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International trade with intermediate and final goods under economic crisis

Abstract

This paper contributes to the discussion about influence of the current economic crisis on international trade in different types of goods. Our fundamental aim is to investigate determinants of bilateral trade in intermediate and final goods before the last economic crisis (1995–2008) and during the crisis (2009–2010). For our empirical test we use gravity models for all countries in the world. We complete this empirical test we with use of a loglinear specification of the gravity model and panel data estimation with Hausman-Taylor method. We test standard factors of gravity models such as size of the markets of trading partners approximated by their GDPs, geographic distance between the trading countries as well as their economic distance measured by difference in GDP *per capita*. We put into our gravity model dummy variables illustrating common official language of trade partners and their membership in regional trade agreements and monetary unions. Our model includes as well two dummy variables representing both years crucial for our study (2009 – the great trade collapse and 2010 – economic rebound). Moreover, we analyze interactions between both dummies connected with the time of the last crisis and other independent variables. Besides expected parameters by standard variables, we expect negative impact of the crisis on trade as well as higher elasticity of trade towards GDP during the crisis. Before gravity model analysis we present general statistics concerning international trade in intermediate and final goods.

Key words: international trade, crisis, gravity model, final goods, intermediate goods

JEL codes: F10, F1

1. Introduction

Baldwin (2010) argues that today's international trade consists not only in exchange of raw materials and final goods, but as well in complex, two-way flows of goods, services, people, ideas, and investments in physical, human and knowledge capital. In his opinion last century trade was dominated by goods made in factories run in one country and sold to customers located in other countries. Two-way flows of goods, people, and ideas were conducted primarily within factories. On the contrary in the early 21st century trade, factories and offices have been unbundled internationally thus creating the trade-investment-service nexus where some of the complex two-way flows that used to take place within factories and offices now take place across international borders. Trade in parts, components and services as well as foreign direct investment are the most easily measured aspect of this multifaceted, multi-directional commerce, but they are only the tip of the proverbial iceberg.

In this article we focus on international trade in intermediate goods as a key feature of contemporary world economy. We see this kind of trade as opposed to trade in final goods analysed traditionally in theory as well as in empirical research. Trade in intermediaries is is not a new phenomenon, but in the past it was quite proportional to trade in final goods. The rapid internationalization of supply chains observed during the last two decades has changed this proportion (Antràs, Staiger 2008; Baldwin, Taglioni 2011). International supply chains enable the use of absolute and comparative advantages of different regions or countries. Consequently, the dominating share of international trade is two-ways flows of intermediate goods. It is noticeable if comparing the value of exports of final goods with the value of exports of intermediaries. The data from table 3 convince that in 1995 the world export of intermediaries was more than 2,6 times bigger than export of final goods. In the year 2010 this proportion almost reached 3.

In studies concerning international trade in intermediate and final goods we use statistics based on *Broad Economic Categories* nomenclature (BEC). This nomenclature includes 19 basic categories: 111, 112, 121, 122, 21,22, 31, 321, 322, 41, 42, 51, 521, 522, 53, 61, 62, 63 and 7. These 19 categories are divided into 7 groups of commodities (first digit of category matters): 1 – food and beverages, 2 –industrial supplies not elsewhere specified, 3 – fuels and lubricants, 4 – capital goods (except transport equipment), and parts and accessories thereof, 5 – transport equipment, and parts and accessories thereof, 6 – consumer goods not elsewhere specified and 7 – goods not elsewhere specified.

