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BACHELORS'S THESIS

Exchange Rate Volatility and Trade: Trade in Intermediates versus Trade in Final Products

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Declaration of Authorship

I hereby proclaim that I wrote my bachelor thesis on my own under the leadership of my supervisor and that the references include all resources and literature I have used.

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Prague, July 31, 2019

Signature

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Abstract

This work represents an attempt to observe exchange rate volatility impact on international trade flows decomposed into intermediates and final products. Existing production chains are costly and sometimes risky to relocate.
This thesis aims to test that belief and further, tests assumption that demand for final products is more elastic with respect to foreign exchange rate volatility than that with intermediates. It uses data from 2000 to 2014 and employs gravity model of trade on the sample of 43 countries. Country pair Fixed effects and Bonus Vetus OLS are then used as method of estimation. This work emphasize proper theory-consistent estimation. It stay in line with contemporary empirical literature only a small negative overall effect is estimated. I find that when foreign exchange rate volatility grows by 10% trade is reduced by less then 0,5%. Regarding expected difference in effect of elasticities I however remain inconclusive.

Keywords foreign exchange rate volatility, international trade, gravity model, world input output table, indirect trade

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Abstrakt

Tato práce představuje pokus zkoumat vliv kurzové volatility na přeshraniční toky rozdělené na meziprodukty a finální produkty. Relokace již existujícíh výrobních řetězců je spojena s nezanedbatelnými náklady a leckdy i s rizikem. Tato práce si klade za cíl ověřit toto tvrzení a dále testuje předpoklad, že poptávka právě po importu finálních produktů je elastičtější vzhledem ke stabilitě kurzu než poptávka po meziproduktech. K tomu využívá data od roku 2000 do roku 2014 a gravitační rovnici mezinárodního obchodu na vzorku 43 zemí. Jako odhadovací metody jsou použity fixní efekty na dvojicích obchodujících zemí a Bonus vetus OLS. Tato páce akcentuje důležitost důkladného teoretického základu pro specifikaci a odhadování gravitační rovnice. Můj závěr zůstavá ve shodě s dosavadními zjištěními vědecké literatury a to v tom ohledu, že nachází malý záporný vztah kurzové volatility na obchod Zjišťuje, že když míra kurzové volatility vzorste o 10% konečný dopad na obchod není větší než 0,5%. Nemůžu však učinit závěr ohledně výchozího předpokladu, tedy že poptávka po finálních produktech je elastičtější.

Klíčová slova	volatilita měnového kurzu, mezinárodní obchod, gravitační rovnice, world input output table, obchod s meziprodukty

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Exchange rate volatility and trade: trade in intermediates versus trade in final products

Preliminary scope of work:

Research question and motivation

Interconnectedness of global production chains is widely recognised global phenomenon. My thesis will focus on international trade flows between suppliers and manufacturers influenced by volatile exchange rate, this narrows the area of research, which will allow me to observe specific effects and differs it from other studies, that have been completed on topic of exchange rate volatility influencing international trade.

The aim is to run the regression and test hypothesis about impact of exchange rate volatility on trade using gravity model of exports.

The fundamental questions, I am going to discus in my thesis, are: "What is the estimated effect of fluctuating exchange rate on trade relations between suppliers and manufacturers?", "How well gravity model works in this case?".

Contribution

As primary data for my thesis I will use WIOT (= World input output table, matrices of mutual inputs traded globally) This type of data is very recent (released in 2016, available at http://www.wiod.org/release16). Though, its variability is limited, there are trade flows among 43 countries (28 of which are EU countries and the remaining 15 are major world economies) featured from 2000 to 2014. This might cause problems, that I will address later in my work, since this sample is distributed quite unevenly. For instance, minor economy such as Estonia shall be analysed with major economies of the world (China, Australia, etc.), but lesser economies outside the Europe are missing here.

Contemporary literature is considerably sceptical about impacts of monetary unions (i.e. exchange rate indirectly) – (see survey paper Havránek, Rose Effect and the Euro: The Magic is Gone below), but in theory, we might expect that existing production chains might be less elastic with respect to exchange rate due to costs associated with switching to another supplier. That is why WIOT data are convenient for my analysis since there are featured both trade relations between supplier and manufacturer and demand for final product. I am going to aggregate both export and demand in order, to match them with my model results. Furthermore, there are significant attempts in field of gravity model analysis worth referring in my thesis, these are studies by Anderson & Van Wincoop and Baldwin & Taglioni listed below.

International trade analyses have broad implications for policy makers and participants of trade relations. Besides the goal I explained above, my work should promote gravity model as one of estimates of trade potentials.

Methodology

As said before, I will employ gravity model as a tool for analysing my data. Gravity model is very popular model used for estimation of trends in international trade. Alike gravity equation from classical Newtonian physics, which describes gravity

force as a product of two objects' masses divided by the square of their distance multiplied by given gravitational constant, gravity model tries to approximate trade flows between two economies in the same manner, larger the economy the greater is its "mass" and greater the force it is attracted to another weighty economy and "force weakens" further they are.
"One money, one market: Estimating the effect of common currencies on trade" by A. Rose is a very influential study published on this topic that focuses on impact of being a member of monetary union, rather than exchange rate volatility. However, I am going to use gravity models which respect latest requirements (based on micro foundations, models which account for the non-linearity of the MTR).
I will use Rstudio software to compute the model using gravity model package (available at: https://www.rdocumentation.org/packages/gravity/versions/0.6)

Outline

1) Introduction
2) Literature review
3) Data
4) Methodology
5) Results
6) Conclusion

List of academic literature:

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Author **Supervisor**

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Acronyms

FX Foreign exchange rate (or just *foreign exchange* whichever makes meaningful sense)

WIOT World input-output table

EMU European monetary union

MRT Multilateral resistance term

RTA Regional trade agreement

OLS Ordinary least squares

Chapter 1

Introduction

Interconnectedness of global production chains is widely recognized global phenomenon. For decades balance of trade has been viewed as an indicator of economic strength and prosperity. My thesis will focus on demand for imports and how is it influenced by volatile exchange rate from its two major components - demand for intermediates (demanded by firms) and secondly, final demand for products (demanded by households, governments and non-profit sector). This division of observed trade flows narrows the area of research , which will allow me to examine specific effects which are presumably different.

This aspect too differs my work from other studies in otherwise well described field of exchange rate volatility influencing international trade.
The aim is to assess the separate effect of exchange rate volatility on trade using gravity model of international trade. The fundamental questions, I am going to discus in my thesis, are: "What is the estimated effect (if any) of fluctuating exchange rate on value of trade with intermediates and final products?", "Are those effects any different?" and "How well gravity model works in this case?". Which correspond to hypothesis that can be formulated: "Has foreign exchange rate volatility statistically significant effect on value bilateral trade flows?" (= does it have non-zero regression coefficient)?

Rose (2000): *"(...) economists have worked hard to quantify the effects of reduced exchange rate volatility on trade. Sadly, there is almost no consensus in the area, (...)"*.

Furthermore, I would like to add an argument to discussion described above and thus, to enrich existing literature on topic aiming for exchange rate volatil-

ity impact assessment and for bilateral trade flows analysis in general.
Within scope of my thesis I cannot possibly provide competent answer to question this complex, (on the grounds that my dataset is rather restricted e.g.) but I can present some evidence to support or oppose the claim.

In theory, we expect that trade flows with intermediates are less elastic with respect to foreign exchange rate volatility than those with final products due to various reasons. Firstly, we suspect that switching to different supplier is associated with non-negligible cost and risk. Larger firms usually employ hedging in forms of forwards or other financial derivatives instruments in order to protect themselves from unfavorable impacts of undesired foreign exchange rate shift in case of payments in foreign currency (Allayannis & Ofek 2001). Additionally, some manufactures use as an input very specific input (e.g. spare parts for specialized machinery) obviously these would by extremely inelastic with respect to FX volatility. And lastly, we imagine that there exist some factors of convenience that are particularly difficult to be quantified - some sort trust for long term suppliers or appreciation for quality for given intermediates. On the other hand, we intuitively feel that final consumers might react more swiftly to moving exchange rate, since they have no ties to international production chains whatsoever. Besides, the market with intermediates can also be imperfectly competitive. Firms diversifying risk may be able to transfer some of their extra cost onto consumers, which cause them to be more elastic to this cost (incurred initially by volatile FX rate).

The thesis is structured as follows:
Chapter 2 deals with both empirical and theoretical research literature review on the subject which is intrinsically linked to the development gravity model and its theoretical foundation, at last, it covers literature aiming solely on topic of exchange rate volatility from perspective of theoretical and empirical stance further it discuses concisely background of floating exchange rate as Brettonwood system collapsed. Chapter 3 gives description on data as well as platforms they gathered from. Moreover, it addresses various issues connected to the process of its collection. Chapter 4 outlines methodology of research. Chapter 5 presents results of research and discuses them. Chapter 6 summarizes our findings and provides general recapitulation contribution, proposes future line of work.

Chapter 2

Literature Review

This chapter provides a review of selected literature written on topic of gravity modeling and exchange rate volatility until 2017. First section outlines theoretical literature that attempts to empower popular gravity model with justifiable microeconomic foundation which as later shown, is key concept to a proper model specification and its efficient estimation. Outlined findings of theoretical literature are directly applied to empirical research later in this thesis. Prior to that a brief overview of gravity model's history and background is added.
After that follows a section that summarizes literature issued on topic of FX volatility's impact on international trade both from theoretical perspective and individual empirical studies as well as far-reaching meta analyses.

