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Metody robustní ekonometrie s aplikacemi na ekonomická data

Dizertační práce

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Methods of Robust Econometrics with Applications to Economic Data

Dissertation Thesis

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I, Eva Michalíková hereby declare that this dissertation thesis is my original work and that all source materials used here have been clearly identified and referenced.

Eva Michalíková, undersigned

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Czech Abstract

Tato disertační práce se zabývá aplikací metod robustní ekonometrie na reálná ekonomická data. Práce se věnuje zejména problematice zahraničního obchodu České Republiky a dále zaměstnanosti a růstu malých podniků v Evropě. Dále je práce zaměřena na odhady panelových dat, a to jak pomocí klasických postupů (nejmenší čtverce, fixní efekty, GMM), tak i pomocí robustních metod. V práci je využita především metoda nejmenších useknutých čtverců (Least Trimmed Squares – LTS).

První stať se zabývá analýzou determinant přímých zahraničních investic v českém zpracovatelském průmyslu. Cílem je odhadnout dynamický model, ve kterém je stav přímých zahraničních investic vyjádřen jako funkce různých veličin (podíl práce a kapitálu, R&D, energetická náročnost, podíl zisku na pracovníka, Balassův index a další). Model je odhadován pomocí nejmenších čtverců, fixních efektů a GMM. Vzhledem k tomu, že výsledky těchto tří odhadnutých modelů nevedou k jednoznačným závěrům, je použita metoda LTS pro odhalení odlehlých pozorování. Po postupném vyloučení dvou sektorů zpracovatelského průmyslu dochází k určitému zlepšení signifikance odhadnutých parametrů v jednotlivých modelech.

Druhá stať se zabývá problematikou malých rodinných podniků v 28 státech Evropy. V práci odhadujeme modely zaměstnanosti a produktivity pro malé podniky v závislosti na ekonomických a institucionálních veličinách pomocí speciální techniky odhadu. Tato metoda propojuje metodu LTS a metodu klasických fixních efektů (Within Group odhad). Cílem práce je odhadnout řadu modelů a otestovat touto cestou vlastnosti metody odhadu. Použití metody vede se zvyšujícícm se počtem vyloučených pozorování ke zvýšení kvality odhadu a ke zvýšení signifikance jednotlivých parametrů.

Poslední stať se věnuje problematice státní exportní podpory. V této práci je odhadován statický a dynamický gravitační model závislosti českého exportu na různých veličinách. V první řadě se snažíme zjistit, zda je export prokazatelně závislý na exportní podpoře (vyjádřené hodnotou uzavřených smluv Českou exportní bankou), dále model zahrnuje další veličiny (vzdálenost, HDP, populace, politické riziko aj.). Vzhledem k protichůdným závěrům odhadů statického a dynamického modelu je použita metoda LTS, na jejíž základě dochází k vyřazení některých specifických zemí Střední Ameriky, Afriky a Asie z datového souboru. Na základě opětovně získaných odhadů je možné uzavřít, že státní exportní podpora má pozitivní vliv na velikost českého exportu.

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I. Foreword

The present dissertation thesis is focused on the application of methods of robust econometrics to real economic data. These methods play an important role when working with data which are influenced by observations numerically distant from the rest of the data and behave differently. Such observations are called outliers and they can be the result of measurement errors or mixture of more distributions. Robust methods can cope with such polluted observations and can weaken their impact (for example by removing or modifying a small percentage of the dataset). There exist many areas from which it is possible to choose such data. If we are interested in the area of economic data, we can focus on data describing export, import, foreign direct investments, economic growth or growth of productivity, taxes, inflation, privatization and many more. It is especially at the present time when economies have been driven into recession that it is necessary to deal with problems of international trade or economic growth.

If these data are characterized by a somewhat heterogeneous pattern (e.g. a certain subset of the data has different features and characteristics from the rest of the data), the traditional techniques of estimation fail. However, it is necessary to appreciate that economic data described above usually have the character of panels, i.e. every single observation is realized for one individual (firm, sector of industry, country) in time (usually year). Such a datastructure is important: cross-sectional data themselves would not enable the assessment of different changes in time. On the other hand, adding more individuals to a data set makes it possible to introduce more heterogeneity. Panels are likely to contain atypical observations or gross errors. Thus it is necessary to employ methods of estimation which respect data's panel structure and which are robust with respect to outliers.

Robust methods have been applied over the past 50 years. These techniques are well-developed nowadays and there exist many of them – for example M-estimators or GM-estimators (maximum likelihood type estimator), L-estimators (based on order statistics) and its special cases Least Trimmed Squares (LTS) and Least Median of Squares (LMS), R-estimators based on ranks and others. Nevertheless, their usage within the panel data have only had sporadic implementation, robust methods for the case of panel data still are not well described in literature and are not implemented by software very well. Sometimes authors believe that outliers can be identified simply by eye or they find robust techniques unaware. Moreover, robust methods have extreme requirements on the memory and the speed of computers and this is another reason why these methods have not been used very much. Even now the speed of estimation can take long (especially if the dimension of panel data is large). On the other hand, it would be a waste of important information if we do not work with panel structure of data. For the linear mixed models, the use of M-estimators seems to be practical as they have been paid much attention to and robust versions of certain model selection procedures have been available. Therefore, these estimators are very popular. A higher favor ffor M-estimators has its root in their easier theoretical treatment. Moreover, they are more efficient than LTS estimators. On the other hand, these estimators in their basic forms are not scale and regression equivariant. They require studentization of residuals. Thus, if we ask for the scale and regression equivariance of M-estimators, we have to have the corresponding estimator of the standard deviation of disturbances scale equivariant and regression invariant. Such estiamtors can be difficult to compute or are based on a preliminary estimator of regression coefficients with high breakdown point (such as LMS, LTS, LWS). Therefore it seems preferable to use such estimators which are directly without studentization scale- and regression-equivariant.