In these 7 groups of commodities final and intermediate goods are put together (e.g. in the groups 4 and 5 it is even stressed with the names of the respective groups). For our analysis we need more disaggregated data. For this reason we use another division proposed by BEC with final goods belonging to categories: 112 – primary food and beverages mainly for household consumption, 122 – processed food and beverages mainly for household consumption, 51 – passenger motor cars, 61 – durable consumer goods not elsewhere specified, 62 – semi-durable consumer goods not elsewhere specified and 63 – nondurable consumer goods not elsewhere specified. As intermediaries we class commodities from categories: 111 – primary food and beverages mainly for industry, 121 – processed food and beverages mainly for industry, 21 – primary industrial supplies not elsewhere specified, 22 – processed industrial supplies not elsewhere specified, 321 and 322 – processed fuels and lubricants, 41 and 42 – capital goods (except transport equipment), and parts and accessories thereof, and 53 parts and accessories of transport equipment[1]. In the global export the fraction of the above mentioned final goods is 23% and of the intermediaries 66%. It means that both groups together constitute almost 90% of the world export what is so dominating part of trade that we can make general conclusion as far the whole world export is concerned.

We analyze only export of final and intermediate goods as the statistics concerning imports are distorted by tariffs and other protection measures (usually value of world import exceeds value of world export because of protection and different ways of calculation of prices in export and in import). Before estimating gravity models (based only on exports statistics as well) we present general trends in global trade of final and intermediate goods before and during the last economic crisis.

2. General trends in export of intermediate and final goods (1995 – 2010)

In 2009 world export of final goods dropped by almost 14% (408.2 bln USD) and in 2010 it rose by more than 12% (322.6 bln USD). It means that export did not recover after the downturn and did not achieve the level from the year 2008. In the year 2009 global export of intermediate goods fell even more than the export of the final goods. It dropped by 23%, what is equivalent of decrease in value by 2118.9 bln USD. One year later it increased by almost

[1]Commodities from categories: 31 – primary fuels and lubricants, 521 and 522 – other transport equipment, and 7 – goods not elsewhere specified cannot be unequivocally classed as final or as intermediate goods. Consequently, we do not analyze trade in commodities from the mentioned categories. Therefore, the sum of international trade of final and intermediate goods we analyze is smaller than the total international trade (as we already mentioned it equals ca. 90% of the world export).

23% (1580.93 bln USD) but still did not achieve the value from the year 2008 (see tables 1 and 2). It means that export of both analyzed groups of commodities was harmed by the crisis though the volatility of export of intermediaries was relatively higher. Statistics confirm the gloomy forecast stemming from the bullwhip effect[2]. During the crisis even mere fall of retailer demand brings severe decreases in intermediaries production, especially in industries with long supply chains. As many of these chains are international, during the crisis bullwhip effect leads to stronger drops in international trade of intermediaries than in trade with final goods.

In 2009 falls in exports were much higher than changes in GDP as the decreases of nominal and real GDP did not outstrip 10%. Moreover, in 2010 value of world nominal and real GDP was higher than in the year 2008. It means that world economy made up loses from the year 2009. As we pointed out before it is not the case of export.

Before and during the crisis the dominating part of export of both analyzed categories of goods accounts for developed countries (their export of both categories of goods in all analyzed years was bigger than the sum of the exports of both other groups of countries (developing countries and transition economies – see table 1).

Table 1. Export of final and intermediate goods during the period 1995–2010 (bln USD; BEC nomenclature)

	Final goods					Intermediate goods				
	1995	**2000**	**2008**	**2009**	**2010**	**1995**	**2000**	**2008**	**2009**	**2010**
Word	1101.5	1312.0	3011.3	2603.1	2925.7	2896.6	3673.9	9060.7	6941.8	8522.7
Developing countries*	265.5	362.6	895.2	810.0	947.0	564.5	882.3	3000.3	2423.5	3123.3
Transition economies*	26.6	45.6	19.6	17.8	20.2	56.9	157.7	307.1	190.2	229.7
Developed countries*	758.9	904.1	2097.2	1776.1	1959.2	2174.4	2634.5	5756.6	4330.3	5171.5

*UNCTAD country classification

Source: Own study based on COMTRADE database, The World Bank, http://wits.worldbank.org, [access: April 2012]

However, in the year 2009 export of final goods from developed countries decreased by more than 15%. These countries suffered relatively more than the other groups during the crisis (the respective fall in developing countries' export reached -9.5% and in transition economies' export -9%). In the same year export of intermediate goods from developed countries dropped by almost 25%, from developing countries by ca. 19% and from transition economies by 38%. Generally, in value terms export from developed countries was hit by the crisis more than export from developing countries (see table 2). The case of transition

[2]The bullwhip effect (or whiplash effect) is a phenomenon observed in forecast-driven distribution channels. It refers to a trend of larger and larger swings in inventory in response to changes in demand, as one looks at firms' further back in the supply chain for a product (Forrester, 1961).

countries is different as they are specialized in export of primary fuels which are classed neither as final nor as intermediate goods (thus a large part of export from this group of countries is not considered in this analysis, and the remaining part of its export hardly allow to conclude about the whole export).