2.1 Gravity Model of International Trade

Trends in international economics have very broad and crucial implications, therefore, there are numerous commonly used to tools available to investigate them – among those *Gravity model*, a very popular instrument used for estimation of bilateral flows relative to sizes and the distance between participants to those flows. Gravity models in their naive form trace back to the work of Ravenstein (1889) and Tinbergen (1962). They owe their popularity to high explanatory power and relatively robust results across many datasets and different scientific works (Anderson 2011).
Alike gravity equation from classical Newtonian physics (Equation 2.1), which describes gravity force as a product of two objects' masses divided by the square of their distance multiplied by given gravitational constant,

$$F_{ij} = G\frac{M_i M_j}{D_{ij}^2} \tag{2.1}$$

gravity model tries to approximate trade flows between two economies in the same manner, larger the economy the greater is its "mass" (economic mass often approximated by national GDP) and the greater is the force attracting it to another weighty economy. "Force weakens" further they are. Distance here has same relevance as if in "standard" gravity from physics. It serves here as a hindering factor. Nevertheless, the intuition behind the gravity model is truly simple = large economic chunks trade more intensively than smaller ones and closer they are, volume of trade grows. (Van Bergeijk & Brakman 2010).

For almost 60 years, gravity model has been used to infer trade flow effects of various institutional arrangements - currency unions, trade agreements (GAT, WTO, EMU) as well as cultural, historical or ethnic ties. It has not been used only to predict volume of trade but also to explain whole variety of international interactions - trade, migration, foreign direct investments between countries.

Despite gravity's universality outlined above, many empirical studies lack theoretical foundation and thus suffer from serious issues that undermine reliability of their conclusions. The underlying idea of gravity is so intuitive and straightforward and yet at the same time proves to be very successful in empirical field, that simply some researchers do not bother with model's theoretical justification.

2.1.1 Theoretical Background for Gravity

In order to perform proper analysis, that does not result in biased or inconsistent estimates one has to impose model that has profound theoretical basis at their disposal. Eminent number of pieces of literature that focuses on purely empirical research often ignores this fact and use specification that may yield pleasing result but has no ground in theory. Tinbergen (1962) initially did not have any theoretical basis for this model. Bergstrand (1989) admits that gravity model may have high statistical explanatory power but lacks strong microeconomic backing. Anderson (2011) described this initial absence of any theoretical foundation as gravity model being *"an intellectual orphan"* unconnected to the rich family of economic theory.

One of first notable efforts to underlay gravity equation with legitimate theoretical foundation was made by Linnemann (1966), who build gravity's theoretical basis on general equilibrium framework (implying gravity model is a reduced form from a four-equation partial equilibrium model of export supply and import demand) (Bergstrand 1985). This approach was later enhanced by Leamer & Stern (1970) who pointed out general equilibrium nature of analysis implies exclusion of price variables - *"In such setting prices are endogenous and merely adjust to equate supply and demand."*. This obstructs whole variety of model specifications, one may find intuitive to include various price indices[1] to estimation, but eventually under this framework have no theoretical justification. One of most distinguished works providing microeconomic grounding for gravity model is offered by Anderson (1979). Anderson derived gravity equation from system of expenditure functions and constant elasticity of substitution, assuming products are differentiated by region of origin. Additionally, Bergstrand (1989) (from structure of monopolistic competition in case of inter-industry trade) and Deardorff (1998) proved that gravity model is consistent with Heckscher-Ohlin theorem of comparative advantage.

Deardorff (1998) expressed belief with regard to intuitivness of gravity that any theoretical trade approach would eventually produce gravity equation in some form: "I suspect that just about any plausible model of trade would yield something very like the gravity equation, whose empirical success is therefore not evidence of anything, but just a fact of life."

Publishing Anderson & Van Wincoop (2003) meant breakthrough in pursuing theoretically well-founded estimating of gravity model and until today remains a building block for every decent gravity analysis. Anderson & Van Wincoop (2003) show that bilateral trade is not only influenced by absolute barriers between trading partners but also by these barriers barriers relative to barriers existing with other countries.(see Chapter 4 to learn more) Anderson & Van Wincoop warns that disregarding these MRTs taht cannot be observed results in biased and inefficent results. So is gravity model by its very nature misspecified? No, under given circumstances, Baldwin & Taglioni (2006) refer to not involving of MRTs as *Golden medal mistake* and advocate appropriate specification and method of estimation as a way to treat presence of MRTs. Turn to Chapter 4 to see how this thesis embodied this approach.

[1]Price indices might still be used (and are often used to approximate national income by deflating GDP).

2.2 FX Volatility Impact

To fully understand the context which accompanies rise of interest of scientific literature in FX volatility (and its effect on trade) is convenient to briefly refer to reintroduction of freely floating FX rate as Breton wood system collapsed in 1973.

Effective from 1946, all countries under Bretton Wood system pegged their currencies to US dollar. Any such currency under this fixed exchange rate was convertible for gold. When at the dawn of 70' foreign accumulated reserves exceeded US gold reserves President Nixon "closed Golden window". For the first time after World War II producers and consumers were exposed to FX risk as free floating rate was readopted, to which producers responded by hedging themselves in form of future or forward contracts. Market with financial derivatives, as LiPuma & Lee (2005) describes, went from virtually non-existing to one hundred million dollars market by the end of decade and in the year 2000 that share exceeded 100 trillion dollar market. (LiPuma & Lee 2005; Kenen 2008; Kugler & Straumann 2018)

First efforts to interpret ties of fluctuating FX rate to trade theoretically came instantly after the end of Bretton Wood system and among those - Clark (1973), who assumed perfectly competitive market where firms sell their product overseas for foreign currency. Profit is then converted to national currency since firms do not use any foreign immediate input, therefore, alternation of firm's profitability is equal to trends in exchange rate. Then for any risk averse firm, rise in FX volatility means scaling down the production. (Clark *et al.* 2004)

Henceforth, theoretical literature is more or less homogeneous asserting that FX volatility has small negative effect on trade. Naturally, there are beliefs that state otherwise, e.g. Viaene & De Vries (1992) suggest that risk always has two opposite effect and develop positive relationship through assumption that this favourable opposite risk effect create opportunities to make profit. Majority opinion is contrarily different - often assuming risk averse firms. Hodge (2005) summarizes: "The standard model assumes a risk-averse exporting or importing firm. Increased volatility in the exchange rate is assumed to result in increased uncertainty by such firms about future profitability. The greater such uncertainty is, the less the supply of exports (or the demand for imports) and hence the negative relationship between volatility and the volume of international trade."

When it comes to empirical literature that focuses on evaluating exact effects of exchange rate volatility, a work by Rose (2000) is worth mentioning. It is highly regarded study published on this topic and makes one of first attempts to evaluate effects of currency union and exchange rate volatility on bilateral trade. Rose made one of first attempts to show that common currency boosts bilateral trade - attempt that is well recognized among specialists, given that his work was published in 2000, he did not have any evidence from EMU. Though, he assigned only rather small effect to FX volatility Rose made very optimistic conclusions about volume of trade. Estimates as high as 235% of predicted effect of currency union on trade. This instantly raised suspicion and later specialists regard conclusions of Rose (2000) as rather problematic. Baldwin & Taglioni (2006) accuse Rose (2000) of committing previously mentioned Gold medal mistake. Rose operates with ad hoc specification = insertion of of various instrument variables into equation has no theoretical justification (Anderson & Van Wincoop 2003) and yet his work is still cited. He succeed in raising a interest in topic (along with ever more accessible computation means). Unintentionally serves as an example how important it is obey theoretical findings and stay cautious. .

So what is the view of contemporary literature on exchange rate volatility impact given that even far-fetched saw its effect as rather small? [2]

It is somewhat skeptical too - only a small effect is attributed to impact of FX volatility. It reflects expectations of theoretical literature. Ćorić & Pugh (2010) provides neat meta-regression analysis and finds 33 out of 58 studies came to conclusion that FX rate volatility negative effect (out of remaining 25 are 10 inconclusive, 6 promote positive effect and 9 find no effect at all). For additional overview of studies evaluating effect of FX volatility impact on trade consult Bahmani-Oskooee & Hegerty (2007).

With regard to particular studies the reader is though referred to Clark *et al.* (2004) who found FX volatility has larger impact on developing countries rather than advanced countries. Broda & Romalis (2011) discover that when using disaggregated data, stabilizing FX volatility completely have trade boosting effect within boundaries of 3-5% across market differentiated by products. Hudson & Straathof (2010) stays inline with existing literature with complex analysis of FX variation on 30-year period and suggests that the negative effect of FX volatility is decreasing over time. For recent scientific paper that also

[2] Even before Rose (2000) empirical evidence suggested that exchange rate volatility has only low effect. (McKenzie 1999)

decompose FX volatility effects on intermediates and final products consult Johannsen & Martinéz-Zarzoso (2017), who based on evidence from monthly data find significant negative effects on intermediates, but very small and insignificant effects for final goods.

Chapter 3

Data

Following chapter summarizes the process of data collection and provides detailed description of data and its potential further modification. Data were acquired from 3 main data sources - WIOT, CEPII and Bloomberg.

