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The Impact of Euro Adoption on Export Performance: Comparison of the Czech Republic and Slovakia

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The Impact of Euro Adoption on Export Performance: Comparison of the Czech Republic and Slovakia

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Abstract:
The present paper is focused on the impact of introducing the common European currency on export performance. There has been a lot written about the possible effects of euro adoption on economies of the first eurozone participants. The contribution of this research is that we explore the impact of euro introduction on Slovakia, in comparison to the Czech Republic which still uses its own national currency. Our findings suggest that the export performance and other export-related indicators evolved largely in parallel in both countries. Positive trade effects brought about by the introduction of the euro are rather moderate – up to 5%. The results to some extent do confirm the existence of the so called 'Rose effect' – the effect that two countries sharing the same currency trade more than they would otherwise.

Keywords: competitiveness, euro adoption, export, Czech Republic, Slovakia

JEL: F14, F15

1 Introduction

„A continental currency, with a dual metallic and fiduciary base, resting on all Europe as its capital and driven by the activity of 200 million men: this one currency would replace and bring down all the absurd varieties of money that exist today, with their effigies of princes, those symbols of misery." Victor Hugo, 1855

The presented paper focuses on the impact of introducing the common European currency on a country's export performance. The dream of a currency unit embracing and unifying disparate peoples and filling the wealth gap between economies has been an object of concern to policymakers and economists throughout centuries. The establishment of the Economic and Monetary Union (EMU) on 1 January 1999 was an important milestone in the process of economic integration in Europe. Naturally, great expectations have been laid on this new institution, hoping that, by increasing trade and foreign investments between the member states, it would increase welfare, enhance resource allocation, and help to make Europe more competitive.

Much has been written about the possible effects of euro adoption on the economies of the first participants. However, the objective of this paper is to explore the impact of introducing the common European currency on the export performance of Slovakia, in comparison to the Czech Republic, which still uses its own national currency, the koruna. The euro changeover has undoubtedly been one of the largest integration steps for Slovakia in the previous decade. This step affected all of the country's inhabitants. Neither professional studies nor public declarations published in the period before the introduction of the euro dealt with detailed expectations associated with its impact on the competitiveness of Slovak businesses and the country as a whole. This paper thus aims to somewhat contribute to the discussion over the costs and benefits of the eurozone membership. Indeed, this topic is currently highly relevant, considering the flaws in the governance framework underlying the functioning of the euro area revealed by the recent global economic and financial crisis followed up by the European sovereign debt crisis. Since there is no agreed and generally accepted definition of competitiveness, the current writer cannot hope to cover all the possible implications of the question. Within the scope of the work, it is not possible to include all the relevant factors that may possibly influence the level of competitiveness and thus the topic is explored mostly from the export perspective. This approach is in line with the scoreboard - indicators and thresholds - chosen by the European Commission in its Alert Mechanism Report so as to provide a "reliable signaling device for potentially harmful imbalances and competitiveness losses at an early stage of their emergence **[15]**." The Alert Mechanism Report puts a lot of weight on export-derived or export-related indicators. Based on an extensive literature review and the author's own empirical research, the paper should address and verify several questions, above all: "Has the euro adoption in Slovakia had a positive effect on trade?"

The remainder of this work is organized as follows. Chapter 2 briefly discusses the theoretical background on the impact of currency unions on trade. Chapter 3 proceeds with analytical framework. Emphasizing the experience of Slovakia and the Czech Republic, it reviews the empirical evidence and achieved results regarding the impact of euro adoption on foreign trade. Finally, Chapter 4 assesses all the information and arguments presented in the paper and on their basis formulates a conclusion.

2 Theoretical background

For most of the last hundred years, economists and policymakers thought that exchange rate volatility and multiple currencies depressed trade. For instance, the older economists of the nineteenth century generally favored a world currency. As John Stuart Mill puts it, there is so much of barbarism "in the transactions of most civilized nations that almost all independent countries choose to assert their nationality by having, to their own inconvenience and that of their neighbors, a peculiar currency of their own **[33]**." French dramatist Victor Hugo envisioned a common unit of money that would comprise of European nations and the United States of America. These blocs would extend their hands over the seas, "exchanging their products, their commerce, their industry, their arts, their genius, opening up the globe, colonizing the deserts, improving creation under the gaze of the Creator." This stemmed from causal empiricism, most of it related to the period from 1880 to 1914, also known as the classical gold standard. During that time, the majority of countries in varying degrees adhered to gold. It was also a period of unprecedented economic growth with relatively free trade in goods, labor, and capital **[11]**. From this Mundell deducted that more trade would be the main microeconomic gain enjoyed when two nations form a currency union, claiming that if factors of production are mobile across national boundaries then a flexible exchange system becomes unnecessary, and may even be positively harmful **[34, p. 657-665]**. However, this cornerstone of Mundell's famous 'optimal currency area' theory rested on no econometric evidence. Until relatively recently, economists could not find robust empirical evidence for a negative impact of exchange-rates and volatility on trade flows despite increasingly sophisticated empirical methods and larger datasets. Clear results were not identified even after the exchange rate turmoil accompanying the break-up of the Bretton Woods system in the 1970s and, despite the best efforts of economists, a basic paradox as to the impact of exchange rate volatility on trade flows remained unresolved **[31, p. 71-106]**.

The situation changed dramatically at the turn of the 21st century. Rose published his finding that a currency union is a powerful stimulant to trade **[38]**. Furthermore, he found a small negative trade effect of exchange rate volatility, even after controlling for a host of features, including the endogenous nature of the exchange rate regime. The results withstood an initial barrage of cross checks and sensitivity analyses and the estimates seemed to be robust. The so called 'Rose effects' implied that two countries that share the same currency trade three times as much as they would with different currencies. Since the introduction of this revolutionary paper, a lot of research has been conducted either to confirm or disprove Rose's results. The empirical literature on the boost to trade due to the formation of a monetary and currency union is, however, rather ambiguous. Estimates published by researchers range significantly. Berger and Nitsch, taking a long-run view of European integration, found that the introduction of the euro had had almost no measurable effect on trade **[9]**. More specifically, there is strong evidence for a gradual increase (rather than a one-time jump) in trade intensity between countries that later join the EMU over a period of more than fifty years. As soon as they controlled for this long-term trend, the introduction of the euro had no additional effect on trade. Pakko and Wall even reported a 40% negative effect of currency unions on trade **[36, p. 37-46]**. On the other side of the

spectrum lies the paper by Alesina, Barro and Tenreyro, estimating that currency union has a positive effect on bilateral trade of as much as 1,388% **[1].** According to McKinsey & Company the trade increase within the euro area is an important lever substantially benefiting EMU members **[32]**. Nonetheless, the study states that the countries benefit to different degrees, with most of the profits accruing to Germany. Dědek reports of the negative trade effects after the breakup of the common currency area in case of the former Czech and Slovak Federal Republic and the subsequent creation of independent Czech and Slovak Republics on 1 January 1993. In the first two years after the split, exports to the other Republic declined by 22% and 19% respectively in the Czech Republic and by 18% and 8% respectively in Slovakia. At the same time, export to other countries rose markedly.