Table 2. Changes in export of final and intermediate goods during the period 2000–2010 (bln USD; BEC nomenclature)

	Final goods			Intermediate goods		
	2009/2008	**2010/2009**	**2010/2000**	**2009/2008**	**2010/2009**	**2010/2000**
World	-408.2	322.6	1613.7	-2118.9	1580.9	4848.8
Developing countries*	-85.3	137.0	584.4	-576.8	699.8	2241.0
Transition countries*	-1.8	2.4	-25.4	-116.9	39.6	72.0
Developed countries*	-321.1	183.1	1055.1	-1426.3	841.2	2537.0

*UNCTAD country classification

Source: Own study based on COMTRADE database, The World Bank, http://wits.worldbank.org, [access: April 2012]

During 1995–2010 the export value of intermediaries was almost three times higher than the export value of final goods (see table 3). This proportion was increasing in the global export as well as in export from developed and developing countries till 2008 what confirms the increasing role of intermediaries in global trade. But in 2009 there was a fall of this proportion which appears indirect proof of bullwhip effect (higher decrease in export of intermediate than of final goods).

Table 3. The ratio of export value of intermediaries to export value of final goods during 1995 – 2010

	1995	**2000**	**2008**	**2009**	**2010**
Word	2.6	2.8	3.0	2.7	2.9
Developing countries	2.1	2.4	3.4	3.0	3.3
Transition countries	2.1	3.5	15.7	10.7	11.4
Developer countries	2.9	2.9	2.7	2.4	2.6

*UNCTAD country classification

Source: Own study based on COMTRADE database, The World Bank, http://wits.worldbank.org, [access: April 2012]

To sum up, during the last economic crisis global export of final as well as of intermediate goods was magnified harmed and its falls were bigger than decreases of GDP. Moreover, crisis hit stronger exports from developed than from developing countries and exports of intermediaries than export of final goods.

3. Gravity models specification and estimation method

In empirical studies[3] we use gravity models to analyze export (*Exp*) of intermediate and final goods from all countries (*i*) to all countries of the world (*j*) during the period 1995–2010 – see equation (1) in table 4. We use values of natural logarithms of dependent variable and independent variables (apart from dummy variables)[4]. We include standard independent variables such as: exporter's and importer's GDPs (total and *per capita*), and geographic distance between capitals of trading partners. Therefore, gravity models encompass three dummy variables illustrating common official language, membership in regional trading agreements and in monetary unions.

In order to scrutinize the influence of the last crisis, our models include two dummy variables (*y2009* and *y2010*) representing both crucial years of our study (2009 – the great trade collapse and 2010 – economic rebound). Coefficients by variables *y2009* and *y2010* inform about the difference between conditional expected values of dependent variable (*Exp*) before the crisis, namely during the period 1995–2008, and during the crisis (in 2009 and 2010 respectively). Moreover, we analyze interactions between *y2009* (*y2010*) and other independent variables (see variables $\boldsymbol{x_{2009}}$ and $\boldsymbol{x_{2010}}$) to compare the significance and strength of determinants of bilateral trade in intermediate and final goods before and during the crisis. Interactions variables were included in order to fish out potential instability of model in the time of last crisis. Coefficients by interactions (x_{2009} and x_{2010}) can be interpreted as the difference between (semi)elasticity of dependent variable (*Exp*) and independent variables before the crisis (during the period 1995–2008), and during the crisis (2009–2010).