This thesis consists of three parts. In each part we focus on concrete economic data (related to topical economic problems) which have the structure of panel. Since after the application of traditional methods of estimation all three datasets embody symptoms of heterogeneous pattern and consequently the presence of outliers, we additionally estimate models by means of least trimmed squares. Individual parts of thesis are ordered chronologically according to the time when I worked on them and according to their submission into journals. They do not depend on each other and all have the same importance. Each part has its own numbering of figures and tables. We number especially equations which are mentioned in text.

The first part of my dissertation, *Determinants of FDI in Czech Manufacturing Industry between 2000 and 2008*, focuses on analyzing the behavior of foreign investors in their decision where to place their investments in the Czech manufacturing industry. This research results in a paper co-authored by Elisa Galeotti and was published in IES WP 17/2009 and in South East European Journal of Economics and Business 2/2010[1].

In this paper we analyze a dynamic model of behavior of investors in 23 sectors of manufacturing industry between 2000 and 2008. We run several regression analyses where

[1]My contribution to the article was approximately 50%.

the stock of FDI is expressed as a function of several economic factors (capital per labor, profit, R&D, energy intensity, wages, Balassa index and others) and we estimate these models by OLS, fixed affects and GMM. With regard to ambiguous results and heterogeneous behavior of investors we used least trimmed squares as a diagnostic tool and on the basis of results of estimation by LTS we try to drop out specific industries (always only one in particular model) out of the data. We conclude that labor is still a comparative advantage in the Czech Republic (as contrasted to expensive physical capital). Foreign investors prefer to invest in industries with higher level of R&D which are more profitable and have higher energy requirements. Elimination of two polluting industries out of the data set brings certain improvement in significance of some factors (R&D, wages, relative unit labor costs).

In the second part of the present dissertation, *The Factors of Growth of Small Family Businesses. A Robust Estimation of the Behavioral Consistency in the Panel Data Models*, we focus on an estimation of models of employment and net production in 28 European countries between 2002 and 2008. This paper picks up on older paper Role of Economic and Institutional Factors in the Rise and Fall of Family Businesses in Europe[2]. The paper was published in IES WP 6/20111 and will be submitted to Small Business Economics in Spring 2012.

In this paper we describe robust version of within group fixed effects estimation. The principle of our method is the centering by median (instead of mean) following by the usage of LTS (instead of OLS). Further in the paper we describe the role of micro and small family businesses in present-day economy and their growth, which is related to employment and value added. With the help of robust version of fixed effect we remove outlying observations in models where we regress employment and net production on gross capital returns, GDP per capita and labor costs as well as on institutional variables. Besides an economic interpretation of results we monitor how the estimated parameters and the model in its entirety change with increasing percentage of excluded observations. With regard to the current worldwide financial crisis the topic of this research is all the more important because family businesses can provide incentives for innovative growth as

[2]Published in: J. Večerník: Individuals and Households in the Czech Republic and in Countries of Central Europe. Prague, SoU Academy of Sciences of the Czech Republic, 2010, co-authored by Vladimír Benáček. My contribution to this article was approximately 50% of the work.

they present the source of employment and job creation.

The last paper *Credit Support for Export: Robust Evidence from the Czech Republic* is devoted to estimation of gravity model of Czech exports and is co-authored by Karel Janda and Jiří Skuhrovec. My contribution to the article was approximately 50% of the work. This research builds on unbalanced panel data of 160 countries between 1996 and 2008 and tackles the importance of export promotion in the Czech Republic. In this paper we describe export promotion in the Czech Republic and we estimate two gravity models – static by fixed effects and dynamic by GMM, where export is expressed in its dependence on export promotion, distance, population, GDP, political risk and other factors.

With respect to the impossibility of summarizing the results of both models into one unique conclusion we use least trimmed squares as a diagnostic tool, detecting suspicious observations and trying to exclude some of these observations from our data. Since we work with relatively large data set we can eliminate more numerous groups of countries at once. Additional regression analyses lead to the conclusion that together with elimination of some countries of Africa, Central America and southeast Asia (where export from the Czech Republic reaches low volumes) export promotion is a significant factor. Besides this we confirm the significance of other factors in gravity model: distance, political risk or GDP. Also these estimated parameters become more significant with the use of LTS.

This paper is a modified version of the paper Gravity and Fiscal Models of Government of Export Credit in the Czech Republic (published in Politická Ekonomie 3/2010, co-authored by Karel Janda and Věra Potácelová) and was submitted to CERGE WP in 2011 (February) and to The World Economy. The paper underwent the first round of submission process at The World Economy and it was invited for minor revisions in February 2012.

II. Determinants of FDI in Czech Manufacturing Industry between 2000 – 2008

Abstract:

The Czech Republic (and its manufacturing industry) has been a successful recipient of foreign direct investment (FDI) over recent years. Therefore, it is important to understand the decisions made by foreign investors as to where to place their investments and how to decide about their location between alternative industries. The aim of this paper is to find and estimate an econometric model describing the determinants of FDI in manufacturing industry of the Czech Republic between 2000 and 2008 and make a review of recent literature on the topic. Econometric model includes several economic variables (such as labor, physical capital, R&D, profits per labor and the Balassa index). Together with simple techniques of estimation (OLS, fixed effects) we used the generalized method of moments (GMM). In our effort to improve the result we used also the Least Trimmed Squares Estimator (LTS) from the class of robust estimators as a diagnostic tool for the heterogeneous pattern of data.

Keywords: FDI, manufacturing industry, Czech Republic, GMM

JEL Classification: C01, C23, C51, C82, F21, F40

1. Introduction

It is important to understand the decision making process of foreign investors as to where they place investments. Foreign direct investment (FDI) can provide a firm with new markets and marketing channels, cheaper production facilities, access to new technologies, products, skills and financing. For the host country or the domestic firm which receives the investment in form of mergers and acquisitions, it can provide a source of new technologies, capital, processes, products, organizational technologies and management skills, an increase in employment and competition. Therefore, FDIs can give a strong impetus to economic development. On the other hand, the presence of FDI can bring some hazards: hostile takeovers with the aim to damp domestic production in that field so that the foreign parent company would not have competition, crowding out of domestic savings by foreign savings,transfer of domestic savings abroad under unfavorable conditions, increase in wages in sectors with foreign ownership overspill to sectors with domestic firms in which the labor productivity grows at slower pace, and many others.