Apparently, the researchers' findings are rather equivocal. Thus, in order to carefully assess the results and answer the formulated research questions, the following sections take a closer look at the export performance of the Czech Republic and Slovakia.

3 Export performance of the Czech Republic and Slovakia

Too little time has passed since the introduction of the euro to make a serious in-depth econometric analysis examining its impact on the Slovak economy, especially if we consider that the euro is generally expected to be beneficial mainly from the long-term. The task becomes even harder bearing in mind the fact that the currency changeover coincided with emergence of the economic recession which severely harmed the country's small and export-dependent economy. In addition to that, negative effects of the economic downturn were exacerbated by a fortnight-long interruption of industrial production caused by the gas crisis that occurred at the turn of 2008-2009.

After more than two and a half years spent in the Exchange Rate Mechanism II (ERM II), the Council of the EU decided that Slovakia would join the euro area as its 16th member as of 1 January 2009. The Slovak koruna entered ERM II with an initial central parity at 38.455 SKK/EUR, and a standard fluctuation band of ±15%. In order to reflect improvements in underlying fundamentals the central parity of the koruna was revalued to 35.4424 SKK/EUR, with effect from March 2007 and to 30.1260 SKK/EUR, with effect from May 2008. The central parity level was set as the ultimate SKK/EUR conversion rate in July 2008. The nominal exchange rate against the euro was thus fixed.

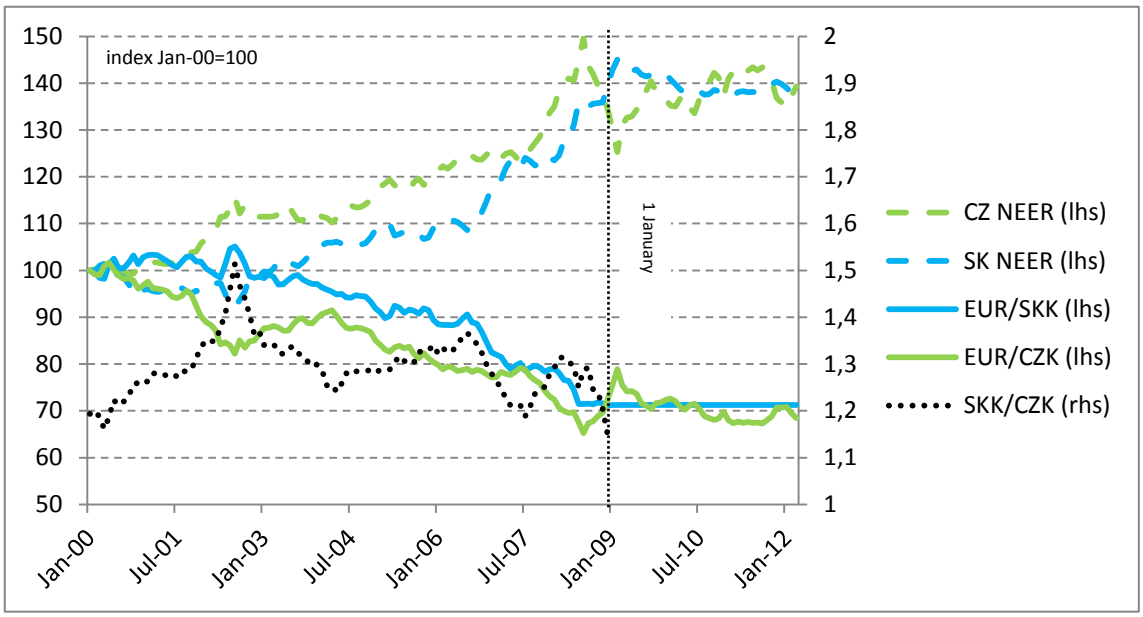
Before analyzing export performance, a closer look at the development of the exchange rate is desirable. The nominal effective exchange rate (NEER)[1] is computed as a weighted average of a currency's exchange rates versus several of the most important foreign currencies[2], and thus measures the global appreciation/depreciation of a currency **[16]**. Graph 1 illustrates that the CZK and SKK had evolved broadly in parallel from 2004 until mid-2008. Especially in the second half of the period, both currencies recorded substantial nominal-effective appreciation. The exchange rate between the two currencies had remained broadly stable, oscillating around 1.25 SKK/CZK. Fixation of the EUR/SKK[3] exchange rate was confirmed by market development, with trades close to the conversion rate until the end of 2008 in spite of the considerable market instability. Meantime, the Czech koruna, while enjoying full exchange rate flexibility, depreciated sharply against the euro between mid-2008 and early 2009 and, despite a subsequent strong rebound, it has not fully recovered yet.

[1] An increase of the indices represents effective exchange rate appreciation.

[2] For Slovakia, 15 trading partners were included: Germany, Czech Republic, Italy, France, Austria, Poland, Hungary, United Kingdom, United States, Netherlands, Belgium, Spain, Russian Federation, China and Korea. For the Czech Republic: eurozone, Russia, Poland, United Kingdom, USA, Japan, Hungary, Switzerland, Sweden, Denmark, China, Korea and Romania.

[3] If this rate goes up, more foreign currency can be obtained for EUR. It therefore becomes more expensive for those who want to exchange foreign currency for euro. In other words, an upward movement of EUR/SKK line means EUR is appreciating and SKK is depreciating.