Table 4. Specification of gravity models

$$\ln X_{ij}^{t} = \gamma + \alpha_1 \ln(GDP_i^{t}) + \alpha_2 \ln(GDP_j^{t}) + \alpha_3 \ln\left|GDPpc_i^{t} - GDPpc_j^{t}\right| + \alpha_4 \ln dist_{ij} + \alpha_5 lang_{ij} + \alpha_6 mu_{ij}^{t} + \alpha_7 rta_{ij}^{t} + \alpha_8 y2009^{t} + \alpha_9 y2010^{t} + \boldsymbol{\beta x}_{2009,ij}^{t} + \boldsymbol{\delta x}_{2010,ij}^{t} + \varepsilon_{ijt} \quad (1)$$

Abbreviation	Description	Data source
Exp	Export (current prices and exchanges rates, USD; BEC nomenclature)	COMTRADE, The World Bank, http://wits.worldbank.org, [access: November 2011]
GDP	Gross Domestic Product (current prices and exchanges rates, USD)	WDI, The World Bank, http://data.worldbank.org/data-catalog/world-development-indicators, [access: November 2011]
GDPpc	Gross Domestic Product *per capita* (current prices and exchanges rates, USD)	WDI, The World Bank, http://data.worldbank.org/data-catalog/world-development-indicators, [access: November 2011]

[3]Model specification and estimation methods are based on Śledziewska, Witkowski (2012).
[4]Consequently, coefficients:α_1, α_2, α_3 and α_4 can be interpreted as elasticities and coefficients α_5, α_6, α_7 α_8 and α_9 as semielasticities.

Dist	Geographic distance between capitals (km)	CEPII, http://cepii.fr [access: November 2011]
Lang	Dummy variable with value 1 if exporter and importer use common official language and 0 otherwise	CEPII, http://cepii.fr [access: November 2011]
Rta	Dummy variable with value 1 if both trading countries are members of regional trading arrangements	WTO, http://rtais.wto.org, [access: November 2011]
Mu	Dummy variable with value 1 if both trading countries are members of monetary union	IFS, International Monetary Fund, http://elibrary-data.imf.org/, [access: November 2011]
y2009	Dummy variable with value 1 for year 2009	-
y2010	Dummy variable with value 1 for year 2009	-
x_{2009}	Interactions between *y2009* and other independent variables	
x_{2010}	Interactions between *y2010* and other independent variables	
E	error term	-
i, *j*, *t*	subscripts for exporter (reporter), importer (partner) and year	-

Source: Own study

The choice of proper estimation method is the next issue. A standard choice is to adopt one of the typical panel data based estimators, such as fixed or random effects. However, the main disadvantage of the fixed effects approach is the unavailability of parameter estimates on the variables that are constant over time for all observations. They simply cannot be computed, because the within transformation of the data, which is applied in the estimation process, eliminates all such variables from the model equation. An example of this kind of variables is a geographic distance between trading partners. Since it is most likely a relevant variable and simultaneously, it might be correlated with the variables in the model, resigning on it could cause an omitted variable error and in consequence, could result in obtaining biased estimates of parameters. The necessity to eliminate such variables as the above mentioned distance and the fact that this would most likely cause the omitted variables problem, makes the use of fixed effects approach a bad idea.

Another possibility is thus to use the random effects approach. In this case one of the necessary assumptions is the zero correlation of the individual effects and the independent variables of the model. This assumption does not hold. If we assume that the functional form and the regressors of the model are valid, Hausman test is the way to verify it and the null hypothesis of no correlation between the individual effects and the regressors must be rejected on any reasonable significance level. There might be some doubts though, whether rejection of the null hypothesis in the Hausman test is truly due to the problem of correlation between individual effects and independent variables. Another possible reason of rejecting the null hypothesis in the Hausman test is a general specification error of the model, which, in most

cases, is due to endogeneity of the regressors, whereas in the mentioned approaches we assume a strong form of exogeneity[5].

