



LUND UNIVERSITY
School of Economics and Management

Revising the effect of the Internet access on International trade

A study on submarine Internet cables' effect on international trade

by

Gustav Ridell & Martin Weishaupt

May 2019

Master's Programme in Economics

Supervisor: Maria Persson

Abstract

The purpose of this thesis is to further the knowledge of the Internet's effect on trade. The study is conducted by examining the specific example of the introduction of the SAT-3/WASC submarine Internet cable in Benin. The research is conducted by using a Difference in Difference estimator and observing the treatment effect of the Internet cable on the country's exports. Previous studies have mostly used the gravity model. Our approach allows us to observe a more sudden and large variation of the Internet. Exports from Benin and the control country Guinea to 167 other importing countries, between the period of 1998 to 2007 are observed, both on an overall trade level and when additionally allowing for four different product group treatment effects. The paper finds no significant effect of the treatment on the overall trade. The initial results do however suggest that trade on a product level is restructured, trade in some product categories increase while others decrease. However, the results of the placebo test denounce these results.

Table of Content

1	Introduction	6
2	The Internet and trade	8
2.1	Theoretical framework: How the Internet affects trade by decreasing the cost of distance.....	8
2.2	Literature review: Empirical papers	10
2.3	How to measure the Internet?.....	11
2.4	Submarine Internet cables and the specific example of the South Atlantic Telephone Cable 3/West African Submarine Internet Cable	12
2.5	Our approach	15
3	Empirical Methodology	16
3.1	The basic framework of the Difference in Difference estimator	16
3.2	The difference in Difference framework applied to trade and Internet.....	18
4	Data	21
5	Results	24
5.1	Basic Difference in Difference regression	24
5.1.1	Basic Difference in Difference regression	24
5.1.2	Basic Difference in Difference regression allowing for different product group effects	26
5.2	Robustness test	29
5.2.1	Dealing with zero trade flows	30
5.2.2	Placebo test.....	30
5.2.3	Gravity model.....	31
5.2.4	Regressions including population	32
6	Concluding remarks	34
7	References	36
8	Appendix	38

List of Tables

Table 1: Results of the Basic DiD-regression on an overall level.....	26
Table 2: Results of the DiD-regression allowing for different product group effects.....	29
Table 3: Products and export value.....	38

List of Graphs

Graph 1: Internet development in Benin and Guinea.....	
Graph 2: Illustration of Difference in Difference in accordance with (Angrist and Pischke, 2009).....	
Graph 3: GDP in Billion US-\$ for Guinea and Benin.....	
Graph 4: Exports in Million US-\$ for Benin and Guinea	
Graph 5: Skewness of Exports in percent	

1 Introduction

The vast majority of economist today stresses the importance of international trade in order to enhance economic growth and productivity. An environment facilitating trade enables the existence of open economies and greater markets, increases the overall employment and profits and allows for an exchange of knowledge and technologies (World Trade Organisation, 2019).

When highlighting the importance of international trade, more and more researchers emphasize the Internet's role. Venables (2001) states that the Internet improves trade in numerous aspects. Firstly, it decreases the matching and costs for producers when searching for customers and wholesalers. Secondly, the Internet lowers the transmitting cost of digital products to a value close to zero. Thirdly, monitoring and management cost decreases and lastly the Internet reduces costs connected to the supply process.

Previous studies assessing the Internet's impact on trade have mostly used panel gravity models in their research and measured the Internet by controlling for the number of Internet users or web hosts per capita, or other Internet indexes. Time series variation in these Internet variables is likely to be rather low compared to when using a Difference in Difference estimator, the authors' therefore risk of only obtaining cross-sectional variation in the Internet data. The studies are likely to only find a correlation between the Internet and trade, and not a true causal effect of the Internet on trade, especially when there is a lot of unobserved heterogeneity between the countries.

In this thesis, we analyse the Internet's effect on trade by investigating the introduction of a submarine Internet cable (the SAT-3/WASC) in the West-African coastal country Benin in 2002. According to several reports, a direct connection to a submarine cable largely benefits the Internet development of a country and hence also the Internet usage. On a global level, 99 percent of all international Internet traffic is channelled through submarine cables, according to Winseck (2017). Submarine cables are especially important for international data exchange, as they are faster and safer than satellites. The introduction of a submarine Internet cable should therefore create large variation in the Internet from one year to another. Guinea is another West-African coastal country with similar country characteristics which did not receive any major Internet improvements in the same time period. This allows us to conduct a Difference in Difference framework (DiD), where Benin is the treated country and Guinea the control

country. The approach enables us to conduct a before and after comparison, between the treated and control country, and investigate the effect of the treatment, the introduction of the submarine Internet cable in Benin. By obtaining a large sudden variation in the Internet, this study avoids the risk of only looking at cross-sectional data. The aim of the study is to precise and revise the study of the Internet's impact on trade. Export data on an overall and product level from Benin and Guinea to 167 other countries between 1998 to 2008 are used. Controlling for trade on a product level allows us to further precise the research and estimate different effects for different product groups.

Our results suggest that there is no effect of the introduction of treatment on the overall trade, differently to previous literature and our robustness test using the gravity model. When controlling for the four different product groups, the results suggest that the Internet changed the composition of the trade. This, since the results, indicate that some export products increased their trade due to the treatment, while others decreased theirs. However, the placebo test on the four different product group treatment effects denounces these results such that no causal effect could be found. This study concludes that the Internet does not have any effects on trade in this case and that applied gravity models in previous literature most likely have overestimated the effect of the Internet on trade. However, further research on the topic needs to be conducted.

The paper begins with a theoretical framework discussing the Internet's effect on trade and a literature review. This is followed up by a section reviewing the specific example of Benin and the SAT-3/WASC submarine Internet cable. The empirical methodology is then presented, and the data discussed. After that, the results are shown in combination with a discussion of the findings. Lastly, the paper is summarized with some concluding remarks.

2 The Internet and trade

2.1 Theoretical framework: How the Internet affects trade by decreasing the cost of distance

The Internet influences trade by decreasing the costs of distance. Venables (2001) argues that the cost of distance, affected by the Internet, can be divided into four main parts: Search costs, direct shipping costs, control and management costs and the cost of time involved in shipping to and communicating with distant locations. The author describes how these costs can be decreased with the help of the Internet.

Firstly, the Internet decreases the searching and matching costs for producers as it enables them to advertise their goods worldwide at a low cost, which facilitates trade. So that a consumer on the other side of the world can order goods, which would be nearly impossible without the Internet or just very expensive. This makes it easier for producers to find suppliers and consumers far away. For example, Online Market places such as eBay and Amazon help to connect different actors on the market. To summarize, manufacturers can advertise their products with a few mouse clicks on the Internet to a worldwide consumer audience, and the consumers can find companies more easily with the help of various search-engines online.

Secondly, the Internet cuts down the costs of transmitting digital products to a value close to zero. There are several examples of how real goods and services have been transformed into digital products, such as Airline-Tickets, Bank operations and technical drawings. For these goods, distance doesn't matter anymore. The server of an airline can be located on the other side of the world and the consumers will still be able to purchase the ticket for a transportation cost close to zero.

Thirdly, monitoring and management costs can be lowered, and production outsourced, by the usage of the Internet. By outsourcing production to low-cost countries, profits will increase, if the costs of distance are smaller than the wage differences. To keep the cost of distance low, it is not only the transportation costs that should be taken into account, but also management and monitoring costs. Venables (2001) argues that monitoring costs will be decreased by the usage of the Internet and that it additionally enables outsourcing. This holds especially for mass production with standardized products, as the design of standardized goods often can be

digitalized so that the quality of the products can be controlled more efficiently. The production of a computer, for example, can easily be outsourced, as all computer components are mostly standardized. Concerning management costs, the Internet helps to connect people. To some extent, the Internet can substitute phone calls and other communication methods. However, there is still a need for face-to-face conversations to ensure contracts. The Internet will not be able to substitute this.

Fourthly, the time of the supply process, and hence costs related to this, can be decreased with the help of the Internet. Especially for costs related to basic information when dealing with customer orders, since the Internet can transmit information online in a matter of seconds. For example, the Internet enables retailers to use electronic stock controls, so that they receive immediate notifications if a product is out of stock and thereby reduce delays in the supply process. The Internet can also help to completely automate order systems.