The Czech Republic has been an intensive recipient of foreign capital during the last 15 years. In 1995, FDIs in the Czech Republic reached 195.5 billion CZK, in 2000 it was 818.3 billion CZK and in 2005 it was 1491.6 billion CZK. For years the manufacturing industry was a leading recipient of FDIs even though in recent years the share of manufacturing has decreased. In 1995, the share of manufacturing was 64%, while after 2000 the share of inflows of FDI moves around 38% and this trend has continued till the present time. Data describing the flows of FDI to the Czech Republic are summarized in Table 1.

Many authors of economic papers and empirical studies are interested in the problem of foreign direct investment and their determinants. Many analyses have considered the problem of FDI and determinants of FDI in Europe or in the Czech Republic and have played an important role in literature hitherto (Alfaro et al., 2008; Breuss, Egger and Pfaffermayr, 2010; Zamrazilová, 2007; Kadeřábková, 2007; Blonigen, 2006; Benáček, 2000; Benáček and Zemplinerová, 1997; Smarzynska and Spartareanu, 2004; Mody, 2004; Mody, 2007). In the case of determinants, the thrust of the research has focused on why foreign investors prefer some countries over others (cross-country analysis) or why some sectors dispose of higher flows of foreign capital (cross-industrial analysis) (Benáček, 2000). The second approach has most of its hypotheses in microeconomic theories of production allocation. Many take the classical approach by applying the theories of comparative advantages. However, a substantial part is derived from the new theories of allocation and trade, theories of industry organization and economic geography (Krugman and Obstfeld, 1997 or Dunning, 1980, 1998 and 2000). Moreover, these analyses are based on the theory of specialization (Yang and Ng, 1993).

Year	Total FDI stock (billions CZK)	Annual increase (billions CZK)	Share of manufacturing (%)
1995	195.5	–	64 %
1996	234.3	39	65 %
1997	319.8	86	55 %
1998	429.2	109	46 %
1999	631.5	202	39 %
2000	818.3	187	38 %
2001	982.3	164	38 %
2002	1165.5	183	46 %
2003	1161.8	-3.7	42 %
2004	1280.6	119	40 %
2005	1491.6	211	38 %
2006	1666.8	175	36 %
2007	2032.1	365	37 %
2008	2189.5	157	35 %

Table 1: Stock of FDI in Czech Republic and in manufacturing industry, 1995 – 2008. Source: CNB, own calculation.

An econometric model for the analysis of FDI can therefore explain FDI as a function of many factors (Blonigen, 2006; Francis, Zheng and Mukherji, 2009). One of these factors is the size of the market. Such result was presented in studies by Lankes and Venables (1997), Savary (1997), Pye (1998), Altzinger (1999) and Walsh (2010). In another empirical study, the authors show the important role played by foreign investors in the expected growth of a market (Barrell and Holland 1999) or access to a market (Amiti and Smarzynska Javorcik, 2005).

The size of foreign capital can also be influenced by labor costs (Savary, 1997; Pye, 1998;

Holland and Pain, 1998; Bevan and Estrin, 2000; Benáček and Víšek, 1999). Additionally, Pye (1998) also specified other important factors: profitability, political and economic stability of country or access to market. Stability was important in the study of Lankes and Venables (1997) as well.

Moreover, the decision of foreign investors depends on the level of research and development of domestic firms. Benáček and Víšek (1999) presented in their study that foreign investors preferred investment into manufacturing sectors with higher expenditures in research and development. This contradicts Altzinger (1999) who showed in an earlier study that human capital and know-how were not significant factors in investors' decisions. In contrast, Savary (1997) and Pye (1998) described expert knowledge as very important. It is possible that research and development did not play such an important role as it does today.

Another decisive element within cross-country analysis can be the process of privatization. In the countries of Central and Eastern Europe, three different privatization processes were employed. The first (mostly used in the Czech Republic and Slovakia) were based on the principles of coupon booklets and the sale of state enterprises to domestic residents was preferred. The second (mainly in the Balkan states) was the sale of state firms to the hands of their managers. The alternative (almost exclusively in Hungary) was the sale of state enterprises to the hands of strategic partners and the implementation of certain restrictions for foreign agents. Savary (1997) showed that the regions of Central and Eastern Europe were more advantageous for inflows of FDI than southern Europe. On the other hand, Holland and Pain (1998) declared that the way of privatization was the most important.

There is a number of other important determinants for the presence of FDI; for example in cross-country empirical analyse, an important factor can be the distance from the countries of Western Europe (Bevan and Estrin, 2000 or Holland and Pain, 1999). Lankes and Venables (1997) did not confirm the importance of this factor. Other influences can be natural resources (Kinoshita and Campos, 2003), total factor productivity (Savary, 1997 or Benáček and Víšek, 1999) or bureaucratic obstructions (Pomery, 1997).

There exist two cross-industry studies describing determinants of FDI in the Czech manufacturing industry: Benáček and Víšek (1999) and Benáček and Víšek (1999a). In the first study the authors described the determinants of FDI in the manufacturing sector in 1994, while in the second, they analyzed determinants between 1991 and 1997. The authors concluded that it was not possible to find a universal econometric model describing all determinants of all sectors in the manufacturing industry. In the Czech economy, there existed two or three groups of industries where the investors behaved differently because their perspectives were different. With the help of robust estimation techniques, they managed to find in both studies that possible determinants of FDI could be, for example, price increases in the industry, total factor productivity, skilled labor force and/or the profitability of sectors.

In this paper we will analyze the data for about 23 sectors of manufacturing industry between 2000 and 2008. Our aim is to describe the history of FDI in the Czech Republic and in Czech manufacturing industry over 10 years, analyze important historical events and consult relevant literature. Finally, we will find and estimate an econometric model describing the determinants of FDI in Czech manufacturing. Our aim is to continue in previous cross-industry empirical analyses and therefore base on theories of comparative advantages, the theory of allocation and trade, industry organization and the theory of specialization and focus on sector analysis.