Graph 1: NEER and the bilateral SKK/CZK exchange rate



Source: National central banks; Oanda

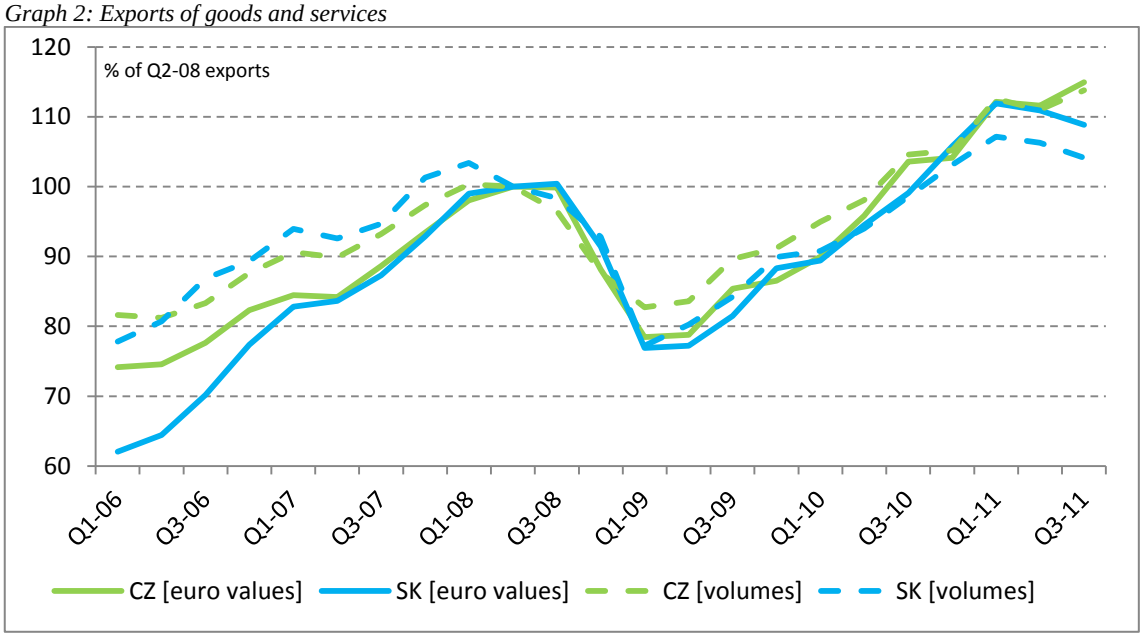
Taking into account all the above points, export earnings in euro terms evolved largely in parallel in both countries, showing no substantial difference in performance of the two neighbors. As of 2007, exports in terms of euros experienced very similar development, with the correlation of 0.98. The euro value of both Czech and Slovak exports dropped sharply by more than 20% during Q4-2008 and Q2-2009, and then gradually recovered back to its original level by mid-2010, i.e. exports reached the pre-crisis levels over the period of five quarters.

On the other hand, in terms of volume, a different trend can be observed. While Czech exports fared better, losing around 17% of their Q2-2008 level and then climbing above 100% by Q3-2010, Slovakia's export volume dropped by 23% between the onset of the crisis and its peak in 2009, and only regained its pre-crisis values by Q4-2010, still lagging behind the Czech Republic. Nominal exchange rate depreciation against the euro witnessed at the beginning of the economic slowdown may have enabled Czech exporters to lower their prices and thus to somewhat mitigate the negative impact of the external demand shock on their sales abroad at the peak of the crisis. Fidrmuc *et al.* also point up that the interaction of the crisis and the strong real appreciation in the run-up to joining the euro area caused that the EUR/SKK exchange rate was probably locked in at a too high level **[18]**. At first glance, and in accordance with the common belief, the difference could be explained by a too strong exchange rate caused by the devaluation of neighboring currencies. However, as to the loss of independent monetary policy, the National Bank of Slovakia (2006) explains that Slovak monetary policy had had a limited scope to respond to the development within core sectors of the economy even before it introduced the new currency. Pillars of the economy, such as automotive and electrotechnical industries, are strongly oriented towards exports, their import intensity is also very high and finances are acquired on international markets. NBS reports that since the monetary policy is not able to influence this sector, its loss does not mean higher exposure of the Slovak economy to shocks in the industry **[35]**. Lalinský points out that comparing the development in Slovakia with other countries allows admitting a possible, though hard to quantify, negative impact which the strengthening of the effective exchange rate could have had on selected services **[26]**. On the other hand, considering the hypothesis that fixing of the koruna exchange rate and the euro

transition had a significant negative impact on the competitiveness of Slovakia, exports would have recovered more slowly in 2009 (or would even have fallen) in comparison with the Czech Republic or other countries with floating exchange rates.

Moreover, as Jevčák explains, "the initial competitiveness boost from the sudden weakening of the Czech koruna at the onset of the crisis might have been partly offset by the fact that a large part of export revenues was at the time hedged" at lower exchange rate levels at which the koruna had traded before the crisis **[23]**. This is evidenced by the fact that the export performance in nominal euro terms (i.e. export earnings) was almost identical for both economies, i.e. relatively higher real exports compensated for lower export prices.

Graph 2: Exports of goods and services

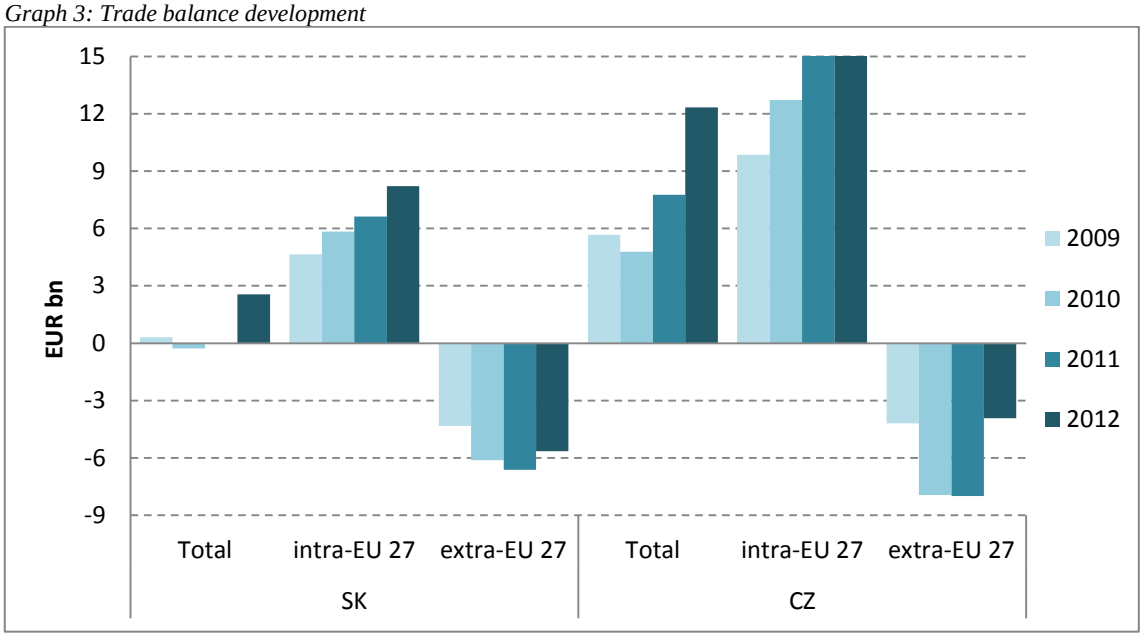


Source: Author's calculations based on Eurostat data

Lalinský suggests the high level of openness of the Slovak economy played a major role in a steeper decline of its exports **[26]**. Another factor is that value added is created mainly by cyclically sensitive industries. "These factors made the impact of external negative developments on the Slovak economy quicker and stronger," he concludes. Naturally, tight trade linkages with its main trading partners mean that growth shocks in those countries were transmitted to Slovakia also via slower trade growth. Slovakia is particularly sensitive to developments in Germany and in the euro zone, on which it has almost the highest trade dependence **[21]**.