In this situation there is still one solution to be applied, which is the Hausman-Taylor estimation method. It allows for the use of both time-varying and time invariant variables, however it is allowed that some of them can be endogenous in the sense of correlation with individual effects, but still exogenous with respect to idiosyncratic error term. We assume that variables: $dist_{ij}$, $|GDPpc^t_i\text{-}GDPpc^t_j|$ and rta^t_{ij} are correlated with individual effects. Firstly, due to historical relationships and trade within borderlands, geographic proximity can intensify trade and increase the value of individual effects. Secondly, also small economic distance measured by the difference in GDP *per capita* of trading partners enhance trade intensity and might have positive impact on the value of individual effects. Thirdly, regional trading arrangements (independent upon its specific form) affect propensity to bilateral trade. For the similar reasons, variable illustrating former colonial links between countries is probably correlated with individual effects. However, we decide not to include this variable in our models and simultaneously exclude from sample pairs of countries with former colonial links. We want to avoid distortions in the models stemming from enormous size (in relation with its respective GDPs) of trade between metropolitan states and their formers colonies.

4. Estimation results of gravity models

We estimate gravity models of trade in intermediate and final goods for all countries of the world (see table 5). In both models, namely in model explaining determinants of export of final goods as well as in model referring to intermediate goods, standard variables (exporter's and importer's GDPs, distance and difference in GDP *per capita*) are statistically significant. Coefficients of these variables have signs expected in the theory of trade. Exporter's GDP and importer's GDP have positive impact on exports. On the contrary the influence of geographic distance and difference in GDP *per capita* is negative.

[5]A theoretical way to check if this is not the true problem is to apply some form of instrumental variables approach. Although it is numerically feasible, the problem lies in the choice of instruments. Typical approach is to use lags of the endogenous regressors as instruments. Unfortunately, if the variables of the model are not exogenous, their lags themselves will not be proper instruments since they themselves will not be strictly exogenous either. This is due to the fact, that most regressors cannot be viewed as white noise: it is actually quite the opposite. In most cases they are seriously auto correlated. Possible correlation of some *Exp*'s with error term might be due to the fact, that current value of the error term is influenced by some previous values of the same *Exp*'s. Thus endogeneity of current value of a given *Exp* is likely to coexist with certain form of endogeneity of its lagged values. Also it is difficult to find any additional instruments, which would be strong in econometric sense and truly strictly exogenous.

In the period 1995–2008 (before the last economic crisis) the increase of exporter's GDP by 1% caused *ceteris paribus* the growth in export of final goods by 0.49%. Respective increase in export of intermediate goods used to be higher (0.66%). Moreover, the rise of importer's GDP by 1% resulted *ceteris paribus* in an increase in exports of final goods by 0.69% (and by 0.64% in the case of intermediate goods). Consequently, export of intermediate goods is more vulnerable to changes of exporter's GDP than to changes of importer's GDP. On the contrary, export of final goods is noticeably more sensitive to changes of importer's GDP.

In comparison to the period before the crisis (1995–2008), in the years 2009–2010 elasticity of export of final as well as of intermediate goods towards exporter's and importer's GDP were higher. It means that exports were more vulnerable to changes of GDP of both trading partners during the economic crisis. Moreover, before the crisis the increase in difference between GDP *per capita* of trading partners by 1% caused *ceteris paribus* the fall of export of final goods by more than 0.09% and a smaller drop of export of intermediate goods by more than 0.07%. In the years 2009 and 2010 the negative impact of difference in GDP *per capita* was even stronger than before the crisis. It confirms the hypothesis that exports are more sensitive to GDP changes in the time of the economic crisis.