The paper is organized as follows. Section 2 describes important historical events in Czech manufacturing. Section 3 describes the data and methodology of estimation. Section 4 reports results and section 5 concludes the paper.

2. Privatization in the Czech Republic and FDI 2000–2008

Privatization strategy of the Czech Repoublic was three-pronged. Restitutions restored assets to those who had owned them before they were natonalized by the communist regime in 1948. Small-scale privatization contains primarily small economic units that were sold at public auctions. The most important program in the Czech Republic was the Large (Mass) privatization which began in 1991 and concluded in 1995 and contained firms not privatized through the first two programs. This stage of privatization allowed the combination of the following techniques: holding in tenders (typically small business), holding in tenders or to a predetermined buyer (medium-sized business) – direct sales, and the largest firms were transformed into joint stock companies whose shares were distributed within voucher privatization (almost one half of the total number of all shares), sold for cash or transferred free of charge to municipalities (Kočenda and Valachy, 2001).

According to the Annual Reports of the Czech National Bank (CNB), the end of 1990s was characterized by extraordinary flows of foreign capital into the Czech Republic. Many large companies were privatized and large foreign trading companies have expanded to the Czech Republic. Privatization – especially of financial institutions – and better infrastructure contributed substantially to FDI growth.

In 1998, the System of state Investment Incentives was established and in 2000, a law for investment incentives was ratified. These measures introduced criteria for an award for incentives, for example income-tax abatement limit for a specific period for newly established or for already existing companies, support for the buildup of infrastructure and/or subsidies for staff training. These incentives were awarded under certain conditions – especially if the investment targeted some preferred sectors of the manufacturing industry or certain underdeveloped regions.

In the beginning of the millennium, dominant manufacturing sectors were motor vehicles, electric machines, petroleum products, chemicals, and non-metallic mineral products. In addition, investments into business machines, computers, paper and food industry were high. The year of 2005 should be mentioned when more than a half of the increase of FDI flows was due to investment in equity, of which the sales of state-owned stakes in Český Telecom and Unipetrol were the largest investment transactions. However, the expansion of existing foreign investments also accounted for a considerable share of the foreign capital income.

At the end of the period under the present study's consideration there were no major investment projects. In regards to the sector structure of capital invested into the Czech Republic, the situation was the same for several previous years: the most dominant were services, followed by manufacturing industry. The largest investments in manufacturing were allocated to motor vehicles, petroleum and chemical products.

In the period under consideration, in terms of geographical breakdown the Netherlands, Germany and Austria accounted for the largest share of FDI. In the CNB statistics made among 3 000 – 4 000 foreign-owned companies, about 70 of them accounted for around half the total FDI.

3. Data and Methodology of Estimation

In this paper, we used a panel of 23 sectors from the manufacturing industry (classified according to Industrial Classification of Economic Activities – NACE-CZ divisions, the complete list of industries can be found in the Table 2) between 2000 and 2008. The number of observations is 207 (= 23 × 9). The time-series aspect of our analysis is very important. Self-reinforcing effects of FDI can only be addressed if there is a time series of FDI. Industries can go through comprehensive reforms during long time periods and a newly-made investment could be a follow-up function of the past investment. The cross-sectional aspect of this study can be also important due to difficulty of obtaining sufficiently long FDI data (Kinoshita and Campos, 2003).

	Name of industry		Name of industry
1	Food products and beverages	13	Basic metals
2	Tobacco products	14	Fabricated metal products
3	Textiles	15	Machinery and equipment n.e.c.
4	Wearing apparel	16	Office machinery and computers
5	Tanning and dressing of leather	17	Electrical machinery and apparatus n.e.c.
6	Wood and products of wood and cork	18	Radio, television and communication equipment
7	Pulp, paper and paper products		
8	Publishing, printing and reproduction of recorded media	19	Medical, precision and optical instruments
		20	Motor vehicles, trailers and semi-trailers
9	Coke, refined petroleum products		
10	Chemicals and chemical products	21	Other transport equipment
11	Rubber and plastic products	22	Furniture; manufacturing n.e.c.
12	Other non-metallic mineral products	23	Recycling

Table 2: List of industries

The data used in this paper come from different sources. The information about foreign capital flows (as a part of information about balance payment) is from the Czech National Bank. Direct investment according to the CNB includes equity capital, re-invested earnings and other capital covering the borrowing and lending of funds, including debt

