415)		
eu_o	0.250***	0.274***		
	(0.0271)	(0.0399)		
eu_d	-0.136***	0.202***		
	(0.0374)	(0.0396)		
gmt_offset_2020_o	-	-	-	-
gmt_offset_2020_d	-	-	-	-
comlang_ethno	0.168***	0.0372		
	(0.0408)	(0.0642)		
heg_o	1.224***	0.0659		
	(0.116)	(0.124)		
heg_d	1.482***	-0.114		
	(0.138)	(0.171)		
col_dep_ever	-	-	-	-
sibling	0.156**	-0.328***	0.453**	-0.338
	(0.0624)	(0.106)	(0.183)	(0.297)
sibling_ever	0.563***	0.251***		
	(0.0430)	(0.0786)		
comleg_pretrans	0.621***	-0.0470		
	(0.0400)	(0.0826)		
comleg_posttrans	-0.385***	0.238***		
	(0.0393)	(0.0688)		
comrelig	0.217***	0.155*		
	(0.0486)	(0.0801)		
scaled_sci_2021	2.51e-07***	7.43e-07***		
	(8.09e-08)	(1.82e-07)		
One_two_African	-0.318***	-0.545***		
	(0.0554)	(0.128)		
Depth_1_2	0.251***	0.0318	0.0988***	0.0870***
	(0.0471)	(0.0692)	(0.0344)	(0.0332)
Depth_1_2One_two_African	-0.145**	0.244**	-0.176***	-0.188**
	(0.0569)	(0.103)	(0.0498)	(0.0840)
Depth_3_4	0.473***	0.364***	0.236***	0.0896***
	(0.0440)	(0.0534)	(0.0320)	(0.0280)
Depth_3_4One_two_African	0.228***	0.339***	0.0405	-0.0332
	(0.0609)	(0.0890)	(0.0491)	(0.0752)
Depth_5_7	0.356***	0.458***	0.389***	0.143***
	(0.0340)	(0.0503)	(0.0288)	(0.0274)
Depth_5_7One_two_African	0.125	-0.109	-0.635***	-0.387***
	(0.136)	(0.118)	(0.143)	(0.119)
Constant	-1.177*	-2.072	4.528	16.13***
	(0.697)	(1.413)	(11.63)	(0.0225)
iso3_o	Yes	Yes	No	No
iso3_d	Yes	Yes	No	No
year	Yes	Yes	No	No
country_pair	No	No	Yes	Yes
exp_year	No	No	Yes	Yes
imp_year	No	No	Yes	Yes
Observations	661,058	661,058	659,728	659,728
R-squared	0.705		0.862	
Adjusted R^2	0.705		0.852	
Pseudo R-squared		0.990		0.990

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

6.3 EU-African regions agreements impact

This section explores the impact of agreements for all five African regions separately instead of assuming the whole continent[19]. In contrast with the first section, the dummy *EU_Africa* is replaced with five new variables *EU_North*, *EU_West*, *EU_middle*, *EU_South*, and *EU_East* showing if a pair contains the EU member and a country from the respective African region. Since many current trade agreement policies approximately correlate with this geographical segmentation and the EU aims to approach local countries through the whole region as described in Chapter 3, this research question allows us to evaluate these policies separately.

Table (6) pictures the result with a relatively higher amount of coefficients due to dummies combinations, which is why the control culture variables and trade facilitation are not shown[20]. The interpretation is, however, as straightforward as before, we use column 1 and the West region as an example. The general impact of treaties with depth 1 or 2 is a 32.3% growth in trade volume, while the specific effect of country pairs containing the EU member and one of the West region countries reaches -64.7%, both coefficients are statistically significant. Hence, the agreements concluded with Western region countries decreases the overall trade by 32.3%[21]. The analogical calculation can be done for *depth_3_4* and *depth_5_7* and the remaining combinations.

Summarizing the impacts across African regions, they differ based on the method used and seem not to be as clear. The North African countries report the *depth_1_2* agreements effect to be even 69.9% higher than the general one based on method (3), *depth_3_4* to be 34.9% lower than general ones based on method (1), and *depth_5_7* to be 55.1% lower based on column (2). Since the remaining column shows non-significant values, these numbers create rather an idea of a sign than a precise meaning.

The remaining regions do not have the *depth_5_7* coefficient estimated due to perfect collinearity, which can be caused by a small number of observations – not enough agreements of this strength in these locations. We will not refer to them later.