Table 5. Estimations results for gravity models concerning all countries of the world

	Final goods	**Intermediate goods**
$\ln GDP_i^t$	0.492***	0.662***
	(0.0202)	(0.0180)
interaction with 2009	0.0778***	0.0528***
	(0.00885)	(0.00859)
interaction with 2010	0.109***	0.0311***
	(0.0103)	(0.00967)
$\ln GDP_j^t$	0.691***	0.635***
	(0.0131)	(0.0119)
interaction with 2009	0.0205***	0.0252***
	(0.00699)	(0.00671)
interaction with 2010	0.0148*	0.0387***
	(0.00764)	(0.00728)
$\ln\left\|GDPpc_i^t - GDPpc_j^t\right\|$	-0.0921***	-0.0736***
	(0.0109)	(0.0103)
interaction with 2009	-0.137***	-0.0578***
	(0.0104)	(0.00998)
interaction with 2010	-0.176***	-0.0627***
	(0.0115)	(0.0110)
$lang_{ij}$	0.244	-0.119
	(0.205)	(0.164)
interaction with 2009	-0.0813*	-0.0910**
	(0.0417)	(0.0407)
interaction with 2010	-0.153***	-0.225***
	(0.0471)	(0.0460)
mu_{ij}^t	0.0535	0.0317
	(0.0805)	(0.0794)
interaction with 2009	-0.208*	-0.277**
	(0.119)	(0.117)

interaction with 2010	-0.294**	-0.230*
	(0.130)	(0.128)
rta_{ij}^{t}	0.131***	0.180***
	(0.0263)	(0.0255)
interaction with 2009	0.0774**	-0.0734**
	(0.0371)	(0.0358)
interaction with 2010	0.0929**	-0.0326
	(0.0397)	(0.0382)
$\ln dist_{ij}$	-1.690***	-2.254***
	(0.240)	(0.200)
interaction with 2009	-0.0322	-0.0338*
	(0.0196)	(0.0190)
interaction with 2010	-0.0553**	-0.00215
	(0.0218)	(0.0209)
$y2009^{t}$	-1.062***	-1.259***
	(0.307)	(0.300)
$y2010^{t}$	-1.122***	-1.181***
	(0.342)	(0.328)
Constant	-7.488***	-4.773***
	(2.062)	(1.716)
Number of observations	124 984	132 163
Number of country pairs	12 976	13 280

*** p<0.01, ** p<0.05, * p<0.1

Source: Own study based on estimations conducted in STATA

Variable illustrating common official language of trading countries appears not statistically significant. It suggests that due to the dominating position of English as the international language and IT development, common official language does not intensify bilateral trade.

In the period 1995–2008 dummy variable illustrating membership in monetary unions is not statistically significant. Consequently, both models do not confirm trade creation effect stemming from participation in monetary unions anticipated by theorists. However, in the years 2009 and 2010 there is a negative and statistically significant impact of monetary union on export. It suggests that lack of autonomous national monetary and exchange rate policy is an obstacle to enhance export competitiveness during economic crisis. On the other hand, the variable connected with regional trading arrangements (RTAs) is statistically significant. In the period 1995–2008 membership in RTA increased *ceteris paribus* export of final goods by 14% and export of intermediate goods even more (by almost 20%). Therefore, in the years 2009 and 2010 we can observe intensification of trade in final goods between countries participating in RTA.

Coefficients of variables *y2009* and *y2010* inform about export decreases during economic crisis. If the values of all independent variables in the year 2009 remained constant in comparison to the period before the crisis, the expected value of export of final goods would have dropped in 2009 by 65%. Respective drop of export of final goods in 2010 would have been equal about 67%. In the case of intermediate goods drops would have been even

higher: 72% in 2009 and 69% in 2010. Estimations results of gravity models also confirm the significance of bullwhip effect (higher expected decrease in export of intermediate than of final goods). Real decreases caused by crisis in export of final and intermediate goods were much smaller what suggest that falls in exports was accompanied by drops of GDP of trading partner (violation of the assumption about constant values of all independent variables).

4. Conclusions

Gravity models of trade in intermediate and final goods for all countries of the world confirm interdependence between bilateral trade and GDP. Estimations results confirm that strength of relationship between export and GDP of trading partners was higher during the economic crisis. It is indirect proof that sharp recession in the year 2009 and rapid economic rebound one year later was accompanied by similar changes in trade of final as well as intermediate goods. Gravity models confirm also trade creation effect as a consequence of participation in RTA but they do not confirm this effect in the case of monetary union.

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