Graph 3 shows the evolution of trade balance in nominal terms. Overall, the trade balance of both countries has been gradually improving over the 2009-2012 period, as the crisis-related decline in domestic demand resulted in contraction of the spread between exports and imports. The Czech Republic maintains a highly positive balance, whereas Slovakia oscillates around zero. Negative trade balance with extra-EU 27 partners partially offsets the positive intra-EU statistics. This indicator shows a considerable distinction between the two countries. Most likely it is caused by different structure of their respective economies, with more value added being created in the Czech Republic.

Graph 3: Trade balance development



Source: Eurostat

3.1 Simple regression analysis

In order to empirically assess how the euro adoption affected Slovak exports, we first perform a simple regression analysis. The technique used to estimate the euro trade effects is similar to the one used by Lalinský but with a couple of new variables and a longer dataset **[26]**. We employ a dummy variable to detect the effect of the euro adoption on Slovak export. The dummy variable takes on the value 1 from Q1-2009 onwards and is set to 0 otherwise. As opposed to the original dataset that ended in Q3-2009, our estimations are based on quarterly data of selected indicators for the period from Q1-2000 to Q1-2013. Data are collected by Eurostat and we use STATA software to perform the calculations.

We include columns A-C to show the original results obtained by Lalinský, using various variables **[26]**.[4] Columns D and E represent the findings of the present author.

Table 1: Overview of the results

	A	B	C	D	E
Foreign demand - World	0.9	0.6			
	(5.9)	(4.4)			
Foreign demand - Germany			0.8		**0.03**
			(4.4)		(4.16)
GDP – EU27					**0.01**
					(4.75)
GDP – Germany				**0.23**	
				(5.12)	
GDP – Czech Republic				**0.48**	

[4] Only coefficients of statistically significant variables are included in the table (t-statistics in the brackets). Several lead or lag variables were significant, but they did not increase the estimation accuracy. In case of Lalinský (2010), growth of wages, employment and prices were significant at some points, but with opposite signs. Unemployment, GDP and gross value added proved insignificant.

			(2.41)
Euro dummy variable[5]	-22.3	-25.3	
	(5.4)	(-3.5)	

Source: Lalinský (2010) and own calculations

A simple regression analysis confirms that export in Slovakia is driven mainly by German and Czech demand. Most of the variables carry the expected signs. As mentioned earlier, the currency changeover in Slovakia was very specific since it coincided with the outbreak of the great global recession. This might be the reason why the euro dummy variable proved statistically insignificant in the present research. This inference is in line with Cieslik *et al.*, who say the lack of statistical significance might result from the fact that the accession of Slovakia took place at the time when world trade flows were depressed **[12]**. The difference between the present research and the original results regarding the euro dummy variable can be explained by four years longer dataset. The results obtained by Lalinský confirm a significant change in the development of indicators monitored in the given period **[26]**. This fact makes it extremely difficult to distinguish between the two opposing effects, because a dummy variable can represent a potential impact of the introduction of the euro, but also a negative impact of the crisis.

Since there has been a substantial change in the external environment of Slovakia in the period just around the euro adoption, one can hardly distinguish between the effects of the introduction of the euro and a negative impact of the crisis. Thus, to answer our research questions, we need to look at the issue from broader perspective. The following section proceeds with an empirical analysis of the euro trade effects elaborated on the data from original member states. In order to carefully analyze and assess the results, one should invest in understanding the main empirical tool in the field: the gravity equation.

3.2 Insight into the Gravity model

The gravity model has a long history as many authors have noted a relationship between, on the one hand, flows between different locations and on the other hand, the 'weight' of these locations and the inverse of distance. As van Bergeijk and Brakman state it in their extensive publication devoted to gravity model's application, perhaps the first formulation of the gravity narrative is mentioned by Ravenstein, who explains how 'currents' of migration are driven by the "absorption of centers of commerce and industry" but "grow less with the distance proportionately **[8], [37, p. 167–235]**." Later on, in 1954 Isard and Peck empirically demonstrated the negative impact of distance for different modes of both domestic and international transport and came close to formulating gravity equation **[22, p. 97–114]**. However, the first mathematical formulation and empirical application of the gravity model occurred a bit later in 1962, thanks to a group of Dutch economists headed by Tinbergen who were the first to actually publish a gravity model and an empirical application. Tinbergen supervised the Ph.D. thesis of Linnemann that has become the standard reference to the early version of the gravity equation **[28]**. Leamer and Stern were the first to explicitly refer to these formulations as 'gravity models' **[27]**. At that time, a solid micro-foundation of the model was still missing and the authors conclude that the significance of such research must be found in the context of seeking a broader understanding of the empirical base of

[5] Dummy variable equals to 1 in the period after the introduction of euro (or after the fixing of the exchange rate, i.e. Q3 2008, Q4 2008 or Q1 2009), and is set to 0 otherwise.

the pure theory of international trade. In his popular article, Anderson deemed the gravity equation to be "the most successful empirical trade device of the last twenty-five years **[3, p. 106-116]**." On the other hand, "its use for policy is severely hampered by its 'unidentified' properties", he admitted. According to Baldwin it is Anderson who provided the first clear micro-foundations that relied only on assumptions that would be considered as standard nowadays, with the cornerstone supposition being the theory that each nation produced a unique good that was only imperfectly substitutable with other nations' goods **[5].** Nevertheless, due to having too few theoretical foundations the model had a rather bad reputation in the 1970's.

This has changed with the introduction of the so called 'new international trade theory'. The author of the theory is Paul Krugman who eventually won the Nobel Prize in Economic Sciences for his contribution in the field **[24, p. 469-479]**. The theory breathed fresh air into the gravity model. Indeed a trend emerged where the model went from having too few theoretical foundations to having too many. For example, in a 1995 paper on the gravity model Deardorff writes: "it is not all that difficult to justify even simple forms of the gravity equation from standard trade theories **[13]**." However, he also adds that because the gravity equation "appears to characterize a large class of models, its use for empirical tests of any of them is suspect." The most recent advances include for instance Anderson and Van Wincoop's introduction of nation-dummies in the framework of theoretical gravity equations and thus efficiently and consistently estimating the impact of national borders on trade between US and Canadian provinces **[4]**. As Baldwin concludes, recent years have seen a number of papers by empirical trade economists that take the theory seriously, but these are typically viewed as contributions to narrow empirical topics, such as the magnitude of the elasticity of substitution and thus "the methodological advances in these papers have been generally ignored in the wider literature **[5]**."