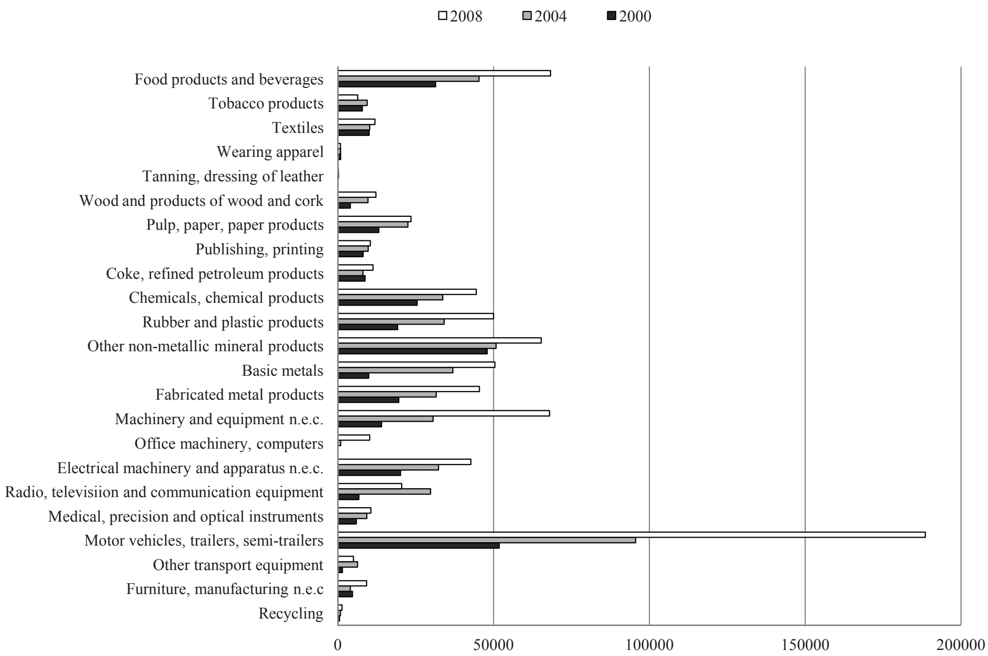

Figure 1: FDI by Industry in 2000, 2004 and 2008 (mill. CZK). Source: CNB

securities and trade credits, between direct investors and their subsidiaries, associations and branches. Information about the rest of variables is from the Czech Statistical Office (CSO). On this point it is important to stress the fact that data from the CSO each year undergo many methodological changes and revisions. Some data published by the CSO are classified only into NACE-CZ subsections, which are not so detailed as NACE-CZ divisions. Another problem is that some of the data are not accessible to the public. Moreover, some data are not available and must be computed with the use of other data. The most substantial problem is the impossibility of obtaining complete data from the 1990's. In comparison with the CSO, information about FDI from the CNB is stable and the numeric data do not change over time. Figure 1 summarizes the stock of FDI in manufacturing industries and different years (2000, 2004 and 2008). It shows that the most dominant industries are motor vehicles, electrical machinery or machinery n.e.c.

Our dependent variable is the intensity of FDI. This intensity in the given industry

i in time t is measured by the volume of foreign capital per value added: *FDI/VA* for each year and sector (Benáček and Víšek, 1999), avoiding thus the problem of industry size. Normalization of the stock of FDI by the size of value added requires that also the explanatory variables reflect relative intensities, excluding thus all size effects.

3.1 Regression Variables

Regression variables were chosen on the basis of the main economic theories of location in an open economy. This allocation can be explained primarily by the pure theory of trade. The location of FDI is closely related to comparative advantages of the industries provided the FDI enters a tradable sector of the economy. A foreign investor would not enter into an industry which has no comparative advantage or where returns are low. In our model we will commence with the test of factor usage: capital and labor intensities of production, human capital, requirements of natural resources in the industry where FDI can enter. FDI entry should also minimise the cost of production, our analyses will also include indicators for the cost of production – total factor productivity. The changes in relative prices use the Stolper-Samuelson theorem: the changes in relative prices after the opening-up can lead to extensive changes in the allocation of resources and investments (Benáček and Víšek, 1999). We will also include a variable describing profitability or wages. The following explanatory variables will be used in our tests:

Physical capital and Labor

The first explanatory variable deals with the Heckscher-Ohlin explanation of investment due to comparative advantages given by country's relative endowments and factor requirements in production. In this paper we will use the combination of the physical capital per unit of net production K/VA and of the labor per unit of net production (L/VA). This variable used in our study is denoted K/L (for each year and sector). We decided to include this normalization because of the compatibility with the Heckscher-Ohlin theory where K/L is the basic explanatory variable. Since there has been a general assumption that the presence of relatively skilled labor in post-communist countries is a comparative advantage that attracts FDI, we expect positive sign of L/VA: the higher the labor intensity of production is, the more competitive the production in international markets and the more attractive the industry for FDI. Physical capital per unit of net production, as an alternative for labor intensity, is a scarce and too expensive factor and we expect it to be a statistically significant variable with a negative sign, on condition that there is no multicollinearity[1]. With the combination of these two factors, we expect negative sign of estimated parameter of K/L, provided the assumption that post-communist economies in Central Europe have comparative advantage in labor is valid. K was measured in billions CZK.

Total factor productivity (*TFP*)

This variable is used as a proxy for the technical efficiency of factor usage: the higher *TFP* is, the lower volume of factors is necessary to produce a unit value of output (Benáček and Víšek, 2000). This means that we expect a positive sign of this variable. There are numbers of ways how to estimate *TFP*. By considering aggregate Cobb-Douglas production function we will obtain

$$TFP_{it} = \frac{VA_{it}}{K_{it}^{a} L_{it}^{b}}$$

where a denotes the capital's share of the value added and b denotes the labor share of the value added[2]. We suppose that $a + b = 1$. It is often assumed that the reasonable estimate for a is between 0.25 (Prescott, 1998) and 0.35 (Collins, Bosworth and Rodrik, 1996) or a is set to 0.3 (Caselli, 2005). We will take the labor's share in the value added in industry as a proxy parameter b.

Change of nominal producer prices in time (*PPI*)

This inflationary indicator measures price changes by the producers for their output. The higher this index is, the higher the potential for the growth of the industry and investments into this industry. The autonomous industrial price "hikes" can be explained by growing market power (e.g. due to the FDI entry) or the increase in the quality (or the image) of products or simply by faster world-wide boost in demand for products in the

[1] Although multicollinearity does not bias the coefficients, it does make them more unstable and standard errors may be larger (Wooldridge, 2003). We checked for the multicolinearity using a correlation matrix and using variance inflation factor (VIF, see O'Brien, 2007). The results suggest that there are no problems with collinearity in our regressions.

[2] We suppose differenct wages in different sectors.

given industry. Thus, a positive sign is expected. The Stolper-Samuelson theorems for a location of trade and growth are consistent with this hypothesis.