Additional examples of how the Internet impacts trade is described by Freund and Weinhold (2004). They construct a model with imperfect competition and segmented markets, where the Internet reduces the fixed entry costs of entering a market. They argue that the main reason for the Internet increasing trade is that it decreases the matching costs, equally as Venables (2001) states. Furthermore, Freund and Weinhold (2004) use Rauch (1999) to emphasize that the Internet decreases information costs with similar effects such as having colonial ties or sharing a common language, because of the information being exchanged easier.

As shown, the Internet can affect the trade in various ways. However, the effect of the Internet is likely to be stronger for services. Venables (2001) for example argues that the costs of transmitting airline tickets are reduced to a value close to zero, while normal goods are not impacted by the same effect. Our study focuses on trade in products. The largest effect of the Internet on trade in products is likely to be achieved by the lowered costs of matching consumer, wholesalers and producers, similarly to what Freund and Weinhold (2004) argue. Venables (2001) also states that different products will be affected differently by the Internet. For example, standardized products such as computers will benefit more than non-standardized goods. Also, homogenous products are likely to not be as majorly affected by the decreased search costs facilitated by the Internet compared to heterogenous products. This, since the need to search for specific variations of homogenous products should not be that important.

2.2 Literature review: Empirical papers

Freund and Weinhold (2004) wrote an important paper on trade and the Internet. It examined the relationship between trade, Internet and distance and if the Internet's effect on trade differed between rich and poor countries. The research was conducted by running several time-series and cross-section regressions, including both the gravity equation and additional panel growth regressions. They used panel data from 56 countries measuring exports from 1995 to 1999. The results differed depending on the years of measurement. The authors found no effect of the Internet on trade in 1996. However, from 1997 and onwards the effect became significantly larger and the impact grew year by year. The paper found that that a one percent increase in Internet growth increased the export by 0.02 percent. The Internet's effect on trade was also stronger for poorer countries than richer ones.

Clarke and Wallsten (2006) investigated the Internet's effect on trade between developed and developing countries. The authors conducted the research by using the gravity model and including similar variables to Freund and Weinhold (2004). Clarke and Wallsten (2006) used export data from 93 countries from 2001. Furthermore, they conducted a 2SLS approach to overcome the problem of causality when measuring the Internet and trade, which will be further discussed later in this section. They also included additional variables to control for possible endogeneity bias. Additionally, they added GDP per capita as an alternative measurement for wealth. Their results showed that the Internet increased the exports from developing countries, with high Internet penetration rates, to developed ones. A one percent increase in the Internet hosts of developing countries increased the export by 0.4 percent to developed countries. The authors could not find any significant effects of the Internet on trade between two developed countries nor between two developing countries with one having a high penetration rate and the other one having a low penetration rate.

Furthermore, Lin (2015) studied how the Internet affected international trade by focusing on the Internet's impact on information costs. The author used the gravity model and introduced export panel data from 200 countries between 1990 and 2006. The possible issue of endogeneity, discussed in the next paragraph, was tackled by adopting an additional instrumental variable and using a GMM estimator. The results indicated that the Internet reduced information costs for traders. Lin's (2015) findings suggested that a one percent increase of the Internet users follows a 0.02 to 0.04 percent increase in trade.

Both Clarke and Wallsten (2006) and Lin (2015) argued that there could arise a problem of endogeneity and the direction of causality when investigating trade and the Internet. Countries who have previously traded more are more likely to have a larger number of Internet users, compared to countries who previously have traded less. Trade is likely to spur international integration and additionally Internet activity, creating a problem of the direction of causality. Lin (2015) additionally stressed that government policies could increase the biases due to the lack of complete information and transparency on export promotion and enforcement of import restrictions.

Abeliansky and Hilbert (2017) estimated the effect of information and communication technology's (including the internet's) effect on trade by employing the gravity model. They used panel data from 122 countries from 1995 to 2008 to measure exports. The results of the paper indicated a significant effect of both the quality and the quantity of ICT on trade. For developing countries, quality was more important than quantity. A one percent increase in the quality of the Internet increased the trade with 0.5 percent while a one percent increase in the quantity of the Internet increased the trade with only 0.3 percent.

To conclude, previous literature has used similar approaches when investigating the Internet and trade. The gravity model has been commonly applied and the studies have found similar results suggesting that the Internet has a positive but rather small effect on trade. The effect of the Internet on trade seems to be larger for developing countries. However, Clarke and Wallsten (2006) found evidence suggesting that developing countries only increased their trade when trading with developed ones.

The data used in previous research has usually been measured from the late 1990s. The concern of the direction of causality when investigating the Internet and trade has been debated and tackled with different approaches. A discussion of how previous literature has measured the Internet is summarized in the next section.

2.3 How to measure the Internet?

The variable measuring the Internet can be constructed in different ways. Freund and Weinhold (2004) introduced the variable *cyber mass* to control for the Internet. *cybermass* consists of data from the Internet-software consortium (ISC) and measured the number of web hosts linked to each country by counting top-level host domain names. The variable has a disadvantage since

it is impossible to be certain that a specific host domain name is situated in the correct country. A website with the domain .se can, for example, be hosted outside of Sweden. There are also domains such as .com or .org that are not tied to a specific country. The authors also ran a regression with an alternative Internet variable that measures the number of Internet users in each country with data from the World Bank. Their second Internet variable included data from 34 out of the initial 56 countries and gave similar results.

Both Clarke and Wallsten (2006) and Lin (2015) introduced an instrumental variable to overcome the problem of endogeneity. Clarke and Wallsten's (2006) instrumental variable accounted for whether a single company had a legal monopoly over data transmission services in a given country, with the intuition that the Internet usage should be lower in a country with a monopoly. Their original variable measuring Internet accounted for the number of Internet hosts per hundred people. Lin (2015) argued that Internet usage of a country is correlated with the citizen's access to the Internet. His instrumental variable measured the sample countries' ranking on the civil liberty index from the NGO Freedom House. The paper's original independent variable measured the number of Internet users per hundred people in a country. Lin (2015) argued that employing the measurement of Internet users instead of the measurement of web hosts, used by Freund and Weinhold (2004) and Clarke and Wallsten (2006), was a more appropriate approach when measuring international trade and Internet. This, since the amount of Internet users, is likely to have a more direct impact on international trade.

Abeliansky and Hilbert (2017) introduced two variables that measured Internet quality and quantity. Internet quantity was defined as data subscriptions per capita and Internet quality as bandwidth data speed per subscription. The authors used bandwidth data speed kbps per subscription, instead of subscription alone or an ICT index. The results suggested that the quantity and quality variable were not massively correlated, which indicates that they were not equivalent.

2.4 Submarine Internet cables and the specific example of the South Atlantic Telephone Cable 3/West African Submarine Internet Cable

In 2016, there were 356 Internet submarine cables with a combined length of about 1.3 million kilometres in the world. For example, in North America, only one percent of the Internet traffic

was running through wireless networks, the rest was channelled through submarine or land cables. On a global level, 99 percent of all international Internet traffic is going through submarine cables, the rest is mostly run through satellites. Submarine cables are especially important for international data exchange, as they are faster and safer than satellites. The submarine cables are a big part of the Internets' backbone, as they connect the local Internet service providers (ISPs) with the 2.000 Internet exchange points (IXPs) worldwide (Rauscher, 2010; Winseck, 2017). Submarine cables are largely important for the international financial sector, national governments and consumers around the world. As they all depended on intercontinental information exchange enabled by the Internet. For example, the network "Society for Worldwide Interbank Financial Telecommunications" (SWIFT) is facilitated partly by submarine Internet cables. SWIFT accounts for 25 million payment messages a day to a value of 7 trillion US-\$ (Winseck, 2017).

The idea of constructing a large African submarine Internet cable was initiated during the late 1990s. The first project was backed by the World Bank to meet the increased demand from Internet users. The cable was planned to connect the East, West and South of Africa and further continue to Europe. However, the initiative was met with a revised proposition from several West-African governments and telecom operators who wanted to make the project more commercially profitable. The new tapered proposition was further discussed as the *South Atlantic Telephone / West African Submarine Cable* (SAT-3/WASC (Esselaar, Gillwald and Sutherland, 2007). The gathering of funding for the SAT-3/WASC cable was finalized in 1999, three years after the initial plan started. The cost of construction was estimated at 650 million US-\$ and the submarine Internet cable began its commercial activities in April 2002 (Jagun, 2008).