3.1 WIOT

As primary dataset for my thesis I used WIOT (= World input output table [1]), matrices of inputs and outputs traded globally that captivates (among others) inter-industry trade as well as final consumption expenditure by households, non-profit organizations serving households (NPISH) and government. It was gathered by researchers at University of Groningen, Netherlands (WIOD 2016). It has classical structure of input-output table (depicted in Figure 3.1) with data for 56 sectors (which are classified according to the International Standard Industrial Classification revision 4). Therefore, standard input-output analysis may be applied (for practical guidance on procedures of input-output analysis see Miller & Blair (2009)). The very nature of input-output table allowed for very easy extraction of sought intermediate and final demand.

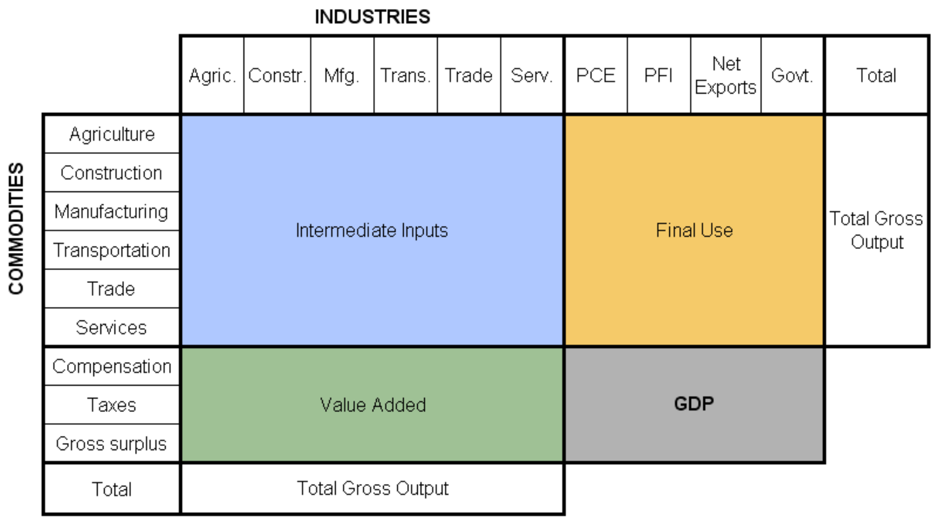
This type of data is relatively recent – it was released 2016. Though, its variability is limited, there are trade flows among 43 countries (28 of which are EU countries and the remaining 15 are major world economies, see the list of countries in Appendix) Timmer *et al.* (2016) explains that these countries have been chosen by considering both the requirement of data availability and sufficient quality and desire to cover major part of the world economy. Although, it cover over 85% of world's GDP, sample is distributed quite unevenly. For

[1]Sometimes denoted as WIOD (=World input output database)

instance, minor economy such as Estonia shall be analyzed with major economies of the world (China, Australia, etc.), but lesser economies outside the Europe are missing here.

(Timmer *et al.* 2015)

Figure 3.1: WIOT structure



Source: Bess *et al.* (2011)

The dataset relies only on imports - i.e. flows are accordingly expressed in *Free on board (=FOB)* price through estimation of international trade transport margins. Tables are featured over 15-years period from 2000 through 2014 (herein after *reference period*).

There was another WIOT release made previously in 2013 covering 40 countries for the period 1995-2011. This thesis works only with 2016 release, however, previous release might be used for purpose of replication study or sensitivity analysis.

3.1.1 Dependent Variable

As said before, input-out conception of WIOT allows for relatively simple extraction of observed flows with intermediates and with final products (denoted *fli* and *fld* respectively; *lfli lfld* when logarithmically transformed.

The are expressed in value of trade flow (*in million US dollars*) and that poses a problem. Due to the fact that we are using data expressed in value in US dollars, we may lose certain degree of reliability, because we do not use data on physical volumes, which can imply some contamination of our data with the effects of exchange rate fluctuations.

These dollar flows are then aggregated across goods throughout all industries, differentiated by country pairs WIOT is constructed on annual principle on 15-year period With data aggregation, we essentially loose some degree variability in therms that we will not be able to observe separate effects on each industry. This way we however fortunately overcome so called Zero trade flow. Since in generally accepted specification trade flows appear in logarithm, various authors how to avoid undefined logarithm and how to treat those zeros (see Silva & Tenreyro (2006) To treat for large number of zeros in under estimated trade flow it is advised to employ Poisson pseudo-maximum likelihood estimation (PPML)), however, this is not the case in my thesis. All flows I investigate are positive (see Table 3.1 for minimal flow value trough out the dataset of just 2000 USD). It would extremely unlikely to have any zero flows in annual aggregated demands among so well-developed countries like those in my sample), I had to deal with a very similar problem though, and that is a problem of 0 volatility observations.

Some literature work with combined collection of flows of both trade partners, however this is not an approach I chose for the reason that it is more convenient to use two sets of flows (i.e. exports from country i to country j and vice versa) firstly, due to fact that we simply have more relevant observations and secondly this would essentially result to misleading observations because exports within industry would be a simple average of both flows between trading partners. When computing trade average, one cannot take simple arithmetic average of imports and exports, this would result in what Baldwin & Taglioni (2006) call *Silver medal mistake*

For sake of my analysis I thus essentially assumesame effect for all industry sectors, but this assumption is likely to be just a simplification unevenly dispersed effect over the sectors.

3.2 CEPII

Secondly, to obtain nominal GDP and geopolitical figures (distance, common official language dummy, contiguity, ...), I used CEPII (Centre d'Etudes Prospectives et d'Informations Internationales) database

The CEPII is the leading French center for research and expertise on the world economy. It contributes to the policy making process trough its inde-

Table 3.1: Descriptive statistics

Statistic	distw	fli	fld	fxv
N	27,090	27,090	27,090	27,090
Mean	4,990.065	2,825.091	1,803.544	0.029
St. Dev.	4,357.678	9,478.785	7,145.325	0.028
Min	160.928	0.002	0.004	0.00001
Pctl(25)	1,339.212	61.828	34.515	0.009
Pctl(75)	8,625.863	1,753.323	996.602	0.040
Max	18,260.400	247,584.700	223,355.100	0.313

pendent in-depth analyses on international trade, migrations, macroeconomics and finance. The CEPII also produces databases and provides a platform for debate among academics, experts, practitioners, decision makers and other private and public stakeholders. Founded in 1978, the CEPII is part of the network coordinated by France Strategy, within the Prime Minister's services. (CEPII Database 2019)

One of advantages of conducting an empirical analysis using gravity equation is that researcher has a profound data basis for wide range of specifications at their disposal. CEPII has its own gravity package contains whole variety of variables that allow for countless specifications for various analyses. (See Chapter 4 to inspect the collection of variables that I chose). CEPII gravity database offers groundwork for 224 individual counties and for complete set of their pairs, for the period 1948 to 2015 (all of which are naturally countries surveyed countries) This extensive materials that are easily accessible contribute to gravity model popularity.

Key variable that is extracted form CEPII database is the *distance* between trading nations. Distance is necessary for gravity equation and its measurement is no less important for modeling.

Database architects chose method (similar to one described in Head & Mayer (2002)) [2] of calculating weighted distance (see Equation 3.1 between country i and country j based on bilateral distances between the biggest cities of trading partners. The distance is weighted in terms of population which approximates center of mass of each country.

[2]Interesting fact is that distance for domestic flows within one country are non-zero in this dataset. Internal distance is calculated following way $dist_{ii} = \frac{67}{100}\sqrt{\frac{area}{\pi}}$, where $area$ means total national area in square kilometers

$$distw_{ij} = \left(\frac{d_{kl}}{\sum_{k \in i} \frac{pop_k}{pop_i} \sum_{l \in j} \frac{pop_l}{pop_j}} \right) \tag{3.1}$$

where pop_k is the population of the largest city k from country i and pop_l is the population of the largest city l from country j and d_{kl} is a distance between those cities.

It implemented quite complex measure for distance, whereas, the approximation for national income it provides mere nominal GDP and again for sake of simplicity it will not be modified or deflated anyhow and will be analyzed as is. (Mayer & Zignago 2006).

Table 3.2: Correlation Matrix

	fld	fli	distw	gdp_o	fxv
fld	1	0.833	−0.028	0.253	−0.019
fli	0.833	1	−0.066	0.303	−0.014
distw	−0.028	−0.066	1	0.199	0.389
gdp_o	0.253	0.303	0.199	1	0.099
fxv	−0.019	−0.014	0.389	0.099	1

3.3 FX Volatility - variable of interest

And finally, to obtain FX rates I used Bloomberg database. Rates were gathered on daily principle such that every observation equals value of a spot rate at the end of the day for every day of reference period that they were published. These published days are equal for all currency pairs, hence, there is not the same array of data for every currency pair (for instance in 2014 rates for currency pair Euro-US dollar were published for 258 days whilst for pair Canadian dollar-Swedish crown, rates were announced for only 181 days) this caused no significant trouble - it was eliminated by measure of volatility.

Once these daily rates are obtained, convenient measure of its fluctuation has to be applied. Various literature makes use of sophisticated measures of FX volatility, though they have only quarterly rates (consult Arize *et al.* (2003); Chit *et al.* (2010)).