3.3 Descriptive data analysis

Panel data methods are used to analyze the influence of euro adoption on trade flows between euro area member states. Before discussing the methodology, it is helpful to understand the behavior of panel data in general terms. The word *panel* is derived from Dutch and originally describes a rectangular board. According to Kunst, in econometrics, the term denotes data sets that have both a time dimension as well as a non-time dimension **[25]**. A genuine panel has the form:

$$Xit, i = 1; \dots, N, \quad t = 1, \dots, T.$$

Here the dimension *i* is called the 'individual dimension', and *t* is the time dimension. *X* can be a scalar (real) variable or also a vector-valued variable. Often, data sets do not correspond exactly to this pattern, even though they have similar dimensions *i* and *t*. For example, *t* may denote an individual time dimension rather than a common time **[25]**.

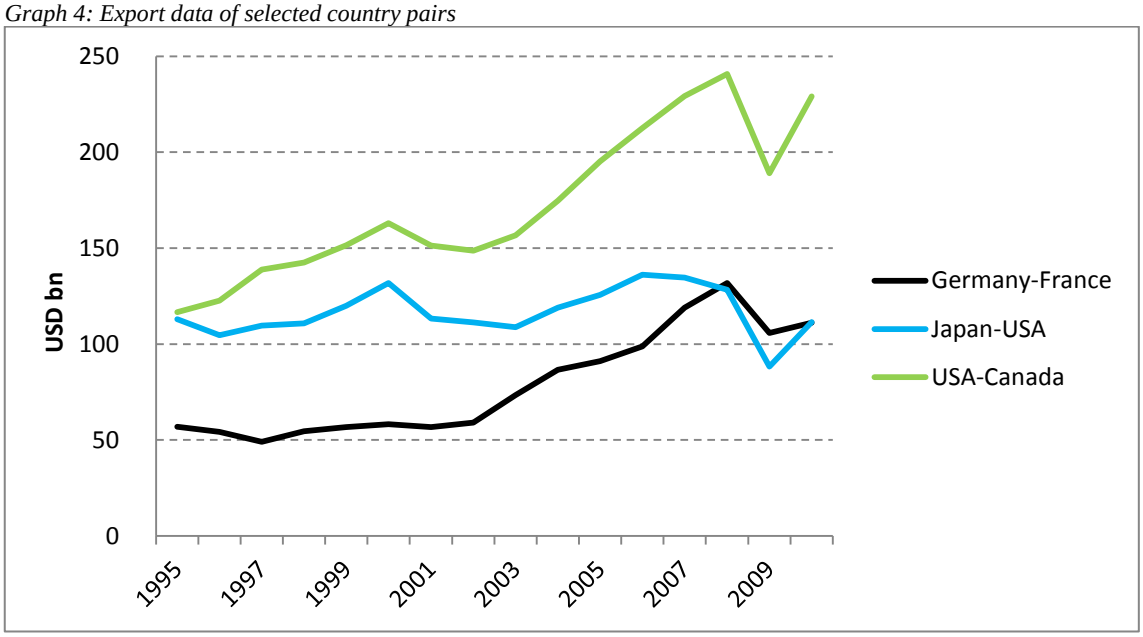
The methodology employed to estimate the euro trade effects draws upon the one used in Baldwin but with a few new variables and a set of data four years longer **[5]**. The country sample consists of 20 countries. Ten participate in the currency union and in the single market: Austria, Belgium-Luxembourg, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal and Spain. As in the paper written by Flam and Nordström, Belgium and Luxembourg are treated as a single country since they were treated as such in trade statistics until 1999 **[19]**. Countries that entered the euro area later, namely Greece, Slovenia, Cyprus, Malta, Slovakia and, most recently, Estonia are

not included due to difficulties with controlling for their late entries and a too short time period spent in the eurozone. Four more countries participate in the single market, but not in the currency union: Denmark, Norway, Sweden and the United Kingdom. Six OECD countries with similar levels of development and per capita income that are outside both the currency union and single market are also included: Australia, Canada, Japan, New Zealand, Switzerland and the United States. Altogether, this sums up to 380 country pairs with 16 observations (years) for each pair. There were trade data missing for Denmark in 1997, therefore the total number of observations in the sample is 6061 and the panel is partially unbalanced. The sample period is 1995-2010. The starting year was chosen because Austria, Finland and Sweden became members of the EU in 1995. By starting in 1995, we do not have to control for the change in their status, nor will there be problems with time series of trade data.

3.3.1 Export data

Export data quoted in current U.S. dollars were taken from the United Nations Comtrade database. They were deflated using a producer price index (PPI) from OECD. As an alternative, a consumer price index was used if the producer price index was unavailable. As mentioned earlier, trade data for Denmark in 1997 were not available. In the model, data are interpreted in a logarithmic form.

Graph 4: Export data of selected country pairs



Source: Own calculation based on UN Comtrade data

3.3.2 Real exchange rate

Current nominal exchange rates were obtained from Oanda webpage. Real exchange rates between countries *i* and *j* (an exporting country and an importing country) are also known as the bilateral exchange rate. They have been constructed by dividing the exporting country's producer price index by the importing country's PPI. The PPIs for all countries are expressed in US dollars, i.e. the index values are multiplied by the current exchange rate of the dollar to the corresponding currency. Exports from country *i* to country *j* are expected to decrease with increasing bilateral exchange rate. Bayoumi explains that PPI-based REERs are better indicators of price competitiveness than the CPI-based measures since they reflect elasticity of exports with respect to foreign activity in a more accurate way **[6]**.

3.3.3 Other independent variables

Table 2 summarizes all the variables employed with the expected signs obtained from the regression. Real GDP data were taken from the OECD database. Trade costs should include geographical distance plus many other factors, such as border contiguity, shared language, common colonial relations etc. In other words, they are costs of exporting from *i* to *j* relative to the cost of exporting from *i*'s competitors to *j* **[4].** Language and geography-related variables were retrieved from the gravity database constructed by CEPII[6]. More relevant to the estimation are the dummy variables for exports to, from, and within the eurozone as well as a set of dummy variables for exports to, from, and within the single market. The set of both dummies will show the difference in exports between eurozone/single market countries and outsiders.