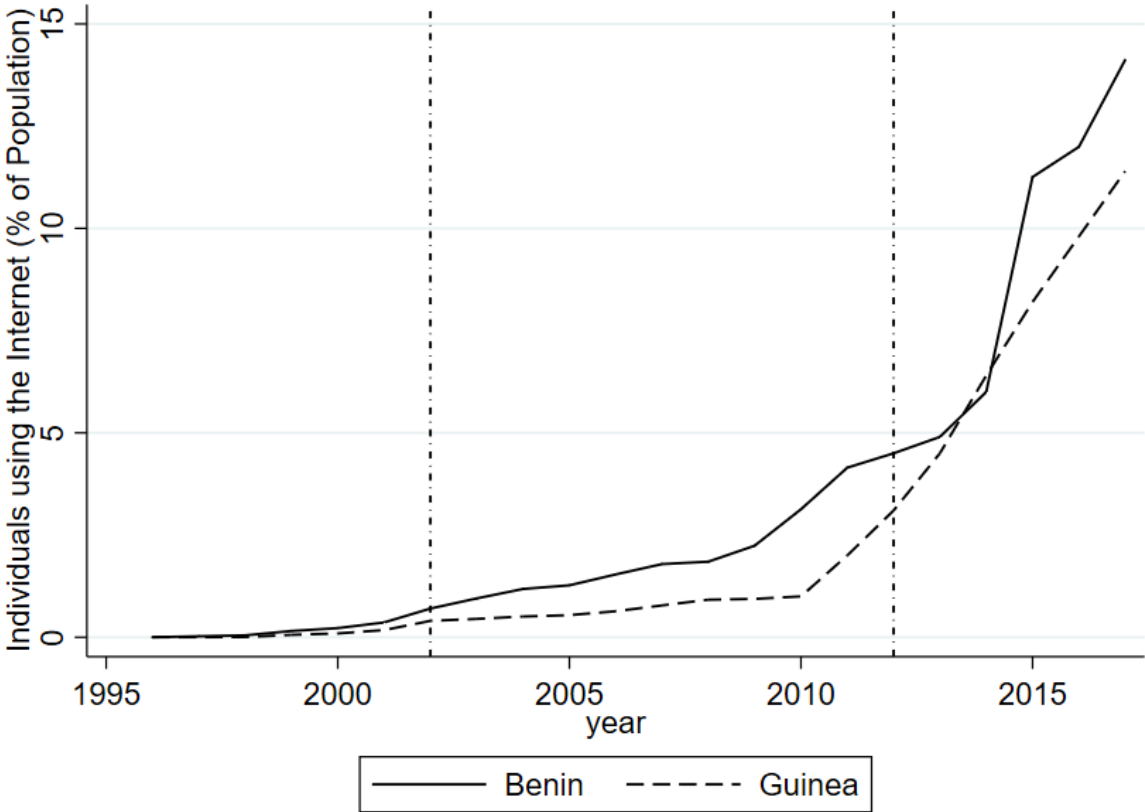
The original cable was 14.350 km long and linked Portugal and Spain to South Africa with several extensions to West African countries (Jagun, 2008). When combined with the South African Fast East (SAFE) submarine cable, it reached all the way to Malaysia and India. The connection to the SAFE enabled a new alternative for Internet operators when connecting East Asia and Europe (Osiakwan, 2008).

Accessing information on the founding agreement is difficult since it was marked as "commercially confidential" (Osiakwan, 2008). This makes it hard to find details on why some West African countries were included in the project and others were not. One reason for excluding some countries, indicated by Frempong (2007), was that the initial consortium

wanted to maintain its monopolistic management, which would be threatened by widening the ownership. An explanation to why Guinea in particular was not included in the SAT-3/WASC project was the previous lack of Internet traffic in the country (Esselaar, Gillwald and Sutherland, 2007).

This paper aims to extend the research of the Internet and trade by investigating the specific example of the SAT-3/WASC submarine Internet cable and the two West African coastal countries Guinea and Benin. Benin was connected to the SAT-3/WASC cable when it was built in 2002. The first submarine Internet cable that Guinea was connected to was the African Coast to Europe (ACE) cable which was constructed in 2012. Benin was also connected to the ACE-cable (TeleGeography, 2019).

Both the SAT-3/WASC and the ACE cable have increased Benin's and Guinea's Internet to a large extent. Domínguez-Torres and Foster (2011) argued in a report from the World Bank that Benin improved their Internet development greatly with the help of the SAT-3/WASC. Similarly, several analysts and experts, including Lancaster (2019), have concluded that Guinea's involvement in the ACE-cable highly increased the capacity of the country's Internet,



Graph 1: Internet development in Benin and Guinea

both in speed and penetration rate. This is illustrated in Graph 1 as for Benin the Internet usage increased after 2002. The internet usage starts to increase majorly in Guinea from 2010 and onwards. This could be explained by the introduction of the ACE-cable in 2012. The Internet increase in 2010 and 2011, is likely to have occurred due to anticipation effects.

2.5 Our approach

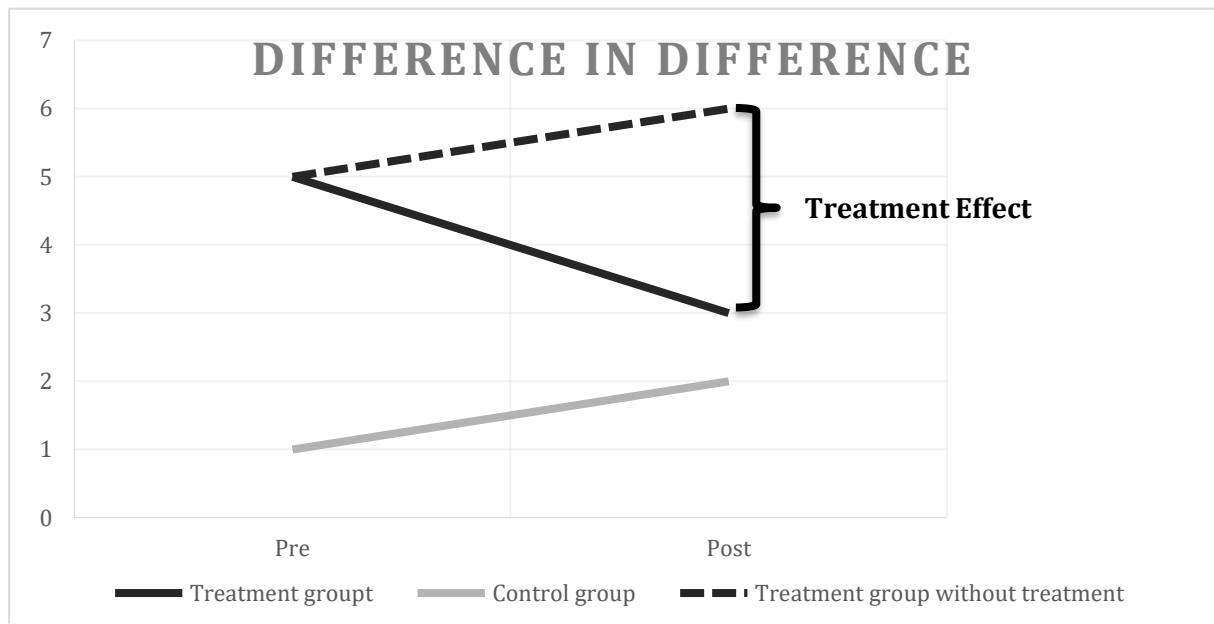
Our approach differs from the previous literature since we are using the difference in difference framework when estimating the effect of the Internet on trade. This enables us to retrieve a larger and more sudden variation of the Internet and therefore retrieving a more casual relationship. The SAT-3's/WASC's early construction makes a comparison between Guinea and Benin favourable as it enables a large variation of the Internet variable. Benin was exposed to a major telecommunications investment at an earlier stage, due to the establishment of the SAT-3/WASC in 2002. Whereas Guineas first submarine internet cable, the ACE-cable, was not built until 2012.