Labour cost in the host country relative to the investor country (*RULC*)

Companies will be attracted to industries where labour cost in their sector of activity are low relative to producing elsewhere. Relative unit labour cost is computed as the ratio of unit labour cost of partner country and unit labour cost of CR. A rise in relative unit labour cost index is interpreted as increase of competitiveness. That equation can also be reversed with unit labour costs of CR in the numerator and in that case increase of RULC is loss of competitiveness of home country (Tica and Jurčic, 2006). We will use following definition of relative unit labour cost:

$$RULC_{it} = \frac{ULC_{it}}{ULC^*_{it}}$$

where ULC_{it} denotes unit labour cost in industry i and year t in the Czech Republic and ULC^*_{it} denotes unit labour cost in appropriately selected partner's country or countries in industry i and year t. As partner countries we take EU15. Unit labour cost is defined as labour cost devided by labour productivity (Havlik, 2005 and Tortian, 2007). A rise in the index indicates deterioration in competitiveness. Therefore, we expect a negative impact on FDI (Tortian, 2007 and Tica and Jurčic, 2006).

Research and development (R&D)

The quality of labor or quality of production and products can also be an important factor for potential foreign investors. CSO offers different sources of information about R&D: the number of people employed in R&D, the number of research workers or the total amount of expenditures on research and development. We decided to use the number of research workers employed in R&D. The role of R&D has become more important in recent years. High expenditures in R&D or higher number of workers employed in R&D can also be a sign of high quality. We expect a positive sign for this factor.

Profits per labor

This variable was included as a proxy for general competitiveness. FDI should be attracted by more profitable firms or the presence of FDI can spill over to higher profits.

Thus, a positive sign of this variable is expected. This variable was measured as profits per number of employees. Profits were measured in billions CZK and calculated as PR=VA-C, where C=wL+rK are costs. Wages w are different in different sectors, which reduces problems with multicollinearity. r denotes the price of K.

Energy intensity

Energy intensity was included as a proxy for natural resources. We have information about different energy requirements: coal, gas, oil, electricity and petrol. In the past ten years, the price of these sources of energy have risen worldwide. The prices of energy grew especially at the end of our period under consideration. Nevertheless, for example in 2001, the prices of electricity for industry in the Czech Republic were among the lowest in the EU and this trend continued until 2004. The prices in 2005 were by far not so high as in some countries in Europe. After 2005, the situation changed. We suppose that the Czech Republic still has a comparative advantage in natural resources. Thus, we expect a significant parameter of this factor with positive sign. The variable was measured as energy consumption in gigajoules (GJ) and normalized by value added.

Wages

We suppose different wages in different sectors. A higher profitability in industries with higher FDI could spill over to higher wages, especially if there is an inelastic labor supply because of low mobility due to a shortage of flats (Benáček and Víšek, 1999). We expect a significant parameter of this factor with a positive sign. This variable was measured as gross monthly wage in thousands CZK.

Balassa index of inter-industrial specialization (*BAL*)

The tendency to relate FDI with higher export specialization to industries is well observed, even though some high export FDI firms can be also important importers (Altzinger, 1999). Thus we will test a hypothesis what kind of revealed comparative advantage is associated with FDI. We expect positive relationship between FDI and BAL.

Balassa index is computed as folowing ratio:

$$BAL_{it} = \frac{X_{it} - M_{it}}{X_{it} + M_{it}}$$

where X_{it} denotes Czech export in industry i and year t and M_{it} denotes Czech import in industry i and year t.

3.2 Methodology of Estimation

Among the different possibilities of organizing and estimating an econometric model we decided to choose the approach of Cheng and Kwan (2000) or Kinoshita and Campos (2003) and to relate current values of FDI to past values of FDI[3] along with other explanatory variables. According to previous studies, the role of past FDI values is formulated as the process of the partial stock adjustment and it takes time for FDI to adjust to equilibrium or desired level:

$$\begin{aligned} Y_{it} - Y_{it-1} &= \alpha(Y_{it}^* - Y_{it-1}) \\ Y_{it} &= (1-\alpha)Y_{it-1} + \alpha Y_{it}^* \end{aligned} \tag{1}$$

where Y_{it}^* is an equilibrium level of the FDI stock and $|\alpha|$ reflects the persistance in the process of adjustment towards an equilibrium and is less than 1 for stability. The equilibrium level of the FDI stock is a function of X_{it}, a vector of $k \in \{1, \ldots, K\}$ explanatory variables described upwards in the previous subsections:

$$Y_{it}^* = \beta X_{it} + v_{it} \tag{2}$$

where v_{it} it is an error term including the individual (industry) specific effect and the error term. By reformulating models (1) and (2) we will get:

$$\begin{aligned} Y_{it} &= \delta Y_{it-1} + \lambda X_{it} + \varepsilon_{it} \\ \varepsilon_{it} &= \mu_i + u_{it} \end{aligned} \tag{3}$$

where $\delta = 1-\alpha$ and $\lambda = \alpha \cdot \beta$ are coefficients to be estimated, β is a vector of dimension $1 \times K$); $\varepsilon_{it} = \alpha v_{it}$, μ_i is individual (industry) specific effect. We will analyze model (3) using simple ordinary least squares (OLS) and fixed effects estimator (FE).

[3] We will take values of FDV/VA between 1999 – 2007.

Fixed effect transformation represents an estimation method which eliminateds the fixed (industry specific) effect μ_i:

$$Y_{it} - \bar{Y}_i = \delta(Y_{it-1} - \bar{Y}_i) + \lambda(X_{it} - \bar{X}_i) + \varepsilon_{it} - \bar{\varepsilon}_i \tag{4}$$

where $\bar{Y}_i = \frac{1}{T}\sum_{t=1}^{T} Y_{it}$, $\bar{X}_i = \frac{1}{T}\sum_{t=1}^{T} X_{it}$, $\bar{\varepsilon}_i = \frac{1}{T}\sum_{t=1}^{T} \varepsilon_{it}$. This transformation is also called the within transformation and we can estimate equation (4) by OLS. A pooled OLS estimator that is based on the time-demeaned variables is called the fixed effect estimator or within estimator (Wooldridge, 2003).