To quantify degree of oscillation of FX rate I used following measure: sample standard deviation over sample mean Equation 3.2 such fraction measure is constructed for every currency pair (see Appendix for which currencies data was collected) (Bloomberg 2019)

$$V(e_{ij})_t = \frac{\sigma_{e_{ijt}}}{\bar{x}_{e_{ijt}}} \tag{3.2}$$

With my daily detailed information so simple Coefficient of variation (also known as *Relative Standard Deviation*) would be sufficient measure To quantify degree of oscillation of FX rate.

With this measure of volatility we intrinsically face again the problem of undefined logarithm (FX volatility (fxv) is in manner of standard gravity specification also logarithmically transformed ($lfxv$)), because countries that share common currency obviously have zero standard deviation for each pair among them. This time we do not deal with dependent Zero trade flow observation. So we simply assign value of 0.00001 to every zero volatility observation in our sample. Table 3.1 suggest this simplification is close to zero enough.

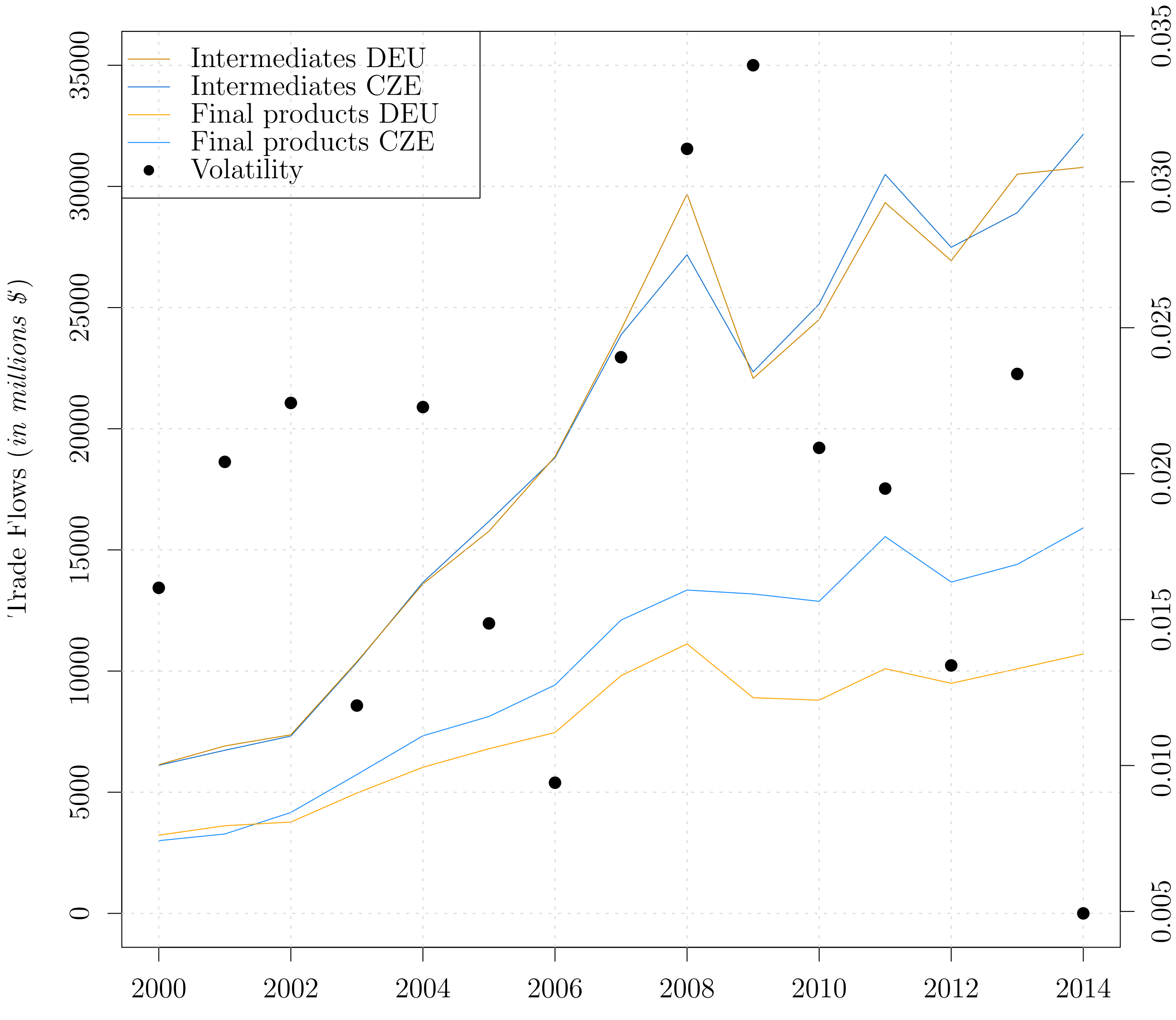
3.4 Descriptive statistics

Dataset is at this point complete. Using that I was able to construct annual panel data specified by country pair each observation observations consists of unique and complete combination set of cross sectional dimensions country i-country (importer) j (destination); year alongside other variables.

It bears gravity essentials being GDP of country i, GDP of country j and distance between them and others such as population and numerous dummies for common official language, common colonial history etc. and of course volume of bilateral flows. Given that and the fact we have data for 43 different countries from 2000 through 2014. We are left with 27090 observations and 23 variables (product of 43 importers by 42 destinations by 15 years)

With such data set at hand we can visualize data sample Figure 3.2 of our dependent variable and explanatory variable of interest in data fragment flows between Czech Republic and Germany.

Figure 3.2: Example of exports between Germany and Czech Republic



It contains just a narrow strip of a data and serves at least as good as an illustration, but it too bears one useful piece of information. 2007 drop most certainly caused by financial crisis. We may as well observe that drop is much more distinct in case of inter-industry flows than those of final demand. This discrepancy might be explained by concept of *consumption smoothing* (consult Highest values of FX volatility are also evident in the same period. It underlines the hypothetical negative relationship between FX volatility and trade. And ultimately, this visualization suggests it would be convenient to include time variables to control for effects like this.

To further visualize the data see Figure A.1 and Figure A.2 in Appendix where again one dimension is held fixed (year set to equal 2012, whereas, previous Figure 3.2 had country pair fixed) to plot of trade flows' value with intermediates and final products

Intuitive negative effects of FX volatility are apparent in both graphs and both also assert that data of trade flows is fairly skewed to the right.

Chapter 4

Metodology

Following Chapter introduces models used for this thesis' analysis and limitations that challenge their application, furthermore, it presents specification and methods of estimation that manage to overcome those limitations. For the reasons given in this chapter, plain pooled OLS would not be sufficient. It has to be enhanced by certain teqniques First off, Fixed effects Secondly, Bonus Vetus OLS The objective here is to comply with the widely acknowledged rules currently applied to this type of analysis derived by theoretical literature. This thesis namely with findings of conclusions made by Anderson & Van Wincoop (2003), Baldwin & Taglioni (2006) and Baier & Bergstrand (2009)

4.1 Breaking-down Gravity

When we scale out a bit and attempt to provide generalized definition of gravity model it would be a tool of regression analysis explaining bilateral cross border interactions approximated by economic mass of given two participants of such interactions relative to their distance.

Distance is here is defined as distance between centres of (economic) mass between trade partners. Anderson & Van Wincoop (2003) deduce that distance as hindering factor serves as cost of trade in this case and may take form not only physical kilometres - but also cultural (language) or and political (mutual colonial history), which essentially incur cost too. besides distance, gravity equation (in most its specifications) neglects other trade obstructing factor (namely tariffs).

On the other hand, size of *economic mass* (often called income and usually approximated by GDP[1]) acts as factor encouraging bilateral trade flows. Countries with *"weighty economic masses"* tend to have more refined and diverse import preferences together with more disposable income. When gravity model is projected like this it is easy to note that gravity model does nothing but predicts international interaction based on trade-off between cost and income.

When we return to gravity equation from physics Equation 2.1 to formalize the relationship and plug-in economic mass Y of an importer i and destination j as well as distance D_{ij} between centres of those masses. We receive following Equation 4.1.

$$X_{ij} = G\frac{Y_i^{\beta_1} Y_j^{\beta_2}}{D_{ij}^{\beta_3}} \tag{4.1}$$

When natural logarithm is then added into equation, we obtain log-log linear model (Equation 4.2). This is what the literature defined as standard gravity model.

$$\log X_{ij} = \log G + \beta_1 \log Y_i + \beta_2 \log Y_j + \beta_3 \log D_{ij} \tag{4.2}$$

Where gravitational constant becomes constant of estimation (= intercept; $\beta_0 = \log G$) (Head & Mayer 2014)

4.2 Limitations

This section shall revise limitations that every decent gravity model analysis should take into consideration to avoid biased results caused and obtain consistent and efficient estimator and to be able to perform standard comparative statics analysis and statistical inference.

(a) How to measure distance and what technique to choose to approximate national economic mass (income)

(b) To what degree should the data be aggregated/ disaggregated

[1]Though "economic mass" too may take a different form other than basic magnitude of nominal GDP (see Equation 4.4 for specification of Rose (2000))

(c) How to treat zero observations (= undefined logarithm)

(d) How to deal wit MRTs

In previous Chapter 3 all issues listed above were addressed but the last one - nonlinear MRT and the treatment of is probably most problematic.