To our knowledge, no previous research has utilized that methodology when measuring the Internet's effect on trade. Additionally, investigating submarine Internet cables' impact on trade has not been commonly conducted before, especially not the specific example of the SAT-3/WASC and Benin. As an alternative to our approach, previous literature on trade and the Internet have mostly used the gravity model and measured the Internet with different indexes, which induces some problems discussed in section 2.3. Additionally, the variation of the Internet variable will be smaller than compared to when applying the DiD-framework. Hence, the validity of their studies can be discussed.

3 Empirical Methodology

3.1 The basic framework of the Difference in Difference estimator

The basic intuition behind the Difference in Difference (DiD) methodology is that one group is affected by a treatment and a comparable control group is not. Due to the treatment occurring at a specific time in the treated group, the pre- and posttreatment effects of the treatment group can be compared to the pre- and posttreatment effects of the control group, such that the control group captures all the characteristics of the treatment group except the effect of the actual treatment. Hence, the effects of the treatment can be observed (Slaughter, 2001). An important



Graph 2: Illustration of Difference in Difference in accordance with (Angrist and Pischke, 2009)

assumption is that the two groups have a common trend, so without any treatment, both groups should have a similar development in the variable of interest, the dependent variable. This is called the parallel trend assumption.

The treatment effect is illustrated in Graph 2. The dashed and the grey line illustrate the changes for the treated and control group over time excluding the treatment effect. However, as the treated group is affected by a treatment, the development differs. The treatment effect is the difference between the dashed and the black line. The dashed line post-treatment cannot be

observed. But with the help of the parallel trend assumption, the point can be estimated and hence the treatment effect can be calculated.

Meyer (1995) specified the following DiD equation:

$$y_{ijt} = \alpha + \lambda d_t + \gamma d_j + \delta d_{jt} + \epsilon_{ijt} \quad 3.1$$

The indices of the variables are j , i and t . For the treatment and control group, j can take the value zero (control-group) or one (treatment-group), i is a unit index and t a time index defined as zero (pre-treatment) or one (post-treatment), indicating that there are two periods. To measure the effect of the treatment, a common approach is taking the averages of the years before and after the treatment. Consequently, the two periods, before and after, are created. The variable of interest in this equation is y_{ijt} . d_t is a dummy variable taking the value one if t is within the treatment period and otherwise zero. Hence, λ picks up the common time variation before and after the treatment for both groups. d_j is a dummy variable taking the value one if group j is the treated one, and otherwise zero. Therefore, γ picks up the difference between the groups that are constant over the two periods. d_{jt} is a dummy variable that is one if both j and t are one and otherwise zero. δ captures the true causal effect of the treatment on the dependent variable. Note that if there is no treatment, δ must be equal to zero, or $E(\epsilon_{ijt} | d_{jt}) = 0$. α is a constant that picks up the effects if j and t are zero for all other variables. The error term is defined as ϵ_{ijt} . To derive the coefficients, mostly Ordinary Least Squares (OLS) are used (Angrist and Pischke, 2009; Meyer, 1995; Wooldridge, 2018).

To further precise the estimation, fixed effects capturing group-specific effects and other control variables can be included. This to control for unobserved effects on levels that might not have been captured by the DiD. This enables the regression to retrieve a more precise estimation and decrease the omitted variable bias.

The estimated average DiD-effect $\hat{\delta}$ is retrieved with the help of the following equation:

$$\hat{\delta} = (\bar{Y}_{treatment, after} - \bar{Y}_{treatment, before}) - (\bar{Y}_{control, after} - \bar{Y}_{control, before}) \quad 3.2$$

In equation 3.2 the estimation of the causal effect is shown. $\hat{\delta}$ is obtained by making a before and after comparison in both the treatment and control group and then subtracting the results. Thereby, all group fixed effects and common time effects are erased. The two groups (treatment

and control) can be broken down into four parts, as for both groups' information is available before and after treatment (Angrist and Pischke, 2009).

3.2 The difference in Difference framework applied to trade and Internet

The DiD-methodology is mostly used within labor economics to analyse changes in government policies, for example, an increase of the minimum wage. We adjust the methodology to utilize the framework in our study of trade and the Internet. We use a sample including Benin and Guinea as exporters, 167 countries from the rest of the world as importers and 97 different product-categories to measure trade. The products are further categorized into four different groups using an additional regression. Since the data is observed on a product level, the "individual" in the specification will be a combination of a product, exporter and importer.

There are several requirements for the DiD-framework to work in this example. There must be one country that invested in Internet infrastructure or adopted new technologies, and one that did not, and thereby suddenly largely increasing the Internet usage. This enables the effect of the adoption/investment to be estimated more precise through a treatment effect. This study utilizes the DiD-framework by studying the specific example of Benin and the introduction of the SAT-3/WASC submarine Internet cable. Benin, the treated country, was connected to its first submarine cable (The SAT-3/WASC) in 2002, whereas Guinea, the non-treated country, received its first direct connection to a cable in 2012. As discussed in section 2.4, having a direct connection to a submarine Internet cable is advantageous for the Internet development and usage of the country, as the Internet becomes faster and more reliable.

Secondly, there should not be any other major investments or adoptions in these countries within the observed time period, such that the pure effect of the treatment effect can be observed. Otherwise, the results risk of becoming biased. According to our research, there were no significant investments in the Internet infrastructure in neither Guinea nor Benin during the observed period.

This study uses an adoption of the Difference in Difference framework from Meyer (1995) discussed in section 3.1 to estimate the SAT-3/WASC submarine Internet cable's effect, which equals the treatment effect, on Benin's export compared to the control country Guinea. Three

dimensions of fixed effects are applied to the regression; time, importer and product fixed effects. This, to control for certain types of omitted variable biases. The time fixed effects capture all the effects that change over time, such as macroeconomic shocks, arise of global conflicts or new trade deals. Hence, any new trade agreements signed by ECOWAS, an economic and political union which both Guinea and Benin are members of, should be captured by the time fixed effects. We introduce time fixed effects instead of the specific time dummy used in equation 3.1¹. This since time fixed effects are custom and almost always used within the research of international trade. The importer fixed effects capture unobserved heterogeneity that is constant over time but varies between importers, such as the financial regulations, languages and historical factors: for example, having a specific former colonizer. The product fixed effects are also included to capture unobserved characteristics that are constant over time, but different across products, such as systematic differences in manufacturing and transportation of products. These effects might not have been controlled for if we only used the original DiD-equation without the additional fixed effects.

GDP and distance are added as control variables in the DiD-equation since they both have a large impact on trade. According to the gravity model described by Bacchetta et al. (2012), countries trade in proportion to their GDP, larger economies tend to trade more with each other, similarly to the Newtonian theory of gravitation. Distance has the opposite effect on trade according to the gravity model: an increase in distance will decrease trade.

Our basic Difference in Difference regression with natural logarithms takes the following form:

$$\ln EX_{ijpt} = \alpha + \gamma BEN_{jp} + \delta(BEN_{jp} \cdot d_t) + \ln GDP_{jt} + \ln GDP_{it} + \ln dist_{ij} + FEI_i + FET_t + FET_p + \varepsilon_{ijpt} \quad 3.3$$

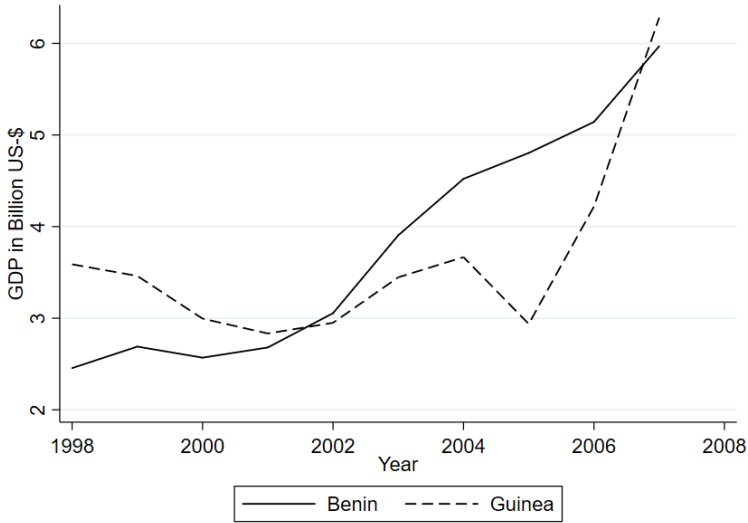
The depended variable $\ln EX_{ijpt}$ is defined as the exports of country $j \in \{\text{Benin, Guinea}\}$ in year $t \in \{1998 - 2007\}$ for the product level p to importer i . α is the intercept, that picks up all the effects of Guinea before the treatment, BEN_{jp} is an export specific dummy variable for Benin which enables the coefficient γ to capture differences between Guinea and Benin over all observed years on a product level, hence a specific time-invariant country effect for Benin.