[19] The African regions are defined in Chapter 3

[20] We excluded coefficients of culture and trade facilitation variables from the result table to keep clarity since they are not the point of interest and serve only as control variables

[21] [exp(0.28)-1] + [exp(-1.04)-1]

Furthermore, all the remaining regions seem to have a strong and significant negative impact on both *depth_1_2* and *depth_3_4* agreements relative to the general effect. One can observe it is slightly less negative for the medium-strong treaties.

To conclude this section, only the North African region shows some possible positive impact for weak agreements, which could be caused, for example, by their relative proximity and the historically longer and deeper mutual trade conditions negotiations. However, the results rather back up Section 1 and decompose the continental effect into its regions. The most negative results are likely in West Africa, where the agreements adjustments should be pursued most. Also, the importance to deepen relationships behind a simple tariff reduction is emphasized once again.

Table 6 - Estimation results 3

	Dependent variable: ln_tradeflow_imf_o			
VARIABLES	(1) FE	(2) PPML	(3) FE	(4) PPML
ln_GDP_o	0.781***	0.703***		
	(0.0198)	(0.0444)		
ln_GDP_d	0.634***	0.545***		
	(0.0171)	(0.0324)		
ln_distw	-1.378***	-0.693***	0.394	
	(0.0205)	(0.0300)	(1.343)	
contig	0.546***	0.414***		
	(0.0891)	(0.0570)		
ln_pop_o	-0.627***	-0.307***		
	(0.0472)	(0.0852)		
ln_pop_d	0.115***	-0.0638		
	(0.0414)	(0.0831)		
EU_North	0.199	0.755***	-0.160	-0.171
	(0.124)	(0.185)	(0.103)	(0.131)
EU_West	0.579***	0.904***	0.0782	0.195
	(0.0950)	(0.181)	(0.0858)	(0.172)
EU_middle	0.474***	0.696***	-0.400***	0.0377
	(0.109)	(0.235)	(0.0985)	(0.178)
EU_South	0.505***	0.523***	0.231	0.421***
	(0.138)	(0.198)	(0.149)	(0.148)
EU_East	0.864***	0.714***	0.246***	0.292**
	(0.0899)	(0.153)	(0.0810)	(0.120)
Depth_1_2	0.282***	0.104	0.141***	0.119***
	(0.0352)	(0.0653)	(0.0299)	(0.0324)
Depth_3_4	0.668***	0.395***	0.312***	0.108***
	(0.0425)	(0.0524)	(0.0315)	(0.0278)
Depth_5_7	0.390***	0.474***	0.366***	0.145***
	(0.0339)	(0.0505)	(0.0278)	(0.0273)
Depth_1_2Eu_North	0.0801	-0.409*	0.534***	0.0343
	(0.177)	(0.215)	(0.181)	(0.181)
Depth_1_2Eu_West	-1.037***	-0.957***	-0.786***	-0.843***
	(0.101)	(0.152)	(0.0882)	(0.151)
Depth_1_2Eu_Middle	-0.743***	-0.560***	-0.140	-0.528***
	(0.107)	(0.205)	(0.105)	(0.186)
Depth_1_2Eu_South	-0.426***	-0.0685	-0.408***	-0.442***
	(0.158)	(0.197)	(0.155)	(0.159)
Depth_1_2Eu_East	-0.838***	-1.007***	-0.437***	-1.047***
	(0.0974)	(0.139)	(0.0893)	(0.142)
Depth_3_4Eu_North	-0.435***	-0.119	0.0376	0.0490
	(0.138)	(0.185)	(0.120)	(0.117)
Depth_3_4Eu_West	-0.736***	-0.784***	-0.435***	-0.516***
	(0.0931)	(0.129)	(0.0788)	(0.108)
Depth_3_4Eu_Middle	-0.398***	-0.494***	-0.0638	-0.249*
	(0.110)	(0.126)	(0.0994)	(0.138)
Depth_3_4Eu_South	-0.758***	-0.577***	-0.416***	-0.457***
	(0.159)	(0.221)	(0.157)	(0.177)
Depth_3_4Eu_East	-0.603***	-0.726***	-0.162**	-0.535***
	(0.0905)	(0.118)	(0.0755)	(0.110)
Depth_5_7Eu_North	-0.0930	-0.797***	-0.373**	-0.290**
	(0.169)	(0.180)	(0.157)	(0.135)
Depth_5_7Eu_West	-	-	-	-
Depth_5_7Eu_Middle	-	-	-	-
Depth_5_7Eu_South	-	-	-	-
Depth_5_7Eu_East	-	-	-	-
Constant	-0.679	-2.122	4.451	16.13***
	(0.698)	(1.426)	(11.54)	(0.0227)
iso3_o	Yes	Yes	No	No
iso3_d	Yes	Yes	No	No
year	Yes	Yes	No	No
country_pair	No	No	Yes	Yes
exp_year	No	No	Yes	Yes
imp_year	No	No	Yes	Yes
Observations	661,058	661,058	659,728	659,728
R-squared	0.705		0.862	
Adjusted R^2	0.705		0.852	
Pseudo R-squared		0.990		0.990