4.2.1 Remoteness and cost of trade - Multilateral Resistance Trade Factor revisited

Anderson & Van Wincoop (2003) derived thorough that bilateral trade is not only influenced by absolute barriers between trading partners but also by these barriers barriers relative to barriers existing with other countries. *Multilateral resistance term* = MRT of country is then defined as average of barrier size with all partners. They derive gravity equation that suggests that once we control for economic mass of all countries, the trade interactions between any of two countries are determined by absolute barrier between them divided by product of their MRTs. Therefore holding a barrier between two countries stable, trade between these two countries increases as any of partner's MRT rises. Anderson & Van Wincoop point out that magnitude of these relative barriers cannot be observed. However, disregarding them causes omitted variable bias, incorrect comparative statics reasoning and generally a lack of understanding of what is driving the results, as Anderson & Van Wincoop (2003) explain. Intuitively, the more resistant to trade with all others a region is, the more it is pushed to trade with a given bilateral partner This intuition might be easier to grasp with following anecdotal evidence on example of Australia and New Zealand. If we were to take comparably as big and as distant economies as pair of Australia and New Zealand in Europe, we would not receive nowhere as same volume of trade as in case of Australia and NZ, simply because their relative cost trade is so high it presses them into intensive remoteness is not however only barrier standing in a way of trade. Literature often offers proxies for each barrier as a technique how to handle MRTs, but in this thesis I implemented methods of estimations that universally treat for entire model specification rather then individual barriers.

4.3 Specification

At this point we leave theoretical derivation of gravity and we will make use of data we gathered in previous Chapter 3.

$$\log X_{ij} = \beta_0 + \beta_1 \log Y_i + \beta_2 \log Y_j + \beta_3 \log D_{ij} + \beta A + \psi V(e_{ij})_t + u_{ijt} \quad (4.3)$$

where A is a vector of other factor(s) either assisting or restraining the mutual trade. Adding this set of variables to equation forms what literature calls Augmented gravity model (Bergstrand 1985)

Baldwin & Taglioni (2006) emphasize that carefully chosen array of dummy variables is vital for efficiency of estimation, otherwise we would face Silver medal problem. They too advise to include time dummies or dummies for country pairs.

All variables names remained unchanged as they were taken from source database (so that it may be compared with other studies using same source or replication study may be carried out)

Additional regresors

comlang_off (= *Common official language*), dummy variable, 1 for observation where country pair share common official language, 0 otherwise. Supposedly, this variable will have positive impact. Particulary, production chains

colony (= *Colony*), dummy variable, 1 for observation where country pair share common colonial past, 0 otherwise. Colonial ties were made to

contig (= *Contiguity*), dummy variable, 1 for observation where country pair share common border, 0 otherwise.

comcur (= *Common currency*), dummy variable, 1 for observation where country pair share common currency, 0 otherwise. In analyzed sample this is represented just by countries of Eurozone. Set of common-currency gets larger during the reference period as EU countries gradually adopted euro (see Table A.1 in Appendix). This variable is too expected to result in positive relationship with volume of trade.

fta_wto (= *Regional trade agreement*), dummy variable, 1 for observation where both counties are parties to Regional trade agreement (RTA), 0 otherwise. CEPII database mentions WTO as a source. RTA is by its nature expected to have positive effect.

tdummyyear20XX (= *Year*), dummy variable, 1 for each of given year from 2000 to 2013, addition dummies is not only motivated by

For sake of comparison consult Equation 4.4, specification of Rose (2000).

$$\begin{aligned}\log X_{ij} = \beta_0 &+ \beta_1 \log(Y_i Y_j)_t + \beta_2 \log(Y_i Y_j / Pop_i Pop_j)_t \\ &+ \beta_3 \log D_{ij} + \beta_4 Cont_{ij} + \beta_5 Lang_{ij} + \beta_6 FTA_{ijt} \\ &+ \beta_7 ComNat_{ij} + \beta_8 ComCol_{ij} + \beta_9 Colony_{ij} \\ &+ \gamma CU_{ijt} + \delta V(e_{ij})_t + e_{ijt}\end{aligned} \tag{4.4}$$

4.4 Methods of estimation

4.5 Fixed Effects

Fixed effects model essentially does not allow to study effects of time invariant variant variables since time they are averaged out. But it succeds at removing any biases connected to MRTs that are not properly dealt with Anderson & Van Wincoop (2003) show that inclusion of country pair fixed effects is a efficient method Head & Mayer (2014) note that estimating gravity equations with [U+FB01]xed e[U+FB00]ects for the importer and exporter, as is now common practice and recommended by major empirical trade economists, does not involve strong structural assumptions on the underlying model. Those assumptions are as follows:

(a) **Assumption FE1:** For each i, the model is: $y_{it} = \beta_0 + \beta_1 x_{it1} + \cdots + \beta_k x_{itk} + a_i + u_{it}, t = 1, \ ..., \ T$, where the β_j are the parameters to estimate and a_i is the unobserved, or fixed effect.

(b) **Assumption FE2:** We have a random sample for the cross section.

(c) **Assumption FE3:** Each explanatory variable changes over time (for at least some i), and there are no perfect linear relationship among the explanatory variables.

(d) **Assumption FE4:** For each t, the expected value of the idiosyncratic error given the explanatory variables in all time periods and the unobserved effect is zero: $E\left(u_{it}|X_i, a_i\right) = 0$.

Under assumptions FE1 – FE4, the Fixed Effects estimator $\widehat{\beta_{FE}}$ is unbiased. The key assumption is FE4 – strict exogeneity.

(e) **Assumption FE5:** $Var\left(u_{it}|X_i, a_i\right) = Var(u_{it}) = \sigma_u^2$, for all $t = 1, ..., T$.

(f) **Assumption FE6:** For all $t \neq s$, the idiosyncratic errors are uncorrelated (conditionally on all explanatory variables and a_i): $Cov\left(u_{it}, u_{is}|X_i, a_i\right) = 0$.

Under assumptions FE1 – FE6, the Fixed Effects estimator $\widehat{\beta_{FE}}$ is best linear unbiased estimator (BLUE).

(g) **Assumption FE7:** Conditional on X_i and a_i, u_{it} are independent and identically distributed normal random variables.

Under FE7, the FE estimator is normally distributed. We can utilize t and F statistics, which have t and F distributions, respectively.

4.6 Bonus Vetus

OLS is one the simplest and therefore most frequent methods of estimation. It was used by wide range of works from first Tinbergen (1962) Tinbergen to controversial Rose (2000). However, as Anderson & Van Wincoop (2003) warns, it would yield a biased estimator due to unobserved MRT of relative price of trade. Baier & Bergstrand (2009) came up with a method how to use OLS and still preserve unbiasedness of the resulting estimator - method exclusive for gravity model estimation. It is called it "Bonus vetus" OLS, which translates to latin as "good old" OSL referring to its popularity. Baier & Bergstrand solve MRT as a function of observed values - through Taylor series of expansion a correction variable (see Equation 4.5 for computation) is derived from framework of Anderson & Van Wincoop (2003). Once we control for MRTs in this manner (good old) OLS might be applied safely as a method of estimation. (Baier & Bergstrand 2009; 2010).

$$MRdistw_{ij} = \frac{1}{N}\left(\sum_{i=1}^{N} \log distw_{ik}\right) + \frac{1}{N}\left(\sum_{j=1}^{N} \log distw_{lj}\right) - \frac{1}{N^2}\left(\sum_{i=1}^{N}\sum_{j=1}^{N} \log distw_{ij}\right) \tag{4.5}$$

This correction variable is then inserted into our model to form function trade volume follows this model where values for distance and FX volatilityfrom function of observables

$$\log X_{ijt} = \beta_0 + \beta_1 \log Y_{it} + \beta_2 \log Y_{jt} + \alpha_3(MRdistw_{ij} - \log distw_{ij}) + \alpha_4(MRfxv_{ijt} - \log(fxv_{ij})_t) + \beta_4 comlang\_off + \beta_5 colony + \beta_6 contig + u_{ijt} \tag{4.6}$$

One last remark should be made on account of Bonus Vetus estimation before we proceed to results of empirical analysis. There are two way how to obtain correction variable, this thesis worked with the one that is computationally less demanding. Examine the other one (Equation 4.7). Method used in this thesis takes simple averages while the other uses GDP weights.

$$MRdistw_{ij} = \left(\sum_{i=1}^{N} \theta_i \log distw_{ik}\right) + \left(\sum_{j=1}^{N} \theta_j \log distw_{lj}\right) - \left(\sum_{i=1}^{N} \theta_i \theta_j \sum_{j=1}^{N} \log distw_{ij}\right) \tag{4.7}$$

Where θ_i and θ_j are economic densities of importer i and destination j respectively and are defined as $\frac{Y_i}{Y_T}$ $(\frac{Y_j}{Y_T})$ where Y_T denotes total income of all regions, which is constant across region pairs.

Chapter 5

Results

This chapter outlines results of empirical research and compiles them in a comprehensive form. The results are further discussed and attempt is made to provide an explanation for those specific results.

Based on evidence described in this chapter, following statement can be made:

"Demand for imports is highly inelastic with respect to foreign exchange rate volatility. This holds even when the demand is decomposed to demand for intermediates and demand for final products."

Furthermore, this discovery is statistically significant and coherent with conclusions of contemporary scientific literature.
However, we do not have sufficient evidence to confirm the initial presumption that demand for industrial inputs is less elastic with respect to FX volatility.

5.1 Bonus Vetus OLS Fixed Effects

Table 5.1 and Table 5.2 depict regression results for independent variable value of trade flows with intermediates and final products respectively. (Year dummies reported in Appendix Table A.2) What comes naturally first under scrutiny is variable of interest FX volatility.