¹¹ We re-ran the regression introducing a similar time-dummy as employed in regression 3.1 This gave us identical results.

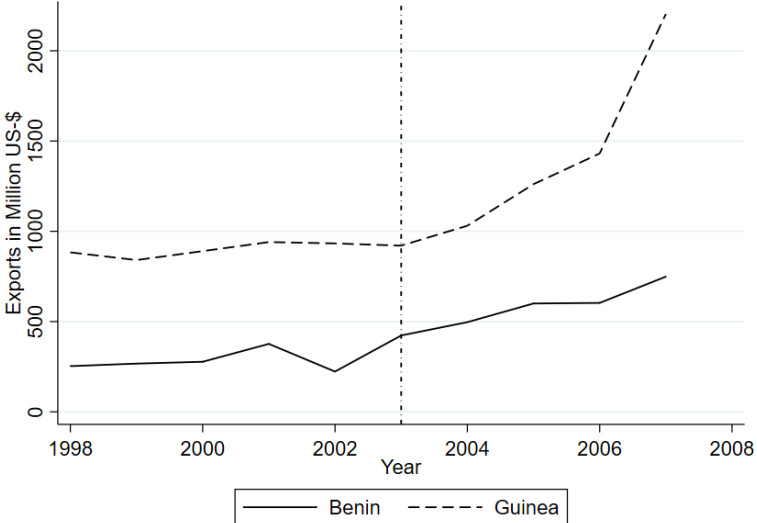
d_t is a time dummy variable taking the value one during the treatment period, and the value zero before. The causal effect – treatment effect – of introducing the submarine Internet cable in Benin on exports is represented by δ as it measures the effects of the interaction term between BEN_{jp} and d_t . In other words, if δ is significant the economic interpretation would be that the Internet clearly affects the exports of Benin. In GDP_{jt} controls for the exporting countries' (Benin and Guinea) GDP. In GDP_{it} controls for the corresponding values for the 167 importing countries' GDP. In $dist_{ij}$ controls for the distance between Guinea and Benin denoted as j , and their associated trading partners, denoted as i . The variable does not have a time index as the distance over time between countries does not alter. FEL_i denotes the importer fixed effects. FET_t the time fixed effects and FET_p the product fixed effects. ε_{ijpt} is the error term of the regression (Angrist and Pischke, 2009; Wooldridge, 2018).

4 Data

The trade data used in this paper was retrieved from the United Nations (2019). It measures exports from Benin and Guinea to 167 countries during the time period of 1998 to 2007, using the rest of the world as importers and Benin and Guinea as exporters. The data set includes a total of 4,126 observations. The trade is measured on a product level using the Harmonized commodity description and coding system (HS) with a two-digit code. The two digit-codes



Graph 3: GDP in Billion US-\$ for Guinea and Benin



Graph 4: Exports in Million US-\$ for Benin and Guinea

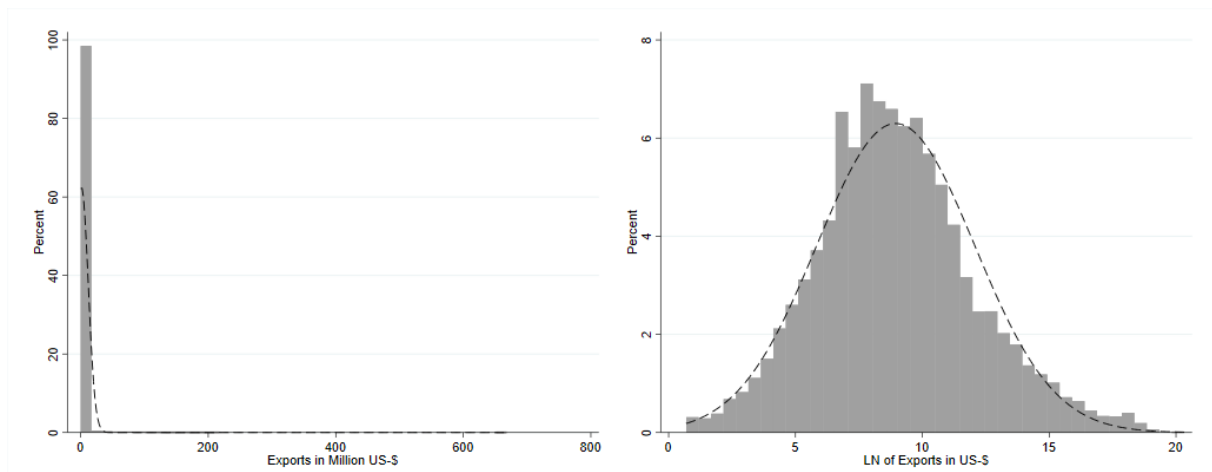
sorts the traded products into 97 different categories according to the 1992 standard. This paper

further categorizes the products into four larger groups. Category one: Food, tobacco, vegetables and wood products. Category two: Raw material, chemicals, other metals and plastics. Category three: Textiles, clothes, furnishing products and other leisure goods. Category four: Machines, military equipment and other products not specific according to kind (see Appendix for the different export values for each product group). Benin's average export value per year amounted to 426.9 million US-\$ and Guinea's to 1133.4 million US-\$.

Data on GDP was collected from the World Bank national accounts data (2019) for both the exporters and importers. 64 observations of GDP were dropped due to missing values. The average GDP per year amounted to 3.9 billion US-\$ for Benin and 3.7 billion US-\$ for Guinea

Benin and Guinea had similar developments in GDP and exports before the treatment effect. Graph 3 illustrates the development of the GDP in Benin and Guinea over the observed time period. Both countries share similar growth trends in GDP but have different fluctuations. Graph 4 illustrates the export values for Benin and Guinea over the observed time period. Both countries share a similar trend before the treatment effect. However, Benin had a temporary decrease in trade in 2002. After the treatment, the trade trend of the countries develops similarly at first. However, Guinea's trade increases rapidly after 2005. This could possibly be explained by the country's large growth of GDP in 2005 and onwards, see Graph 3. Additionally, they have other similar country characteristics such as sharing a similar size of the population, several similar cultural and historical characteristics. French is the official language in both countries, and they share France as a previous colonizer. The above-mentioned factors speak in favour of the parallel trend assumption connected to the DiD-framework, discussed in section 3.1, being fulfilled.

The skewed distribution of the two countries' exports is illustrated in Graph 5. The initial distribution of the trade data is illustrated on the left side. It is highly skewed to the left. Therefore, the natural logarithm of the variables measuring trade, GDP and distance are used in the regression of the study. The distribution then becomes normally distributed, see the right part of Graph 5. By taking the natural logarithms, the results become less bias due to avoiding extreme values.



Graph 5: Skewness of Exports in percent

Data on the distance between Guinea and Benin and their trading partners were retrieved from the CEPII database (2019). The average distance between an importer and an exporter amounted to 4611 km.

The paper measures the treatment effect with a one-year lagged variable. This, since the largest effect of the introduction of the submarine Internet cable, is not likely to occur immediately. There should be an adjustment period connected to large infrastructure investments. Additionally, 2003 was the first year where the new submarine Internet cable was used during all 12 months of the year.

The (United Nations, 2019) data measuring trade values included 85 observations of trade values with the importer denoted as “Other Asian countries”. These observations were dropped since the importer was impossible to identify, no distance or GDP could be matched to the countries.

5 Results

5.1 Basic Difference in Difference regression

The treatment effect is measured with two different approaches. Firstly, on an overall trade level and secondly, by allowing the treatment effect to differ between four different product groups, specified in section 4. The second approach is introduced to investigate if the Internet affect different products differently. Venables (2001) findings, presented in section 2.1, states that different products are likely to be affected differently by the Internet

5.1.1 Basic Difference in Difference regression

The results of the basic DiD-equation on an overall trade level is discussed in this section. The results are presented in Table 1 column 1.