There is one serious problem with the estimation of model (3) by simple techniques. The lagged endogenous variable and the disturbance term it might be correlated and the estimates of such a model could then be inconsistent. Therefore, Anderson and Hsiao (1981) suggest to use the first differences to wipe out the individual effects:

$$\Delta Y_{it} = \delta \Delta Y_{it-1} + \lambda \Delta X_{it} + \Delta \varepsilon_{it}. \tag{5}$$

and to use an instrumental variable uncorrelated with the disturbance. Since this estimator is inefficient (because it does not use all available orthogonality restrictions and neglects the differenced structure of the disturbances), we will estimate model (5) by the generalized method of moments (GMM). This method is a general estimation principle, where estimators are derived from moment conditions. We consider a dynamic fixed effect model of the form (3). We assume:

$$\begin{aligned} u_{it} &\sim N(0, \sigma_u^2) \qquad \sigma_u^2 > 0 \\ E[u_{it}, u_{js}] &= 0 \qquad i \neq j \qquad t \neq s \\ E[\mu_i, u_{jt}] &= 0 \qquad \forall i, j, t \\ E[X_{it}, u_{js}] &= 0 \qquad \forall i, j, t, s \end{aligned}$$

Arellano and Bond (1991) noted the validity of the set of moment conditions

$$\begin{aligned} E[Y_{it-s} \cdot \Delta u_{it}] &= 0 \\ E[X_{it-s} \cdot \Delta u_{it}] &= 0 \end{aligned} \tag{6}$$

for $T = 3, \dots, T$ and $s = 2, \dots, t-1$, and proposed the GMM (sometimes called difference, DIFF-GMM) estimator that treats the model as a system of equations, one for each time period. The equations differ only in their instrument/moment condition sets. The predetermined and endogenous variables in the first differences are instrumented with suitable lags of their own levels.

Arellano and Bover (1995) or Blundell and Bond (1998) proposed the System GMM (SYS-GMM) estimator to give considerable improvements over DIFF-GMM in small samples. SYS-GMM is based on a system compound of first-differences instrumented on lagged levels, and of levels instrumented on lagged first-differences. These are appropriate instruments under the following additional assumptions:

$$\begin{aligned} E[Y_{it+p} \cdot \mu_i] &= E[Y_{it+q} \cdot \mu_i] \\ E[X_{it+p} \cdot \mu_i] &= E[X_{it+q} \cdot \mu_i] \end{aligned}$$

for all p and q and the additional moment conditions for the second part of the system are:

$$\begin{aligned} E[\Delta Y_{it-s} \cdot \varepsilon_{it}] &= 0 \\ E[\Delta X_{it-s} \cdot \varepsilon_{it}] &= 0 \end{aligned} \tag{7}$$

for $s = 1$. Since we have a small sample we decided to use as a third step of estimation System GMM estimator. Then the one-step system GMM estimator based on the moment conditions (6) and (7) is

$$\hat{\theta}^{GMM} = (X'_+ Z A Z' X_+)^{-1} X'_+ Z A Z' Y_+$$

where Y_+ and X_+ are defined as follows:

$$X_{+i} = \begin{bmatrix} \Delta y_{i1} & \Delta x_{i2} \\ \vdots & \vdots \\ \Delta y_{iT-1} & \Delta x_{iT} \\ y_{i1} & x_{i2} \\ \vdots & \vdots \\ y_{iT-1} & x_{iT} \end{bmatrix}, Y_{+i} = \begin{bmatrix} \Delta y_{i2} \\ \vdots \\ \Delta y_{iT} \\ y_{i2} \\ \vdots \\ y_{iT} \end{bmatrix}$$

and Z is a matrix consisting of $(Z_1, \ldots, Z_N)$ where

$$Z_i = \begin{bmatrix} Z_D & 0 \\ 0 & Z_L \end{bmatrix}$$

where $Z_D = [Z_{D1}, Z_{D2}]$, where Z_{D1} is a block diagonal matrix whose s-th block is given by $(Y_{i1}, \ldots Y_{is})$ and Z_{D2} is a block diagonal matrix whose s-th block is given by $(X_{i2}, \ldots, X_{is+1})$ for $s = 1, \ldots, T-2$. $Z_L = [Z_{L1}, Z_{L2}]$ where $Z_{L1} = diag[\Delta Y_{i2}, \Delta Y_{i3}, \ldots \Delta Y_{iT-1}]$ and $Z_{L2} = diag[\Delta X_{i2}, \ldots, \Delta X_{iT}]$. A is a positive weight matrix and a choice of A can be found in Blundell and Bond (2008).

All GMM estimations are carried out using command "xtabond2" for Stata. The validity of instruments is checked by the Hansen test and the second-order correlation of the error term in the first-differenced equation is checked by Arellano-Bond statistics, which are asymptotically distributed as *N(0,1)* (Kinoshita and Campos, 2003).

For stationarity verification we will use a panel unit root test called LLC (Levin, Lin and Chu, 2002) which is based on Dickey-Fuller test. An additional empirical check for small-sample bias is to compare estimated panel GMM with the corresponding estimates from OLS and simple fixed-effects regression.

However, the fact that our data set is a mixture of industries with heterogenous behavior of investors must be taken into account (Benáček and Víšek, 1999). This means that there is a possibility that it would not be possible to obtain explicit and conclusive results by using a classical estimator (which includes all observations into one model). For example, Benáček and Víšek (1999b) analyzed 91 industries of the Czech economy and realized that this population appeared to consist of two segments. The first segment contained industries in which the majority of firms behaved as if in a functioning market economy while the other segment contained industries where firms still behaved as if under socialist paternalism. Thus, we will use one of the robust techniques of estimation that solve the problem of heterogeneous patterns in data sets. Among more possibilities we will use a simple Least Trimmed Square estimator (LTS). We can describe an algorithm of this estimator as follows.