Reader is advised to note that *mrfxv* and *fxv* along with *mrdistw* and *distw* represent estimates for same variable - for FX volatility and distance respectively. The distance and FX volatility estimates are in case Bonus Vetus OLS computed by observed value subtracted from correction variable (denoted *mr-fxv* and *mrdistw*) and estimates very same variables are computed as standard log-log estimate in case of Fixed Effects (denoted *fxv* and *distw*). See previous Chapter 4 for details.

In fashion of established gravity model analysis standard, regression results demonstrate exceptionally good fit ($R^2 > 0.75$)

First glance on regression results brings forth unexpected result. Paradoxically, anticipated separate effects of FX volatility have opposite impact than the estimated result. Originally, I assumed that due to reasons In case of Bonus Vetus OLS the difference is only minimal and that the effects are approximately same. To interpret this we might make use of following intuition, that demand for intermediates is by its nature derived from demand for final products. (See correlation matrix Table 3.2 fox exceptionally high degree of correlation between input flows (fli) and final products flows (fld))

To conduct the testing of fundamental hypothesis H_0 that there is zero effect of FX volatility on value of trade against alternative H_1 that it has non zero coefficient of regression, we employ common p-test and we obviously gather enough evidence to reject null hypothesis at the 5% significance level is that the effect is of great significance in estimating both methods and both segments of import demand.

Then it is safe to say that 10% increase in volatility of FX would result in decrease of trade no greater than 0,5%.

In detail, 10% raise of Fx volatility would diminish trade with intermediates by approximately 0,32% and by 0,48% in case of Bonus vetus OLS and Fixed effect estimation respectively
And in case of trade with final products same FX volatility shift would have approximately 0,36% and 0,28% reduction effect when estimated by Bonus vetus OLS and Fixed effect estimation respectively

Comparing it with only study that too split the aim of interest between intermediates and final products, Johannsen & Martinéz-Zarzoso (2017) also discover that market with intermediates is more elastic with respect to FX volatility and argues that one of explanations might simply be time discrepancy between contracting and payment (this however would not be valid argument under my data which is collected annually).

The overall message is clear and consistent with discovery of other gravity model studies, the FX volatility has little negative impact on trade flows.

Discovery that initial expectations do not correspond to reality does not necessarily pose a problem. In fact earlier in this work several indicators suggested that firms are more responsive to FX volatility, namely, consumption smoothing presented in already in Chapter 2 where graphical representation of final demand suggested presence of this phenomenon.

Moreover, firms may implement inventory planing - at steady FX rates, they might buy more input in advance for when the rate is not stable. So in fact, they would react more swiftly to FX changes then consumers.

Different limitation might be posed by fact that we inherently face here a certain degree of endogeneity of FX volatility - if there is an important volume o trade flows which is sensitive to fluctuations, its presence can lead to a more stable exchange rate with the particular region. Unfortunately, all of these problem is determined by nature of the analyzed matter and much cannot be done about it.

5.2 Discussion

Both estimation methods produce more less consistent coefficients GDPs and FX volatility, they differ substantially in estimating the institutional arrangements of common currency and RTAs.

No less fascinating is discovery that common currency variable is in case of Fixed effects estimation of intermediates insignificant. It is hard to imagine that common currency would have an insignificant effect on bilateral trade flows. This might be due to the fact that, once we included FX volatility in our estimation, we essentially control for common currency. For otherwise zero volatility, we assigned value of 0,0001 (in order to prevent undefined logarithm, see Chapter 3). If this is the case we might run the regression again - this time without *comcur* variable. Contradictorily, *common currency* dummy is statistically significant in case estimation by *Bonus Vetus OLS*, maybe because *comcur* serves here as proxy for EU (common market)[1]

We cannot rely on Fixed effects' results in case of variables that almost time invariant

Additional regression is run this time without *common currency* dummy variable. Consult the results in Appendix results only for sake comparison. This serves well to underline the importance of proper specification. We witness a quite dramatic turn in case of Bonus vetus estimation whilst Fixed effects' results remain almost intact.

[1]At the beginning of reference period (2000) all EU members use common currency (but United Kingdom and Denmark), 13 country became member countries of EU later during reference period, 7 of which adopted Euro as national currency

As established before, FX volatility does not have that dramatic effect. Based on result, we cannot even say decisively whether its effect changes differ in case of final or intermediate consumption. We are however able to deduce based on the evidence that role of distance is substantially different in case of explaining volume of intermediates and final demand. This suggests existence of regional ties as producers are willing to import less with increasing distance. This is underlined by the fact tht shared border boosts trade by 8%.

Table 5.1: Regression results: Intermediates

	Method of estimation:	
	Bonus Vetus OLS	Fixed Effects
lgdp_o	0.845***	0.787***
	(0.004)	(0.017)
lgdp_d	0.752***	0.775***
	(0.004)	(0.017)
mrdist	−1.101***	
	(0.015)	
mrfxv	−0.032***	
	(0.005)	
colony	0.469***	
	(0.041)	
comlang_off	0.104***	
	(0.034)	
contig	0.821***	
	(0.034)	
lfxv		−0.048***
		(0.004)
comcur	0.460***	0.017
	(0.030)	(0.024)
fta_wto	1.044***	0.266***
	(0.017)	(0.015)
Constant	−37.465***	
	(0.178)	
Observations	27,090	27,090
R^2	0.770	0.650
Adjusted R^2	0.769	0.625
F Statistic	3,932.171*** (df = 23; 27066)	2,471.011*** (df = 19; 25265)
Note:		*p<0.1; **p<0.05; ***p<0.01
Reference:		Hlavac (2018), Wölwer *et al.* (2018b), Wölwer *et al.* (2018a)

Table 5.2: Regression results: Final Products

	Method of estimation:	
	Bonus Vetus OLS	Fixed Effects
lgdp_o	0.917***	0.786***
	(0.005)	(0.017)
lgdp_d	0.763***	1.009***
	(0.005)	(0.017)
mrdist	−0.884***	
	(0.016)	
mrfxv	−0.036***	
	(0.005)	
colony	0.425***	
	(0.043)	
comlang_off	0.134***	
	(0.036)	
contig	0.886***	
	(0.036)	
lfxv		−0.028***
		(0.004)
comcur	0.417***	0.116***
	(0.031)	(0.024)
fta_wto	1.274***	0.229***
	(0.018)	(0.015)
Constant	−40.542***	
	(0.187)	
Observations	27,090	27,090
R^2	0.756	0.601
Adjusted R^2	0.755	0.573
F Statistic	3,637.266*** (df = 23; 27066)	2,006.660*** (df = 19; 25265)

Note: *p<0.1; **p<0.05; ***p<0.01

Reference (continued): R Core Team (2018)

Chapter 6

Conclusion

In theory, foreign exchange rate fluctuating around its trend causes uncertainty, higher the degree of this fluctuation, greater the uncertainty, which as a consequnce expectantly discourages demand for import.

This thesis represents an attempt of a comprehensive analysis of separate effects of FX volatility on two components of foreign demand for imports. Its goal was set to test validity of the expectation above. Further motivated by hypothetical difference between such effects, to measure the anticipated effect on trade from its two major segments - trade with final products and with intermediates. This thesis worked with gravity model of international trade (estimated by *Fixed effects* and *Bonus Vetus OLS*) to infer impact of exchange rate volatility on value of bilateral trade flows from *World Input-Output Tables* data consisting of sample of 43 countries from 2000 through 2014.

To recapitulate, my initial suspicion was not confirmed. On contrary, results from Fixed effects estimation suggested opposite result and it is that demand for import of intermediates is more elastic with respect to FX volatility than demand for final products (Although, the difference is not that dramatic and overall effect remains the same, ergo small negative - consistent with finding of recent empirical studies). Given that Bonus vetus estimation yields virtually same results for both intermediate and final consumption, it is more secure to state that this thesis remains inconclusive about comparing those effects. Within my work I also presented possible explanations for this e.g. transfer pricing, inventory planing, consumption smoothing, etc. Eventual next study might look into any of these phenomenona and investigate its probable impact. Overall expectation that global value chains are rigid proportionate to FX rate changes still holds under my discovery of small negative effect. What actually had a notable difference between results in case of intermediates and final products is estimate of role distance. Forthcoming researchers might survey the rationale behind anticipation that I made and it is that producers favor regional ties to very large extent.

In future work it would be also convenient to examine separate effect on each individual industry sector motivated by fact that different areas might reveal potentially different effects. Or further addressing of any limitations presented by this thesis (e.g. including intra-national flows) may become a decent analysis.

One of potential contributions of this thesis might be a recommendation to policy makers. Some might think, that holding foreign exchange rate stable would stimulate export, however my advice would be that in terms of trade this might not be beneficial in the end because the predicted effect is small.

From academia point of view,this thesis entered very well mapped field that has been contributed to for more than 40 years. It processed together ever developing areas of global production chains and market confidence and managed to provide relatively qualified additional evidence (from a perspective decomposed demand and relatively new data) to an issue that may have not been resolved convincingly yet, though, for simplicity it relaxed some aspects of estimation.