The variable $D_{treateffect}$ is an interaction dummy term that captures the impact of the treatment effect on Benin's exports. The treatment variable is lagged one year and measures the effect of the treatment in 2003. The coefficient of $D_{treateffect}$ takes the value of 0.02 which corresponds to an increase of two percent², indicating that the introduction of the submarine Internet cable increased the exports. However, the variable is not significant, such that no causal effect of the infrastructure investment can be made. This finding is not in line with our hypothesis, presented in the introduction, nor the theoretical argument and previous research discussed in section 2. As previous papers mentioned have found significant effects of the Internet on trade.

LN_GDP_EX measures the natural logarithm of GDP in the exporting countries' and its effect on trade (Benin and Guinea). The variable takes a positive sign as expected. LN_GDP_IM is a similar variable that measures the natural logarithm of the importing countries' GDP and its effect on trade (167 countries from the rest of the world). It also takes a positive sign. However, none of the two GDP variables are significant. Hence, no causal correlation between GDP and

² The following equation is used to interpret the coefficient of the dummy variable in percentage points: $100 \times [\exp(C)-1]$

trade in this study can be made. These findings contradict previous research, such as the gravity model including Anderson's (1979) paper which finds a positive relationship between GDP and trade. The insignificant result of the importer GDP variable could partly be explained by the importer fixed effects as they might also capture GDP.

The distance variable *LN_distcap* measures the natural logarithm of the distance, measured in km between the trading partners' capitals. The variable is negative, indicating that an increase in the distance is followed by a decrease in the exports. This result was rather expected. The variable is significant on a one percent level and the results are in line with previous studies, for example, the gravity model and Anderson's (1979) paper which finds a negative relationship between distance and trade.

D_Benin is a dummy variable that captures the specific time-invariant country effect for Benin. The coefficient is significant on a one percent level and takes a negative sign as expected since the exports of Benin are smaller than the exports of Guinea over the observed time period. This is illustrated in Graph 4.

Table 1: Results of the Basic DiD-regression on an overall level

VARIABLES	(1) Basic regression	(2) Robustness test: zero trade	(3) Robustness test: Placebo year 1999	(4) Robustness test placebo test: year 2006	(5) Robustness test: population	(6) Robustness test: Gravity Model
D_treateffect	0.02 (0.93)	0.19 (0.36)	0.62 (0.10)	0.16 (0.40)	0.04 (0.92)	-
LN_GDP_EX	0.10 (0.85)	-0.22 (0.52)	-1.32* (0.08)	0.11 (0.85)	0.12 (0.84)	0.02 (0.96)
LN_GDP_IM	0.48 (0.14)	0.57*** (0.00)	0.50 (0.22)	0.37 (0.25)	0.47 (0.16)	1.23*** (0.01)
LN_POP_EX	-	-	-	-	-1.16 (0.86)	-
LN_POP_IM	-	-	-	-	4.29*** (0.00)	-
LN_distcap	-1.50*** (0.00)	-1.43*** (0.00)	-1.46*** (0.00)	-1.50*** (0.00)	-1.51*** (0.00)	-1.52*** (0.00)
D_Benin	-0.48*** (0.00)	-0.47*** (0.00)	-1.16*** (0.00)	-0.51*** (0.00)	-0.76 (0.63)	-
Internet_IM	-	-	-	-	-	0.01** (0.03)
Constant	21.13*** (0.00)	20.76*** (0.00)	22.82*** (0.00)	21.49*** (0.00)	-31.58 (0.76)	17.78*** (0.00)
Observations	4,126	7,419	3,294	4,564	4,113	2,845
R-squared	0.39	0.38	0.40	0.40	0.39	0.41
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Importer FE	Yes	Yes	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust p-values in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.1.2 Basic Difference in Difference regression allowing for different product group effects

The results of the Basic DiD-regression that allows for four different product group treatment effects are presented in Table 2 column 1. The *prod1*, *prod2*, *prod3* and *prod4* variables measure the impact of the treatment effect on the exports of the corresponding product groups. They are constructed by multiplying the treatment effect (*D_treateffect*) with a dummy variable representing each product group. The regression in this section is created by adding the four new product interaction dummies, *prod1*, *prod2*, *prod3* and *prod4* to the initial DiD-regression,

presented in section 3.2. The *D_treateffect* variable is additionally dropped. Dummies for the product groups are not included as we already use product fixed effects.

The variable *prod1* takes a value of -0.12, indicating a negative effect of the treatment effect on exports of product group one in Benin. However, the variable is insignificant. The variable *prod2* takes the value of -0.47 and is also insignificant. Hence, no major conclusion of the treatment effect on product group one and two can be made. The variable *prod3* takes the value of 1.05 and is significant on a one percent level, indicating that the treatment effect had a positive impact on exports for product group three. The variable *prod4* takes the value of -0.63 and is significant on a five percent level, indicating that the treatment effect had a negative impact on exports for product group four. Overall, different product groups have been affected differently by the treatment effect

The following variables: *LN_GDP_EX*, *LN_GDP_IM*, *LN_distcap* and *D_Benin* did not change significance level or the sign of the coefficients when additionally allowing for the four different product group treatment effects.

When comparing these results with the findings from 5.1.1, the results suggest that the submarine Internet cable did not increase the overall trade, but possibly changed the composition of the trade. Some product groups increased their trade, while others decreased theirs. Consequently, some industries likely gained additional market shares due to the treatment effect while others decreased theirs. The change of composition in trade could possibly be explained by comparative advantages. (Hausman, 2016) from the Center for International Development at Harvard University have data on Benin's exports. It suggests that product groups that had great revealed comparative advantages in Benin benefited the most from the treatment effect. The products that already had large market shares before the treatment seemed to have increased their trade even more due to the increased Internet. Products that took up smaller market shares and lacked comparative advantages before the treatment seemed to not have been able to take advantage of the increased Internet. For example, the data from Hausman (2016) on Benin's exports indicate that cotton was the product with the greatest revealed comparative advantages in Benin around the time of the construction of the cable. Cotton is a part of product group three that increased its trade due to the treatment effect. Hence the statistics from Hausman (2016) strengthens the reasoning of products with large comparative advantages being able to utilize the increased Internet. Industrial machines, on the other hand, had a very small revealed comparative advantage around the time when cable was

introduced, and the product is a part of product group four which decreased its trade due to the treatment.

The lack of a significant treatment effect on product group two could possibly be explained by that the decrease of search costs, facilitated by the Internet, did not benefit the trade of the products in group 2. Raw material, chemicals and other metals usually consist of rather homogenous goods, searching for different variations of the products should not be as important. Additionally, as argued in section 2.1, the Internet's ability to reduce the searching costs connected to products is an important factor of how the Internet increases trade. For product group two, this cost-decreasing ability is likely to not affect the product group to any wider extent.

Table 2: Results of the DiD-regression allowing for different product group effects

VARIABLES	(1) Basic regression	(2) Robustness test: zero trade	(3) Robustness test: Placebo year 1999	(4) Robustness test placebo test: year 2006	(5) Robustness test: population
prod1	-0.12 (0.69)	-0.08 (0.73)	0.26 (0.53)	-0.16 (0.52)	-0.17 (0.68)
prod2	-0.47 (0.22)	0.07 (0.80)	-1.11** (0.01)	0.37 (0.22)	-0.51 (0.28)
prod3	1.05*** (0.00)	1.06*** (0.00)	2.08*** (0.00)	0.91*** (0.00)	1.02** (0.01)
prod4	-0.63** (0.04)	-0.36 (0.12)	0.48 (0.23)	-0.48** (0.04)	-0.69* (0.10)
LN_GDP_EX	0.07 (0.90)	-0.25 (0.47)	-1.34* (0.07)	0.09 (0.88)	0.04 (0.94)
LN_GDP_IM	0.49 (0.14)	0.57*** (0.00)	0.61 (0.13)	0.36 (0.26)	0.47 (0.15)
LN_POP_EX	-	-	-	-	0.12 (0.99)
LN_POP_IM	-	-	-	-	4.55*** (0.00)
LN_distcap	-1.49*** (0.00)	-1.42*** (0.00)	-1.48*** (0.00)	-1.50*** (0.00)	-1.50*** (0.00)
D_Benin	-0.46*** (0.01)	-0.46*** (0.00)	-1.13*** (0.01)	-0.49*** (0.00)	-0.42 (0.79)
Constant	21.08*** (0.00)	20.66*** (0.00)	22.52*** (0.00)	21.56*** (0.00)	-56.32 (0.58)
Observations	4,126	7,419	3,294	4,564	4,113
R-squared	0.40	0.39	0.42	0.41	0.40
Year FE	Yes	Yes	Yes	Yes	Yes
Importer FE	Yes	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes	Yes

Robust p-values in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.2 Robustness test

Several tests are run to check the robustness of the regressions presented in Table 1 and Table 2. The tests consist of dealing with zero trade flows, a placebo test, a gravity model and regressions including population. The tests are run on both the regression measuring trade on an overall level and the regression allowing for the four different product group treatment effects, except the gravity model. It is only run on an overall trade level.