Table 2: Variables and their expected signs

Variable	Description	Source	Exp. sign
$lnExports_{ij}$	dependent variable; natural logarithm of the direction-specific value of bilateral exports from country *i* to country *j*	Comtrade database	
$lnGDP_i$	natural logarithm of the importing country's nominal GDP; the bigger the GDP, the greatest the volume of mutual trade	OECD	+
$lnGDP_j$	natural logarithm of the exporting country's nominal GDP	OECD	+
$lnbilateral_{ij}$	natural logarithm of the exchange rate between the exporting an the importing country; the higher the exchange rate, the more expensive the imported products get	Oanda; Eurostat	-
$adjacency$	dummy variable set to 1 if a country pair shares a common border; the shorter the distance between countries, the greater the volumes traded	CEPII database	+
$common\ language$	dummy variable set to 1 if a country pair uses a common official language; it is expected that countries that share a common language have less obstacles in mutual trade	CEPII database	+
$lndistance_{ij}$	natural logarithm of the distance between the exporter and the importer based on bilateral distances between the biggest cities of the two countries, weighted by the share of the city in the overall country's population; the shorter the distance, the greater the volumes traded	CEPII database	-
$landlocked_i$	dummy variable set to equal 1 if the importing country is landlocked; landlocked countries are typically of smaller size and their trade volumes are	CEPII database	-

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	smaller too		
$landlocked_j$	dummy variable set to equal 1 if the exporting country is landlocked	CEPII database	-
$colony$	dummy variable set to equal 1 if a country pair has ever had a colonial link; it is expected that former colonies trade more with each other	CEPII database	+
same country	dummy variable set to equal 1 if a country pair has been the same country; similar effect as in case of a colonial link is expected	CEPII database	+
EZ_{11}	dummy variable for exports within the eurozone	Own calculation	+
EZ_{10}	dummy variable for exports from the eurozone	Own calculation	+
EZ_{01}	dummy variable for exports to the eurozone	Own calculation	+
SM_{11}	dummy variable for exports within the single market	Own calculation	+
SM_{10}	dummy variable for exports from the single market	Own calculation	+
SM_{01}	dummy variable for exports to the single market	Own calculation	+

Source: Own elaboration

Table 3 reports the descriptive statistics quantitatively describing the main features of the collected data and providing brief summaries about the sample. As the group in this setup is the country pair, the between-group variation is the variation of variables between country pairs for the considered period and the within-group variation is the variation of the country pair variable over the analyzed period **[30]**. Since the between variability is higher than the within variability in all cases, this is an indication of the possible heterogeneity across country pairs **[7]**.

Table 3: Descriptive statistics

Variable		Mean	Std. Dev.	Min	Max	Observations
$lnExports_{ij}$	overall	21.51095	1.84401	15.2668	26.5920	N = 6061
	between		1.81043	16.0114	26.1874	n = 380
	within		0.35452	20.1042	23.1559	T-bar = 15.95
$common\ language$	overall	0.15311	0.36012	0	1	N = 6061
	between		0.36011	0	1	n = 380
	within		0	0.15311	0.15311	T-bar = 15.95
$colony$	overall	0.047517	0.21276	0	1	N = 6061
	between		0.21271	0	1	n = 380
	within		0	0.04752	0.04752	T-bar = 15.95

same country	overall	0.00528	0.07248	0	1	N = 6061
	between		0.07245	0	1	n = 380
	within		0	0.00528	0.00528	T-bar = 15.95
$ln\,distance_{ij}$	overall	8.008689	1.21491	5.08096	9.88019	N = 6061
	between		1.21655	5.08096	9.88019	n = 380
	within		0	8.00869	8.00869	T-bar = 15.95
$landlocked_i$	overall	0.100314	0.30044	0	1	N = 6061
	between		0.30040	0	1	n = 380
	within		0	0.10031	0.10031	T-bar = 15.95
$landlocked_j$	overall	0.099984	0.30000	0	1	N = 6061
	between		0.30040	0	1	n = 380
	within		0	0.09998	0.09998	T-bar = 15.95
$adjacency$	overall	0.105428	0.30713	0	1	N = 6061
	between		0.30730	0	1	n = 380
	within		0	0.10543	0.10543	T-bar = 15.95
$lnGDP_i$	overall	27.04428	1.27830	24.8903	30.3111	N = 6061
	between		1.25818	25.2545	30.0152	n = 380
	within		0.23334	26.3783	27.5335	T-bar = 15.95
$lnGDP_j$	overall	27.04049	1.27870	24.8903	30.3111	N = 6061
	between		1.25883	25.2545	30.0334	n = 380
	within		0.23311	26.3443	27.5297	T-bar = 15.95
$lnbilateral_{ij}$	overall	0.004575	1.67557	-4.95333	4.95333	N = 6061
	between		1.67723	-4.74043	4.74043	n = 380
	within		0.05815	-0.29812	0.30728	T-bar = 15.95

Source: Own elaboration

A *correlation matrix*[7] of the analyzed variables is illustrated in Table 4. At a glance, all the correlations are a matter of common sense. The correlation between exports and distance (0.506) is elevated. But, it is expected that the closer countries are the lower the costs of transportation and thus the higher the trade between them. Also, countries with higher GDP import more. Naturally, adjacency is negatively correlated with distance (-0.458) and positively correlated with common official language (0.379). Bilateral exchange rate does not display any high correlation, which is also quite reasonable.

Table 4: Correlation matrix of main variables

Adjacency	Com_lang_off	Samecountry	Ln_Distw	Landlock_ex	
1.0000	0.3792	0.2122	-0.4583	0.0857	Adjacency
	1.0000	0.1713	-0.0447	0.0776	Com_lang_off
		1.0000	-0.1756	-0.0243	Samecountry
			1.0000	-0.1309	Ln_Distw
				1.0000	Landlock_ex
Landlock_im	Ln_Exports	Ln_GDP_ex	Ln_GDP_im	Ln_Bilateral	
0.0862	0.3973	0.0399	0.0398	-0.0003	Adjacency
0.0782	0.1584	0.0316	0.0328	-0.0012	Com_lang_off
-0.0243	0.1059	-0.0170	-0.0168	-0.0002	Samecountry
-0.1301	-0.5044	0.1033	0.1040	-0.0015	Ln_Distw
-0.0527	-0.0576	-0.2046	0.0105	0.1092	Landlock_ex

[7] Correlation matrix is a matrix giving the correlations between all pairs of data sets, 5% critical value (two-tailed) = 0.0252 for n = 6061