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Appendix A

Appendix

Country List			
Country Name	Currency Name	Country (Currency) Code[1]	Euro adoption [2]
Australia	Australian dollar	AUS (AUD)	
Austria	Euro	AUT (EUR)	
Belgium	Euro	BEL (EUR)	
Bulgaria	Bulgarian lev	BGR (BGN)	
Brazil	Brazilian real	BRA (BRL)	
Canada	Canadian dollar	CAN (CAD)	
Croatia	Croatian kuna	HRV (HRK)	
Cyprus	Cypriot pound	CYP (CYP)	2008
Czech republic	Czech crown	CZE (CZK)	
Denmark	Danish crown	DNK (DKK)	
Estonia	Estonian crown	EST (EEK)	2011
Finland	Euro	FIN (EUR)	
France	Euro	FRA (EUR)	
Germany	Euro	DEU (EUR)	
Greece	Euro	GRC (EUR)	
Hungary	Hungarian forint	HUN (HUF)	
Indonesia	Indonesian rupiah	IDN (IDR)	
India	Indian rupee	IND (INR)	
Ireland	Euro	IRL (EUR)	
Italy	Euro	ITA (EUR)	

[1]ISO Alpha 3 CODE for country and currency *(in parentheses)*
[2]value present if country adopted Euro during the reference period

Japan	Japanese yen	JPN (JPY)	
Latvia	Latvian lat	LVA (LTL)	2014
Lithuania	Lithuanian litas	LTU (LTL)	2015
Malta	Maltese lira	MLT (MTL)	2008
Mexico	Mexican peso	MEX (MXN)	
Netherlands	Euro	NLD (EUR)	
Belgium	Euro	BEL (EUR)	
Norway	Norwegian crown	NOR (NOK)	
South Korea	South Korean won	KOR (KRW)	
Spain	Euro	ESP (EUR)	
Switzerland	Swiss frank	CHE (CHF)	
Poland	Polish złoty	POL (PLZ)	
Portugal	Euro	PRT (EUR)	
Romania	Romania leu	ROM (RON)	
Russia	Russian ruble	RUS (RUB)	
Slovakia	Slovak crown	SVK (SKK)	2009
Slovenia	Slovenian tolar	BEL (EUR)	2007
Sweden	Swedish crown	SWE (SEK)	
Turkey	Turkish lira	TUR (TRY)	
Taiwan	New Taiwan dollar	TWN (TWD)	
United Kingdom	British pound	GBR (GBP)	
United States	US dollar	USA (USD)	