5.2.1 Dealing with zero trade flows

The data set used in section 5.1 did not include any zero trade values, which could potentially cause a bias in the results. To check the robustness of the results, we added zero trade values to the dataset for all combinations of year, importer, exporter and product where no observations were reported previously.

The new results on an aggregated trade level are presented in Table 1 column 2. The *D_treateffect* variable in the new regression takes a positive value. It is larger compared to the corresponding coefficient in section 5.1.1. However, the variable is still insignificant. Most of the coefficients of the other variables take similar values to the corresponding ones in the basic DiD-regression presented in column 1. The only major difference is that the *LN_GDP_IM* now is significant on a one percent level and takes a positive value, it was previously insignificant. The new results are in line with previous research investigating the effect of GDP on trade flows, for example the gravity model and Anderson's (1979) paper. Additionally, all the p-values of the variables decreased, this can probably be explained by the increase of observations in the data set.

The results of adding zero trade values to the DiD-regression when allowing for the four different product group treatment effects are presented in Table 2 column 2. *Prod4* is now insignificant, it was significant and took a negative value in the basic regression presented in column 1. The rest of the *prod* variables take similar values to the basic regression and the significance levels did not change. Similarly, when measuring trade without product group treatment effects, the *LN_GDP_IM* variable is significant and positive when including zero trade. Also, the p-values of all the variables have increased due to including zero trade values.

The results in this section indicate that the zero trade flows do not add any precision to the estimation of the variables.

5.2.2 Placebo test

A placebo test is used to investigate if the treatment effect can be observed at times when there was no treatment, such that the results do not solely depend on the parametrization of the chosen year, and that the parallel trend assumption does not hold. The test is conducted by running the initial DiD-regression with a fictitious treatment year. In a perfect experiment, the coefficients

of the treatment term should be insignificant and close to zero, such that the parallel trend assumption holds. Hence, the leads and lags should have no major significant effect on the dependent variable.

The results of the placebo test on an overall trade level are presented in Table 1 column 3 (treatment year equalling 1999) and column 4 (treatment year equalling 2006). The fictional treatment years have no significant effect on trade. This indicates that our DiD-design is well specified on an overall trade level. Significant results in 1999 or 2006 would highly threaten our research design. However, *LN_GDP_EX* changed its sign in column 3 and has become significant. This finding was not expected. However, it can partly be explained by Guinea's GDP decreasing around 1999 while their exports remained positive, illustrated in Graph 3 and Graph 4. while Benin's GDP increased, and their exports remained stable.

The results of the placebo test on a product level are presented in Table 2 column 3 (treatment year equalling 1999) and 4 (treatment year equalling 2006). The variables *prod2* and *prod3* in column 3, measuring the treatment effect in 1999 for the corresponding product groups, are significant. This indicates that our DiD-regression could be poorly specified on a product level since the treatment variables do not solely pick up the treatment effects of the submarine Internet cable, they pick up other effects too. The effects that are picked up by the fictional treatment variables could be explained by different growth trends for the different product's exports over time. The variables *prod3* and *prod4* in column 4, measuring the treatment effect in 2006 for product groups three and four, are significant. One reason for the treatment variables in 2006 being significant could be that the treatment has a larger lagged effect than expected. Possibly the lagged treatment effect can be observed over several years, including in 2006. The positive significant value of *prod3* could also be explained by the increased growth trend of trade, similarly to the treatment variables in 1999. *prod4* now takes a smaller negative value.

To conclude, no major conclusion of the treatment effect can be made on a product level nor on an overall trade level. This, since all the variables, were insignificant in either 1999 or 2006.

5.2.3 Gravity model

A third robustness test is run by employing the gravity model, based on (Anderson, 1979), and adding the Internet variable *Internet* which measures the percent of the individuals using the Internet in the importing countries, in order to reproduce previous studies, such as Lin (2015)

and Freund and Weinhold (2004), which used the gravity model. The study solely used Internet data from the importing countries and not from the exporting countries, as the variation of the Internet in the exporting countries is too low to find reasonable results. The gravity model includes logged variables of the exports, the GDPs for exporting and importing countries and the distances between the trading partners. Additionally, year, importer and product fixed effects are added. See Table 1 column 6 for the results.

The variable *Internet* is significant on a five percent level and takes the value 0.01, suggesting that a one percent increase in the number of Internet users increases the exports by about 0.01 percent. This result is similar to the results of the previous literature in section 2.2 and the theoretical arguments used in section 2.1. Hence, the gravity model seems to find a relationship between trade and the Internet in our case. The findings contradict the results from section 5.1, where we found no casual effect of the Internet on trade. This highlights that using a gravity model differently to a DiD-framework is likely to generate different results.

For the variables measuring the importers GDP and distance's impact on trade, *LN_GDP_EX* and *LN_distcap*, this study finds similar results to previous studies using the gravity model, GDP having a positive correlation with trade and distance a negative correlation. *LN_GDP_IM* takes a positive value and is significant on a one percent level. *LN_distcap* takes a negative and is also significant on a one percent level. *LN_GDP_EX* is insignificant.

5.2.4 Regressions including population

A fourth robustness test is employed by including population in the regressions from section 5.1. Clarke and Wallsten (2006), discussed in the literature review, included population as a control variable to measure the size of the countries. They argue that small countries may need to trade more, as they can't produce all the goods they want to consume, and hence it is important to control for. We included the variables *LN_POP_EX* and *LN_POP_IM* that measure the exporting and importing countries' population in natural logarithms in the new regression. See Table 1 column 5 for the results on an overall trade level. The findings indicate that the treatment variable, *D_treateffect*, when including population is still insignificant. Hence, the basic results are not driven by a missing variable bias of the population variable.

The variable *LN_POP_IM* is significant on a one percent level and takes a positive value as expected, indicating that an increase of the population increases exports. This contradicts

Clarke and Wallsten (2006), as they find a negative impact of the population on trade. The variable *LN_POP_EX* is insignificant.

The results of the regression when allowing for the four different product group treatment effects are presented in Table 2 column 5. All treatment variables: *prod1*, *prod2*, *prod3* and *prod4* take similar values and significance levels compared to the initial regression presented in section 5.1.2. Hence, when controlling for population, both on an overall trade level and when controlling for the four different product groups, the estimation of the treatment variables did not improve. *LN_POP_IM* and *LN_POP_EX* are therefore excluded from the initial regressions.

6 Concluding remarks

Previous studies have mostly used panel gravity models to assess the relationship between the Internet and trade. This study sets out to examine the impact of the Internet on trade by investigating the specific example of the SAT-3/WASC submarine Internet cable in Benin. The study is conducted by employing a Difference in Difference estimator and comparing the treated West-African coastal country Benin with the other West-African coastal country Guinea, which was not connected to a submarine Internet cable within the same observed time period. Using a Difference in Difference estimator allows us to obtain a larger and more sudden variation of the Internet compared to previous studies, and hence we are more likely to capture a true causal relationship between the Internet and trade. Only conducting a gravity model, similar to previous research, decreases the chance of retrieving a sufficient variation of the Internet, and increases the risk of only observing cross-sectional variation in the Internet data. Export data on an overall and product level from Benin and Guinea to 167 importing countries, between 1998 and 2007, are used.