1.0000	-0.0959	0.0108	-0.2030	-0.1099	Landlock_im
	1.0000	0.4547	0.5064	-0.0477	Ln_Exports
		1.0000	-0.0203	-0.0494	Ln_GDP_ex
			1.0000	0.0456	Ln_GDP_im
				1.0000	Ln_Bilateral

Source: Own elaboration

3.4 Analytical framework and methodology

The traditional gravity model is derived from Newton's Law of Gravitation. In physics, the trade gravity model's namesake describes the force of gravity between two objects as proportional to the product of the masses of the two objects divided by the square of the mutual distance between them. "A mass of goods or labor or other factors of production supplied at origin *i*, Y_i, is attracted to a mass of demand for goods or labor at destination *j*, E_j , but the potential flow is reduced by the distance between them, d_{ij}" **[2]**. Strict application of the analogy leads to the following:

$$\text{force of gravity} = \mathrm{G}\,\frac{\mathrm{Y_i E_j}}{(\mathrm{distance_{ij}})^2}\ ;$$

where E and Y are the two masses. G is the gravitational constant (equal to 6.67300 × 10-11 m3 kg-1 s-2, where m, kg and s stand for meters, kilos and seconds).

The naïve form of the gravity model implies that exports from country *i* to country *j* depend directly on the two countries' exports and inversely on the trade costs between them. Physical mass (M) is replaced by economic mass (GDP) and the power function on distance is removed. The basic function therefore takes the following form:

$$Exports_{ij} = \frac{GDP_i \times GDP_j}{Trade\ costs_{ij}}$$

If we depart from this strict analogy Anderson explains that "traditional gravity allowed the exponents of 1 applied to the mass variables and of -2 applied to bilateral distance to be generated by data to fit a statistically inferred log-linear relationship between data on flows and the mass variables and distance **[2].**" Hence, the gravity model is estimated in log-linearized form:

$$\ln\mathrm{Exports_{ij}} = \beta_1 \ln\mathrm{GDP_i} + \beta_2 \ln\mathrm{GDP_j} - \ln\mathrm{Trade\ Costs_{ij}}$$

Anderson suggests to supplement the traditional gravity "with other proxies for trade frictions, such as the effect of political borders and common language" in order to improve the fit **[2].** Taking this into consideration, the complete model takes the following form:

$$\begin{aligned}\ln Exports_{ij} = {} & \beta_{ij} + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j + \beta_3 \ln bilateral_{ij} + \beta_4 adjacency \\ & + \beta_5 common\ language + \beta_6 colony + \beta_7 same\ country \\ & + \beta_8 \ln distance_{ij} + \beta_9 landlocked_i + \beta_{10} landlocked_j \\ & + \beta_{11} fromEZ + \beta_{12} toEZ + \beta_{13} withinEZ + \beta_{14} fromSM + \beta_{15} toSM \\ & + \beta_{16} withinSM\end{aligned}$$

Concerning the methodology, two different techniques are employed. The first is Ordinary Least Squared method with time trend. In this case, we do not assume any particular structure of the within-panel error term, except for the presence of the

unobserved effect. Standard errors are estimated by using the cluster option and thus calculating standard errors that are robust to within panel serial correlation and heteroscedasticity. The second method is a two-way fixed effects approach, known as the Least Square Dummy Variable (LSDV) regression model, in which the unobserved effect is brought explicitly into the model by a set of dummy variables. STATA and Gretl software are used to execute the tasks.

3.5 Results interpretation

Table 5 summarizes the results of the regressions. For sake of comparison, columns A-F show the original results obtained by Baldwin, using various techniques **[5]**.[8] Columns G and H represent the findings of the present author. Almost all the variables carry the expected signs. They suggest the aggregate intra-eurozone trade was stimulated only slightly, i.e. up to 5%. Astonishingly, the trade flows to eurozone proved negative. This might indicate that the eurozone crisis negatively influenced trade with outsiders but the trading activity among the countries of the control group remained stable. Another explanation for the negative results is a general proclivity to display positive effects. Recently, in a meta-analysis of 61 studies, Havránek reports of the striking degree of publication bias present in the Rosean literature applied on the eurozone, e.g. "if there is a top economist among co-authors, the study reports significantly higher (trade) effects **[20, p. 241-261]**." As Baldwin explains it would be a "vast oversimplification to talk about 'the' impact of the euro on trade" and it is rather difficult to come up with unambiguous results **[5]**.

Regarding the remaining variables, the impact of the euro on the eurozone's exports to non-euro users is also negative, but insignificant and very, very small. GDP size is positive and significant in the case of origin as well as destination. As expected, the impact of distance on trade is negative with the value of $\beta_8 \ln distance_{ij}$ around -1. Border contiguity and shared official language both have a positive impact on mutual trade. Landlocked countries seem to trade less, which is also quite natural given that they are typically of smaller size. Variable $\beta_3 \ln bilateral_{ij}$ is negative, proving that the bilateral real exchange rate time series expressed by way of national producer price indices was constructed correctly. The overall goodness-of-fit of the model is satisfactory (R^2 = 0.92; adjusted R^2 = 0.91).

Table 5: Overview of the results

	A	B	C	D	E	F	G	H
EZ11	0.04	-0	0.01	-0	0.01	0.02	**0.0**	**0.05**
	***				***	***		**
EZ01	0.06	-0	0	0	0	-0	**-0.16**	**-0.16**
	***	***				**	*	***
EZ10	-0	-0	0	-0	0.01	0.03	**-0.06**	**-0.02**
	***	*			***	***		
ly_o	0.69	0.2					**0.75**	**0.72**
	***	***					***	***
ly_d	0.76	0.68					**0.77**	**0.76**

[8] Notes: A = OLS in real terms using log-gravity and time dummies ; B = OLS in nominal terms using log-gravity and time dummies; C = Importer, Exporter and time dummy (i.e. Anderson-Van Wincoop + time dummy) using log-gravity in nominal terms; D = Time-varying importer and exporter using log-gravity in nominal terms; E = Time and pair dummies using log-gravity in nominal terms; F = Time-varying importer and exporter and time invariant pair using log-gravity in nominal terms.