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

6.4 Trade creation & diversion of EU-Africa agreements

The final research question is inspired by Bacchetta et al. (2012) and examines the trade conversion and diversion effect described in the third section of Chapter 2. We defined a "trade block" as two groups of countries belonging either to the EU or Africa. Hence, the already-used variable *EU_Africa* is implemented into the equation capturing the effect of "both members", moreover, the dummy *Imp_EU_Africa*, defined as 1 if an importing country is either the EU or African member while exporter is not, represents the situation of "exactly one member" state. The authors suggest that positive and significant coefficients on both variables mean a presence of trade creation, while positive *Imp_EU_Africa* and negative *EU_Africa* reveal trade diversion.

Table (7) presents the last set of results. Both key variables have negative and statistically significant coefficients, at least for methods (3) and (4), which indicate the trade diversion effect as well as the member states trade flows distortion. In other words, the last section refers to the fact that the EU-African agreements not only relatively reduce the mutual trade inside, but they also distort the trade from the rest of the world that would have arisen otherwise. This can be explained, among others, by the European common market access. The EU-ACP trade diversion effect from the non-EU developed countries was observed also by Raza and Teixeira (2020), who argue it can happen due to the discriminatory nature of the EPAs and can contain also the political subtext. To conclude, it should be further examined to what extent the trade diversion is beneficial for the African countries to prevent the political strategy causing inefficient results.

Table 7 - Estimation results 4

	Dependent variable: ln_tradeflow_imf_o			
VARIABLES	(1) FE	(2) MMPL	(3) FE	(4) MMPL
ln_GDP_o	0.783***	0.705***		
	(0.0200)	(0.0387)		
ln_GDP_d	0.639***	0.552***		
	(0.0172)	(0.0312)		
ln_distw	-1.412***	-0.696***	0.247	
	(0.0206)	(0.0304)	(1.386)	
contig	0.570***	0.446***		
	(0.0900)	(0.0595)		
ln_pop_o	-0.622***	-0.363***		
	(0.0472)	(0.0850)		
ln_pop_d	0.0922**	-0.103		
	(0.0412)	(0.0816)		
gatt_o	0.110***	0.488**		
	(0.0374)	(0.190)		
gatt_d	0.0583*	0.422***		
	(0.0321)	(0.104)		
wto_o	0.0580	0.0893*		
	(0.0387)	(0.0539)		
wto_d	0.162***	0.124***		
	(0.0297)	(0.0442)		
eu_o	0.237***	-0.0207		
	(0.0305)	(0.0513)		
eu_d	0.178***	0.468***		
	(0.0504)	(0.0541)		
gmt_offset_2020_o	-	-	-	-
gmt_offset_2020_d	-	-	-	-
comlang_ethno	0.178***	0.0794		
	(0.0412)	(0.0676)		
heg_o	1.220***	0.00391		
	(0.118)	(0.134)		
heg_d	1.480***	-0.186		
	(0.141)	(0.191)		
col_dep_ever	-	-	-	-
sibling	0.155**	-0.349***	0.464**	-0.354
	(0.0628)	(0.103)	(0.186)	(0.299)
sibling_ever	0.577***	0.318***		
	(0.0434)	(0.0788)		
comleg_pretrans	0.637***	-0.0681		
	(0.0403)	(0.0854)		
comleg_posttrans	-0.403***	0.248***		
	(0.0395)	(0.0714)		
comrelig	0.232***	0.162*		
	(0.0487)	(0.0837)		
scaled_sci_2021	2.54e-07***	8.45e-07***		
	(8.27e-08)	(1.86e-07)		
Imp_EU_Africa	-0.330***	-0.579***	-0.691***	-0.304***
	(0.0480)	(0.0789)	(0.0431)	(0.0337)
EU_Africa	-0.0899*	0.0211	-0.821***	-0.364***
	(0.0461)	(0.0773)	(0.0519)	(0.0736)
Constant	-0.255	-1.098	5.977	16.25***
	(0.686)	(1.284)	(11.91)	(0.0174)
iso3_o	Yes	Yes	No	No
iso3_d	Yes	Yes	No	No
year	Yes	Yes	No	No
country_pair	No	No	Yes	Yes
exp_year	No	No	Yes	Yes
imp_year	No	No	Yes	Yes
Observations	661,058	661,058	659,728	659,728
R-squared	0.703		0.862	
Adjusted R^2	0.703		0.852	
Pseudo R-squared		0.990	0.990	0.990

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Conclusion

The modern approach of the EU consists of establishing policies toward developing countries that would manage to both create positive welfare for its member states and increase the overall living conditions and support the local growth of these nations. Since international trade procurement is predicted to enhance poverty, inequality, unemployment, and many other welfare indicators, several trade agreements between the EU and Africa have been signed to promote it. Therefore, further decision-making requires conducting the ex-post evaluation of the arrangements currently set in place to see how they indeed affect mutual trade flows.