We believed to find a positive significant effect of the treatment effect on Benin's trade. This, since theoretical evidence and empirical papers, presented in section 2.1 and 2.2, indicate a positive effect of the Internet on trade. In addition, previous literature on Internet cables, discussed in section 2.4, stress the importance of submarine Internet cables.

In contradiction to our hypothesis, the study could not find any significant effect of the cable on the overall exports of Benin. This contradicts most of the previous literature, theory and our estimated gravity model used as a robustness test. According to our results, Venables (2001) overestimated the effects of the Internet on trade. Especially the matching costs which the Internet should help to decrease. This effect was not strong enough to increase trade in this case.

The results when allowing for the four different product group treatment effects suggest that there was a compositing effect of the trade. However, as the placebo test demonstrated, the study found similar results when changing the treatment year and hence the placebo test denounces the results, indicating that the cable did not have any effect when allowing for the four different product group effects.

An alternative explanation for not finding any significant effect of the treatment effect on the overall trade could be Benin's substandard and inefficient infrastructure, stressed by the African Development Bank Group (2018), and high user costs, discussed by Jagun (2008). It might be difficult to generalize the results of this study to very different environments, due to the substandard preconditions of Benin's infrastructure capacity. More research on other examples is therefore needed.

Additionally, for future research, more factors need to be considered before a possible causal effect of a submarine Internet cable on trade can be determined. Additional factors that should be controlled for are for example countries' overall infrastructure capacity, digitalization of industries or IXP. Also, researchers should control for countries being either developed or developing when applying the DiD-framework. Clarke and Wallsten (2006) found different results when controlling for this in a gravity model. Furthermore, researchers could investigate if goods and service are affected differently. Venables (2001) argues that the cost of transmitting digital services are cut down close to zero, because of the Internet.

7 References

- Abeliansky, A.L. and Hilbert, M. (2017) 'Digital technology and international trade: Is it the quantity of subscriptions or the quality of data speed that matters?' *Telecommunications Policy*, 41(1), pp. 35–48. doi: 10.1016/j.telpol.2016.11.001
- African Development Bank Group (2018) *Africa's Infrastructure: Great potential but little impact on inclusive growth*. Available at: https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/2018AEO/African_Economic_Outlook_2018_-_EN_Chapter3.pdf (Accessed: 7th May 2019).
- Anderson, J.E. (1979) 'A Theoretical Foundation for the Gravity Equation', *The American Economic Review*, 69(1), pp. 106–116. Available at: <https://www.jstor.org/stable/1802501?seq=1>.
- Angrist, J.D. and Pischke, J.-S. (2009) *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton, NJ, USA: Princeton University Press.
- Bacchetta, M. et al. (2012) *A Practical guide to trade policy analysis*. Geneva: United Nations Publications (Accessed: 11th May 2019).
- CEPII (2019) *CEPII database Geodist*. Available at: http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=6 (Accessed: 1th May 2019).
- Clarke, G.R.G. and Wallsten, S.J. (2006) 'Has the Internet Increased Trade? Developed and Developing Country Evidence', *Economic Inquiry*, 44(3), pp. 465–484. doi: 10.1093/ei/cbj026
- Domínguez-Torres, C. and Foster, V. (2011) 'Benin's Infrastructure: A Continental Perspective'. Available at: http://siteresources.worldbank.org/BENINEXTN/Resources/AICD-Benin_Country_Report.pdf (Accessed: 9th April 2019).
- Esselaar, S., Gillwald, A. and Sutherland, E. (2007) *The regulation of undersea cables and landing stations*. Available at: http://www.cablesm.fr/2007_esselaar-et-al-2007-undersea-cables.pdf (Accessed: 26th April 2019).
- Frempong, S. (2007) *The submarine communications cable ring in Africa*. Available at: <https://peer.asee.org/the-submarine-communications-cable-ring-in-africa.pdf> (Accessed: 2nd May 2019).
- Freund, C.L. and Weinhold, D. (2000) 'On the effect of the internet on international trade', *FRB International Finance Discussion Paper* (693). Available at: <https://www.federalreserve.gov/pubs/ifdp/2000/693/ifdp693.pdf> (Accessed: 16th April 2019).
- Freund, C.L. and Weinhold, D. (2004) 'The effect of the Internet on international trade', *Journal of International Economics*, 62(1), pp. 171–189. doi: 10.1016/S0022-1996(03)00059-X
- Hausman, R. (2016) *Atlas of Economic Complexity*. Available at: <http://atlas.cid.harvard.edu/> (Accessed: 23th of May 2019).
- Jagun, A. (2008) *The case for Open Access communications infrastructure in Africa: impact of international submarine cable infrastructure (SAT-3/WASC) in four African countries*. Available at: <https://www.itu.int/net/wsis/c2/docs/2008-May-19/mdocs/>

- Jagun%20et%20al%20_Telecom%20Africa%202008_final%20_2_.pdf (Accessed: 26th April 2019).
- Lancaster, H. (2019) *Guinea - Telecoms, Mobile and Broadband - Statistics and Analyses*. Available at: <https://www.budde.com.au/Research/Guinea-Telecoms-Mobile-and-Broadband-Statistics-and-Analyses> (Accessed: 9th April 2019).
- Lin, F. (2015) 'Estimating the effect of the Internet on international trade', *The Journal of International Trade & Economic Development*, 24(3), pp. 409–428. doi: 10.1080/09638199.2014.881906
- Meyer, B. (1995) 'Natural and Quasi- Experiments in Economics', *Journal of Business & Economic Statistics*, 13(2), pp. 151–162. Available at: <https://www.jstor.org/stable/pdf/1392369.pdf?refreqid=excelsior%3A2bf16fac27385d6efd523ad71e4dff0b>.
- Osiakwan, E. (2008) *The Case for "Open Access" Communications Infrastructure in Africa: The SAT-3/WASC cable: Ghana case study*. Available at: <https://www.apc.org/en/pubs/issue/case-open-access-communications-infrastructure-afr> (Accessed: 26th April 2019).
- Rauch, J.E. (1999) 'Networks versus markets in international trade', *Journal of International Economics*, 48(1), pp. 7–35. doi: 10.1016/S0022-1996(98)00009-9
- Rauscher, K.F. (2010) *Reliability of global undersea cable communications infrastructure - Report*. New York USA. Available at: <http://www.ieee-rogucci.org/files/The%20ROGUCCI%20Report.pdf> (Accessed: 20th of May 2019).
- Slaughter, M.J. (2001) 'Trade liberalization and per capita income convergence: a difference-in-differences analysis', *Journal of International Economics*, 55(1), pp. 203–228. doi: 10.1016/S0022-1996(00)00087-8
- United Nations (2019) *UN Comtrade Database*. Available at: <https://comtrade.un.org/> (Accessed: 1th May 2019).
- Venables, A.J. (2001) 'Geography and International Inequalities: The Impact of new Technologies', *Journal of Industry, Competition and Trade*, 1(2), pp. 135–159. doi: 10.1023/A:1012830529827
- Winseck (2017) 'The Geopolitical Economy of the Global Internet Infrastructure', *Journal of Information Policy*, 7, p. 228. doi: 10.5325/jinfopoli.7.2017.0228
- Wooldridge, J.M. (2018) *Introductory econometrics: A modern approach*. 6th edn. Australia: Cengage learning.
- World Bank national accounts data (2019) *World Bank Indicator: GDP (current US dollars)*. Available at: <https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=BJ-GN> (Accessed: 1th May 2019).
- World Trade Organisation (2019) *Stimulate economic growth and employment*. Available at: https://www.wto.org/english/thewto_e/whatis_e/10thi_e/10thi03_e.htm (Accessed: 7th May 2019).

8 Appendix

Table 3: Products and export value

Exporter	Product Code	Description	Export value
Benin	1	Food, tobacco, vegetables and wood products	1932490.612
Guinea			1489452.227
Benin	2	Raw material, chemicals, other metals and plastics	3909412.287
Guinea			15690370.46
Benin	3	Textiles, clothes, furnishing products and other leisure goods	3918447.045
Guinea			2220065.789
Benin	4	Machines, military equipment and other products not specific according to kind	122789.4249
Guinea			194576.7412