Table A.1: Country list

Figure A.1: 2012 example Scatter plot intermediates

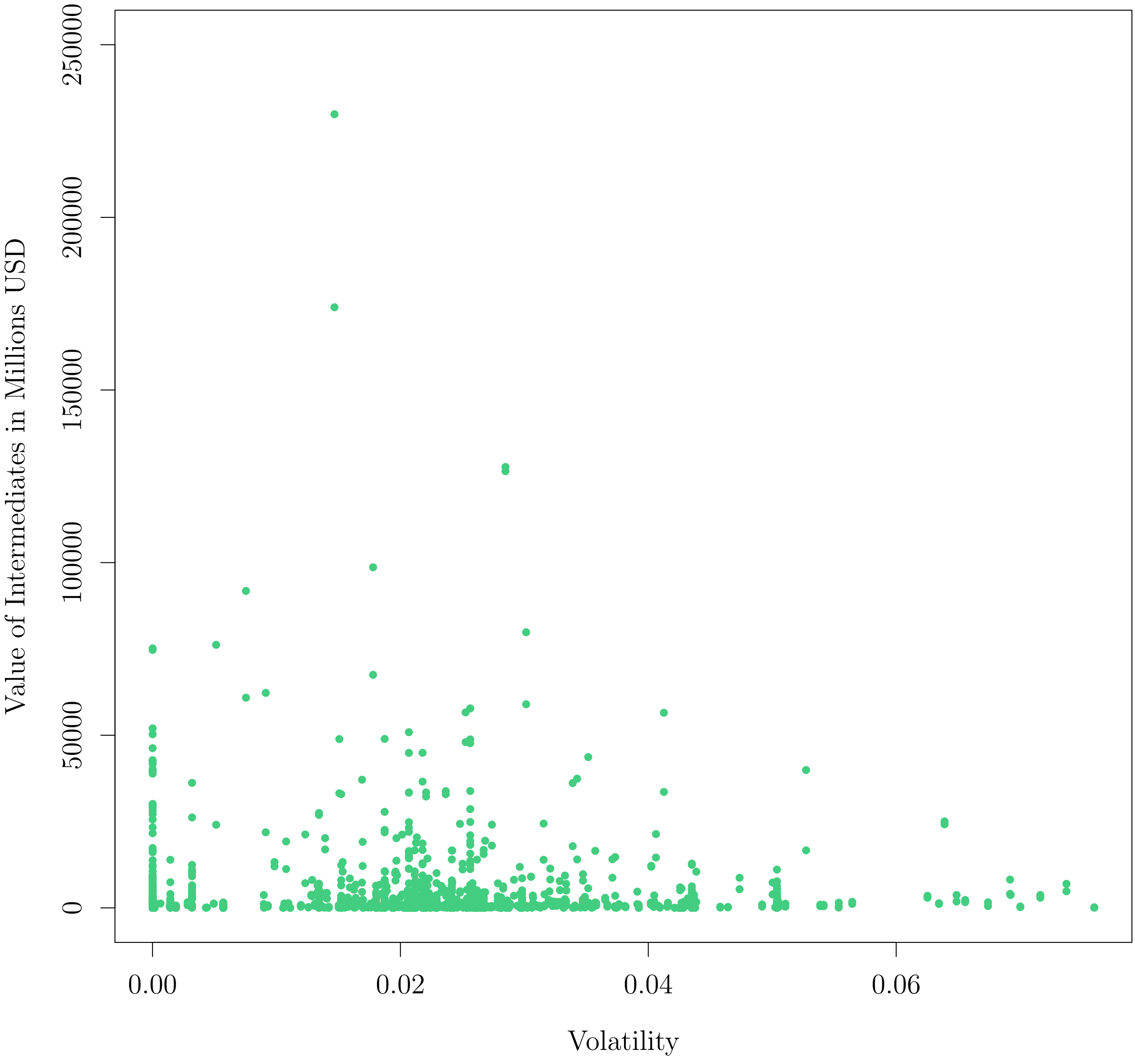

Figure A.2: 2012 example Scatter plot final consumtion

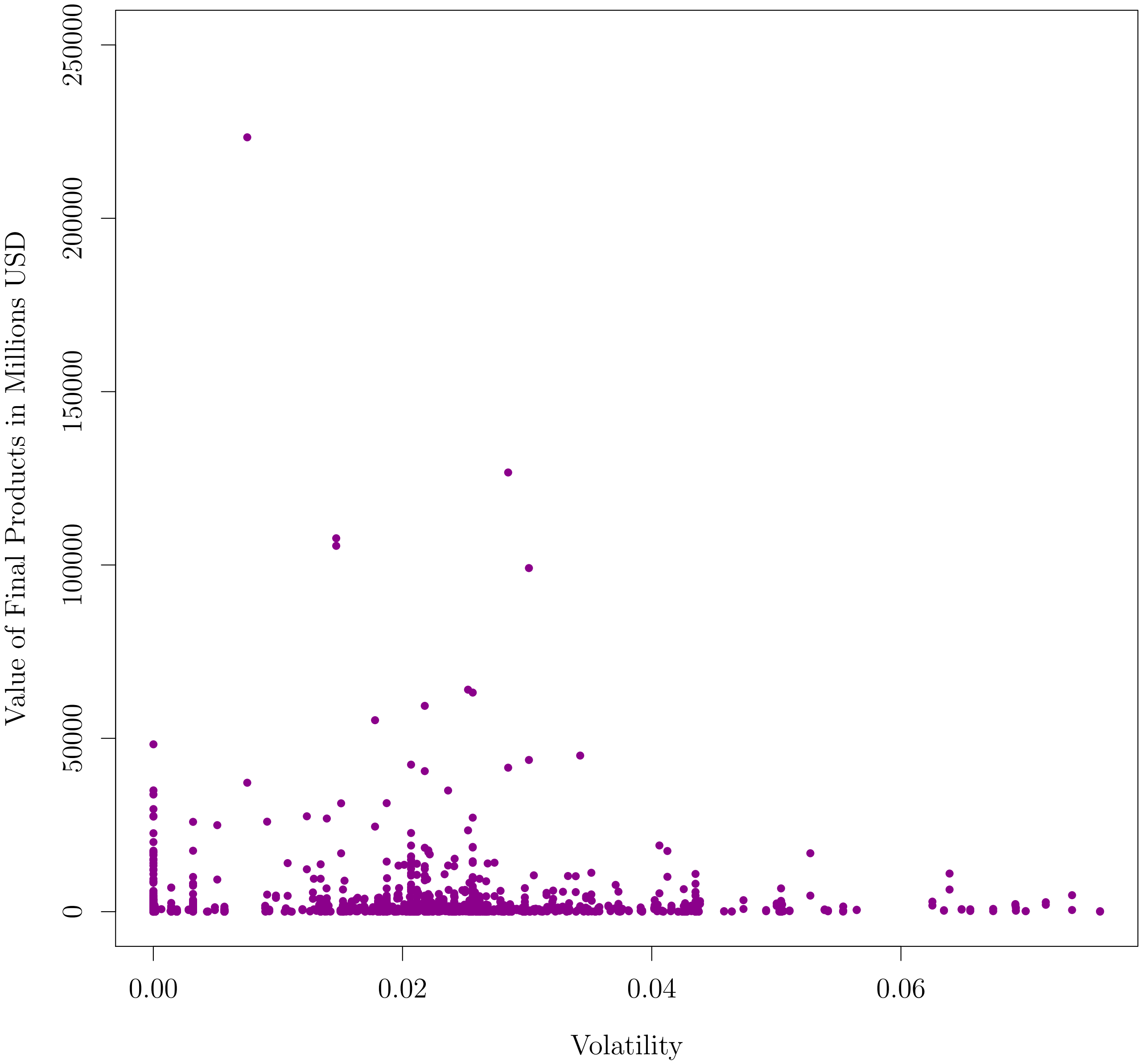

Table A.2: Year Dummies

	Dependent variable:			
	Intermediates		Final products	
	OLS (Bonus v.)	Fixed Effects	OLS (Bonus v.)	Fixed Effects
tdummyyear2000	0.340***	0.107***	0.671***	0.524***
	(0.040)	(0.029)	(0.042)	(0.029)
tdummyyear2001	0.349***	0.136***	0.670***	0.542***
	(0.040)	(0.029)	(0.042)	(0.029)
tdummyyear2002	0.312***	0.119***	0.623***	0.505***
	(0.040)	(0.027)	(0.042)	(0.027)
tdummyyear2003	0.292***	0.107***	0.546***	0.416***
	(0.039)	(0.023)	(0.041)	(0.023)
tdummyyear2004	0.195***	0.106***	0.389***	0.366***
	(0.039)	(0.021)	(0.041)	(0.021)
tdummyyear2005	0.202***	0.118***	0.375***	0.344***
	(0.039)	(0.019)	(0.041)	(0.019)
tdummyyear2006	0.212***	0.129***	0.349***	0.307***
	(0.039)	(0.018)	(0.041)	(0.018)
tdummyyear2007	0.158***	0.093***	0.253***	0.206***
	(0.039)	(0.016)	(0.041)	(0.016)
tdummyyear2008	0.139***	0.102***	0.199***	0.147***
	(0.039)	(0.016)	(0.041)	(0.016)
tdummyyear2009	0.018	−0.023	0.096**	0.064***
	(0.039)	(0.016)	(0.041)	(0.016)
tdummyyear2010	0.089**	0.054***	0.127***	0.098***
	(0.039)	(0.016)	(0.041)	(0.016)
tdummyyear2011	0.096**	0.071***	0.098**	0.063***
	(0.039)	(0.015)	(0.041)	(0.015)
tdummyyear2012	0.089**	0.085***	0.068*	0.072***
	(0.039)	(0.015)	(0.041)	(0.015)
tdummyyear2013	0.050	0.052***	0.025	0.027*
	(0.039)	(0.015)	(0.041)	(0.015)
Note:				*p<0.1; **p<0.05; ***p<0.01

Table A.3: FE versus RE: Intermediates

	Method of estimation:	
	Fixed effects	Random effects
ldist		−0.896***
		(0.025)
lgdp_o	0.787***	0.898***
	(0.017)	(0.011)
lgdp_d	0.775***	0.832***
	(0.017)	(0.011)
lfxv	−0.048***	−0.042***
	(0.004)	(0.004)
colony		0.540***
		(0.129)
comlang_off		0.378***
		(0.108)
contig		0.612***
		(0.108)
comcur	0.017	0.037
	(0.024)	(0.023)
fta_wto	0.266***	0.239***
	(0.015)	(0.015)
Constant		−33.420***
		(0.408)
Observations	27,090	27,090
R^2	0.650	0.671
Adjusted R^2	0.625	0.671
F Statistic	2,471.011*** (df = 19; 25265)	55,206.810***
Note:		*p<0.1; **p<0.05; ***p<0.01

Table A.4: FE versus RE: Final demand

	Method of estimation:	
	Fixed effects	Random effects
ldist		-0.986^{***}
		(0.026)
lgdp_o	0.786^{***}	0.933^{***}
	(0.017)	(0.011)
lgdp_d	1.009^{***}	0.926^{***}
	(0.017)	(0.011)
lfxv	-0.028^{***}	-0.026^{***}
	(0.004)	(0.004)
colony		0.386^{***}
		(0.136)
comlang_off		0.329^{***}
		(0.114)
contig		0.405^{***}
		(0.113)
comcur	0.116^{***}	0.116^{***}
	(0.024)	(0.023)
fta_wto	0.229^{***}	0.218^{***}
	(0.015)	(0.015)
Constant		-36.696^{***}
		(0.420)
Observations	27,090	27,090
R^2	0.601	0.630
Adjusted R^2	0.573	0.629
F Statistic	$2{,}006.660^{***}$ (df = 19; 25265)	$45{,}998.400^{***}$
Note:		*p<0.1; **p<0.05; ***p<0.01

Table A.5: Intermediates: Absolute FX

	Estimation method:		
	OLS (pooled)	Fixed effects	Random effects
ldist	−1.147***		−0.942***
	(0.010)		(0.025)
lgdp_o	0.964***	0.798***	0.898***
	(0.004)	(0.017)	(0.011)
lgdp_d	0.871***	0.805***	0.843***
	(0.004)	(0.017)	(0.011)
fxv	−0.424	0.396***	0.513***
	(0.271)	(0.144)	(0.143)
colony	0.405***		0.497***
	(0.037)		(0.129)
comlang_off	0.338***		0.392***
	(0.031)		(0.108)
contig	0.375***		0.572***
	(0.032)		(0.108)
comcur	0.169***	0.158***	0.170***
	(0.023)	(0.021)	(0.021)
fta_wto	−0.189***	0.285***	0.259***
	(0.020)	(0.015)	(0.015)
Constant	−33.728***		−33.151***
	(0.168)		(0.408)
Observations	27,090	27,090	27,090
R^2	0.810	0.648	0.670
Adjusted R^2	0.810	0.623	0.669
F Statistic	5,011.050***	2,447.070***	54,851.230***

Note: *p<0.1; **p<0.05; ***p<0.01

Table A.6: Final demand: Absolute FX

	Estimation method:		
	OLS (pooled)	Fixed effects	Random effects
ldist	-1.096^{***}		-1.012^{***}
	(0.011)		(0.026)
lgdp_o	1.031^{***}	0.791^{***}	0.933^{***}
	(0.004)	(0.017)	(0.011)
lgdp_d	0.877^{***}	1.025^{***}	0.931^{***}
	(0.004)	(0.017)	(0.011)
fxv	-2.078^{***}	0.126	0.126
	(0.280)	(0.143)	(0.142)
colony	0.322^{***}		0.361^{***}
	(0.038)		(0.135)
comlang_off	0.315^{***}		0.337^{***}
	(0.032)		(0.113)
contig	0.312^{***}		0.383^{***}
	(0.033)		(0.113)
comcur	0.083^{***}	0.198^{***}	0.197^{***}
	(0.024)	(0.021)	(0.021)
fta_wto	0.023	0.240^{***}	0.230^{***}
	(0.021)	(0.015)	(0.015)
Constant	-36.836^{***}		-36.514^{***}
	(0.174)		(0.419)
Observations	27,090	27,090	27,090
R^2	0.805	0.601	0.629
Adjusted R^2	0.805	0.572	0.629
F Statistic	$4,855.059^{***}$	$1,999.326^{***}$	$45,908.160^{***}$
Note:			*p<0.1; **p<0.05; ***p<0.01

Table A.7: Intermediates, BONUS VETUS OLS, no comcur

	Estimation method:	
	Bonus Vetus OLS	Fixed Effects
	lfli	
	(1)	(2)
lgdp_o	0.848***	0.786***
	(0.004)	(0.017)
lgdp_d	0.756***	0.774***
	(0.004)	(0.017)
mrdist	−1.068***	
	(0.015)	
mrfxv	0.011***	
	(0.004)	
colony	0.462***	
	(0.041)	
comlang_off	0.149***	
	(0.034)	
contig	0.876***	
	(0.034)	
lfxv		−0.049***
		(0.003)
fta_wto	1.124***	0.266***
	(0.016)	(0.015)
Constant	−37.425***	
	(0.179)	
Observations	27,090	27,090
R^2	0.768	0.650
Adjusted R^2	0.767	0.625
F Statistic	4,063.508*** (df = 22; 27067)	2,608.314*** (df = 18; 25266)
Note:		*p<0.1; **p<0.05; ***p<0.01

Table A.8: Final demand, BONUS VETUS OLS, no comcur

	Estimation method:	
	Bonus Vetus OLS	Fixed Effects
lgdp_o	0.921***	0.780***
	(0.005)	(0.017)
lgdp_d	0.767***	0.999***
	(0.005)	(0.017)
mrdist	−0.853***	
	(0.016)	
mrfxv	0.003	
	(0.004)	
colony	0.419***	
	(0.043)	
comlang_off	0.174***	
	(0.036)	
contig	0.936***	
	(0.036)	
lfxv		−0.036***
		(0.003)
fta_wto	1.346***	0.233***
	(0.017)	(0.015)
Constant	−40.506***	
	(0.188)	
Observations	27,090	27,090
R^2	0.754	0.601
Adjusted R^2	0.754	0.572
F Statistic	3,769.574*** (df = 22; 27067)	2,114.864*** (df = 18; 25266)
Note:		*p<0.1; **p<0.05; ***p<0.01