This thesis aims to model the historical impact of the EU-African trade agreements using the period 1948-2021. Based on the literature, the Gravity model for trade evaluation has been employed in combination with the Fixed effects and PPML methods of estimation. Many possible sources of bias and their preventions are introduced, including the country, time, and pair effects implementation. Moreover, introducing three levels of depth parameters allows us to compare the effects of different degrees of integration.

The results suggest that the trade agreements between the EU members and African countries reduce the otherwise positive effect on trade. In the case of relatively weaker ones, even an absolute trade reduction can occur. This phenomenon can be caused, for example, by the African 'barriers' to fully utilizing the opportunities due to lack of infrastructure, however, the African continent, in general, seems to react positively to medium-strong agreements. Furthermore, this negative effect is disaggregated into the five African regions since the majority of the current policies are enforced regionally. The Western nations indicates the most negative impact on trade. Finally, the significant trade diversion effect has been found, in addition to the internal trade reduction, that confirms, among other factors, the impact of the Common European market access.

Based on this analysis, we recommend updating the current agreements to prevent the previous trade reduction effect, including finding the optimal degree of integration and African countries' openness. Furthermore, we suggest focusing mainly on the Western and Eastern regions due to their poor performance. From the African point of view, a risk of nonoptimal trade volume excess due to tariff reduction may appear, hence, diversifying trading partners more optimally could be under consideration. Finally, it is important to

support overall local development to ensure the maximum effectiveness of enforced policies.

We are fully aware of many other factors besides trade flows that come into play when trade policy is implemented, for instance, geopolitical relations, technological progress, or unemployment. Therefore, a more detailed analysis could be done to entirely understand the impacts since an agreement can be effective despite negative trade flows. Last but not least, the predictions of potential future arrangements as well as more dynamic ex-post analysis using the lagged variables could follow.

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Appendix 1: Trade creation of African RTAs during 1955-2022

Country	Creation (million of pounds)	% of total trade
BENIN	2139.462	27.678%
BURKINA FASO	1247.393	19.898%
CÔTE D'IVOIRE	37,102.187	28.585%
GUINEA-BISSAU	422.191	19.318%
MALI	552.326	9.544%
MAURITANIA	607.734	2.634%
NIGER	1594.244	20.731%
SENEGAL	12,731.912	53.233%
TOGO	7222.807	52.513%
CAMEROON	3633.084	5.345%
CENTRAL AFRICAN.R	26.998	0.703%
CHAD	122.664	0.622%
CONGO-BRAZAVILLE	486.380	0.572%
EQUATORIAL GUINEA	507.971	0.682%
GABON	373.999	0.421%
CAPE VERDE	11.353	1.919%
GAMBIA	123.203	5.405%
GHANA	3241.532	5.502%
GUINEA	336.126	1.480%
LIBERIA	328.760	1.195%
NIGERIA	40,282.345	5.046%
SIERRA LEONE	93.481	1.101%
BURUNDI	202.121	8.023%
COMOROS	7.602	1.127%
EGYPT	12,000.928	4.408%
ERITREA	17.368	1.451%
ETHIOPIA	1364.629	7.237%
KENYA	26,635.335	42.001%
LESOTHO	841.222	13.572%
LIBYA	1075.592	0.234%
MADAGASCAR	831.207	4.103%
MALAWI	3310.990	26.334%
MAURITUS	3447.369	10.207%
MOZAMBIQUE	7675.941	26.916%
NAMIBIA	2581.165	11.867%
RWANDA	324.470	8.680%
SOMALIA	40.201	0.636%
SUDAN	1493.702	1.674%
SWAZILAND	5837.870	41.037%
TANZANIA	4104.096	14.732%
UGANDA	4384.025	26.077%
ZAMBIA	12762.736	25.219%
ZIMBABWE	13,926.581	35.141%
ANGOLA	11,423.655	3.061%
BOTSWANA	1815.810	5.906%
SOUTH AFRICA	99,353.409	10.117%

Appendix 2: The spheres of influence in Africa arranged on the Berlin conference in 1884/85