	***	***					***	***
ldistw	-1.2	-1.1	-1.2	-1.3			**-1.02**	**-0.99**
	***	***	***	***			***	***
adjacency	0.13	0.1	0.15	0.22			**0.35**	**0.4**
	**	**	***	***			***	***
comlang_off	0.38	0.42	0.18	0.09			**0.2**	**0.15**
	***	***	***				*	***
lremot_o	-1.6	-1.7	0					
	***	***						
lremot_d	3.49	2.35	0					
	***	***						
landlock_o	-0.8	-0.7	1.49				**-0.33**	**-0.4**
	***	***	***				***	***
landlock_d	-0.7	-0.7	0.63				**-0.73**	**-0.69**
	***	***	***				***	***
lrber	-0.1	0.18	-0	0.39			**-0.09**	**-0.08**
		***					***	***
smp_o	0.04	0.01	-0	-0	-0	-0		
	***	***	**		***	***		
smp_d	-0.1	0.01	0	-0.1	0.01	0.02		
	***	**		*	*	*		
_cons	-65	-29	31	33.3	-1.8	21.5	**-10.3**	**-9.6**
	**		***	***		***	***	

Source: Baldwin (2008) and own calculations

Several tests have been performed to verify the reliability of the results. *Multicollinearity* is checked by applying the variance inflation factors (VIF) test **[7]**. VIF are a scaled version of the multiple correlation coefficient between variable j and the rest of the independent variables and is calculated as: $VIF_j = 1/ (1 – R_{j2})$, where R_j is the multiple correlation coefficient **[30]**.

Table 6: Variance inflation factors test

Variable	**VIF**	**1/VIF**
withinsm	10.82	0.092396
ln_distw	4.34	0.230498
tosm	4.09	0.244413
fromsm	4.08	0.244941
withinez	2.26	0.443356
toez	2.09	0.478869
fromez	2.09	0.479318
timetrend	1.69	0.591923
adjacency	1.61	0.622654
com_lang_off	1.42	0.705015
landlock_ex	1.35	0.743362
landlock_im	1.34	0.74402
ln_bilateral	1.29	0.775741
ln_gdp_im	1.24	0.805967
ln_gdp_ex	1.24	0.807237
samecountry	1.1	0.911903
Mean VIF	**2.63**	

Standardly, VIF values are acceptable when lower than 10. The 1/VIF column tells us what proportion of an independent variable's variance is independent of all the other x variables. A low proportion (e.g., 0.10) indicates potential trouble. The results described in Table 5 reveal that some work still might be done to improve the single market dummies. In general, there are no problems due to multicollinearity among the independent variables as all the values of 1/VIF are above 0.10 **[30]**.

Regarding the heteroscedasticity problem, country data are often collected using clustering and so some country groups may be oversampled. Viewing each country's data period as a cluster should yield more realistic standard errors. The heteroscedasticity problem is solved because the estimation method used is clustered Ordinary Least Square that calculates standard errors robust to within panel serial correlation and heteroscedasticity. More specifically, the cluster(*id*) option is added to the regression command, where *id* is the identification number of a particular country pair.

To sum up the findings, our empirical evidence suggests that the positive trade effects brought about by the introduction of the common European currency are rather moderate – around 5%. This allows us to conclude that the euro adoption typically implies more trade between member states. Such conclusion is in line with Baldwin, who believes that while it is impossible to fully understand the euro's trade impact without another decade or so of data, the effect seems to be diminishing, i.e. "the aggregate trade effect of the euro – the Rose effect - is positive but small **[5]**." Havránek concludes "the trade effect of the euro (at least based on available empirical studies) is probably much lower than we believed, even if 'what we believed' was already twentyfold less than what Rose reported in his famous article **[20]**." However, some authors emphasize that while the overall effect of the euro adoption may be positive, the distribution of benefits significantly varies across member states. Marsh comments that because nations within a single currency area were not able to devalue their currency, some of the southern and western peripheral countries "such as Ireland, Portugal, Spain and Greece with higher inflation than the core group around Germany effectively had exchange rates that were far too high, pricing their goods and services out of business in international trade **[29]**." This point is quite consistent with Berger and Nitsch who find that EMU has led to larger and more persistent trade imbalances **[10]**. These imbalances have their origin in product and labor markets rigidities, the authors conclude. Lalinský even observes differences between industries, claiming that those businesses using decreasing costs of scale profited the most from the launch of the euro **[26]**. He says that, besides industry-related division and industry location, factors such as different access to production resources and market liberalization rate "could have played a decisive role" in the euro conversion being a benefit for a particular country and industry or not." Baldwin also tangentially touches the differences across sectors and member states, but he adds that "there is really not enough data to firmly establish such differences in a credible fashion **[5]**."

4 Conclusion

This paper has analyzed the trade effects associated with the creation of the eurozone. Much has been written about the possible effects of euro adoption on the economies of the first participants. However, the objective of this paper was to explore the impact of introducing the common European currency on the export performance of Slovakia, in comparison to the Czech Republic, which still uses its own national currency, the koruna.

The evolution of exports during the observed period (2008-2012) was rather specific due to the global market turmoil that coincided with the euro introduction in Slovakia. The crisis radically changed the external environment of the highly open and export-oriented Slovak economy. Taking this into consideration, Czech exports fared relatively better at the onset of the crisis. Nominal exchange rate depreciation against the euro witnessed at the beginning of the economic slowdown may have enabled Czech exporters to lower their prices and thus to somewhat mitigate the negative impact of the external demand shock on their sales abroad at the peak of the crisis. On the other hand, the export earnings evolved largely in parallel, confirming the hypothesis that higher real exports were offset by lower prices. Hence, the currency depreciation did not prove to be a measurable advantage.

Looking exclusively at Slovakia, a regression analysis estimating the impact of the euro adoption on the country's export development did not lead to statistically significant results. It is a natural consequence of the fact that the accession of Slovakia took place at the time when world trade flows were depressed. Earlier studies dealing with the topic confirm a significant change in the development of monitored indicators in the period around Slovak euro adoption. This fact makes it extremely difficult to distinguish between the two effects, because a dummy variable can represent a potential impact of the introduction of the euro, but also a negative impact of the crisis.

Thus, to answer our research questions, we had to look at the issue from broader perspective and analyze the trade effects associated with creation of the eurozone as a whole. The so called 'Rose effects' implies that two countries that share the same currency trade more than they would otherwise. The empirical literature on the boost to trade due to the formation of a monetary union is, however, rather ambiguous. Estimates published by researchers range from negative or marginal effect to more than decuple increase in bilateral trade. Our empirical evidence suggests that positive trade effects brought about by the introduction of the common European currency are rather moderate – around 5%. This result is in line with some of the earlier estimates showing that the euro changeover typically stimulates foreign trade between member states, but to a much lower extent than previously believed. Even though the effect varies across countries, it can be concluded that the euro adoption has a positive, though hard to quantify, impact on trade. However, our results also confirm that being a member of the euro zone is in itself no panacea. Although out of the scope of this paper, evaluation of other competitiveness metrics could also contribute to the euro-related policy discussions. Investors carefully distinguish between countries even within one region and their confidence must inevitably be supported by sound fiscal policy and economic

reforms. Time will tell whether the rapid Slovak introduction of the euro has really been worthwhile.

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