We consider standard linear regression model

$$Y_i = \beta X_i + \varepsilon_i.$$

For an arbitrary $b \in R^k$ we shall denote by $r_i(b) = Y_i - bX_i$ the i-th residual at b. Further, we shall denote $r^2_{(i)}(b)$ for the i-th order statistics among the squared residuals:

$$r^2_{(1)}(b) \leq r^2_{(2)}(b) \leq \ldots \leq r^2_{(n)}(b)$$

Finally, let us define the LTS estimator by the minimization

$$b^{LTS} = arg \min \sum_{i=1}^{h} r^2_{(i)}(b)$$

where $n/2 \leq h \leq n$ and the minimization is performed over all $b \in R^k$ (Rousseeuw and Leroy, 1987, Víšek, 1996 and Víšek, 2000). In other words, in this extremal problem we are looking for such an argument $b \in R^k$ for which the sum of h smallest squared residuals is minimal. Finally, we built an OLS estimator for these h observations[3]. Unfortunately,

[3] Welsh and Ronchetti (2002) show that asymptotic variance of LTS estimator (OLS estimator, where we manipulate with some observations and exclude them from the model) is greater than classical variance of OLS estimator. On the other hand, the solving of problem of exact p-values for least trimmed square estimator is not so easy and requires a much larger discussion. Many theoretical properties of LTS have been adressed but the basic problem of significance of explanatory variable has not yet been considered. The simplified process could be as follows: It is clear that for classical OLS estimator the test is based on $\frac{\hat{\beta}^{LS}-\beta}{s \cdot c}$ where $c = (X'X)^{-1}$ and $s^2 = \frac{1}{n-p}\sum_{i=1}^{n}(Y_i - X_i'\hat{\beta})^2$ and which has a distribution t_{n-p} according Fisher-Cochran theorem. Then we are interested in distribution of variable $\frac{\hat{\beta}^{LS}-\beta}{d}$, where $d^2 = (X'X)^{-1} \cdot \sum_{i=1}^{n} r_i^2(\hat{\beta}^{LS}) \cdot X_i \cdot X_i'(X'X)^{-1}$. Since LTS is a special case of LWS (least weighted squares) we can work with LWS and show that $\hat{\beta}^{LWS}(Y,X) = \hat{\beta}^{OLS}(\tilde{Y},\tilde{X})$, where $\tilde{Y} = WY$ and $\tilde{X} = WX$, where W is a weight matrix (in case of LTS with 1 and 0 on diagonal and 0 elsewhere, i.e. $W = diag(1,1,\ldots,1,0,\ldots,0)$ and the number of ones is h). So we consider model $\tilde{Y} = \tilde{X}\beta + \tilde{\varepsilon}$, where $\tilde{\varepsilon}$ has a distribution $N(0,\sigma^2 W^2)$. It can be then shown that the distribution of variable $\frac{\hat{\beta}^{LTS}-\beta}{\sqrt{var\hat{\beta}^{LTS}}}$ has a distribution $N(0,1)$ and $\frac{\hat{\beta}^{LTS}-\beta}{D(W,X)} \cdot$

we are limited by the dynamic form of model (2). Due to the presence of lagged value of response variable on the right side of the equation it s not so easy to exclude some observations out of the data set. Instead of this, we decided to exclude a whole industry or industries. Therefore, we will use this technique only as a diagnostic tool and we will ascertain if the LTS estimator would systematically exclude (almost nearly) a whole industry or industries in (almost nearly) all years.

4. Results

In the first step, we report OLS estimation and fixed-effects panel estimates (Blanchard, Gaigné, Mathieu, 2008). However, both pooled OLS and fixed effects of an autoregressive panel model are subject to bias in the estimation of all model parameters. Thus, we also report the results of System GMM. Finally, besides results of GMM estimator we will also comment results of OLS and fixed effects in an effort to compare the results in terms of an economic interpretation. All regression are estimated in Stata. In all regressions, the response variable is *FDI/VA*. Table 3 reports panel regressions: We report pooled OLS and fixed effects models in column (a) and (b) and GMM model in column (c).

The coefficient of determination for model (a) and (b) is satisfactorily high (67% and 60%, respectively). LLC test for stationarity suggest that each individual time series is stationary. We present three specification tests for GMM. The Hansen test does not reject the null hypothesis that the over-identifying restrictions are valid. The Arellano-Bond test for AR(2) determined that there is no second order serial correlation. It implies that the model is correctly specified. The coefficient of the lagged *FDI/VA*, δ, is 0.53 in regression (a), 0.23 in regression (b) and 0.52 in regression (c). This means that the coefficient of partial adjustment is thus 0.47 in the case of model (a) and the net investment in one year is 47% of the difference between Y^* and Y[4]. If the steady-state level of the *FDI/VA* stock does not change it will take about 2 years for the gap between the equilibrium and

$\left(\frac{\sum_{i=1}^{h}(1-d_{ii})}{\tilde{r}'(\hat{\beta}^{LTS}\cdot\tilde{r}(\hat{\beta}^{LTS}}\right)^{\frac{1}{2}}$ has a distribution t_{n-p}, where $\sigma^2 D^2(W,X) = var\hat{\beta}^{LTS}$, $E(\tilde{r}'(\hat{\beta}^{LTS})\cdot\tilde{r}(\hat{\beta}^{LTS})) = \sigma^2\sum_{h}^{i=1}(1-d_{ii})$. It is clear that the problem of "correct" p-values is not simple and would also require deep and extensive numerical study. However, solving this problem would probably take an entire new dissertation.

[4] Y^* and Y are defined in subsection 3.2.

	OLS (a)	FE (b)	GMM (c)
Lagged FDI/VA	0.528***(0.093)	0.230**(0.104)	0.518***(0.174)
Capital per labor	-0.086***(0.032)	-0.022(0.134)	-0.062**(0.030)
Profits per labor	0.428***(0.088)	0.181**(0.151)	0.348***(0.117)
R & D	7.975*(4.907)	39.100*(23.102)	2.202(1.63)
Energy intensity	0.131***(0.032)	0.120***(0.023)	0.127***(0.022)
Wage	0.025**(0.010)	-0.039(0.043)	0.023*(0.013)
PPI	-0.011**(0.004)	0.009(0.006)	-0.001(0.001)
TFP	-0.076(0.114)	-0.110(0.153)	-0.055(0.049)
RULC	-0.106**(0.053)	-0.005(0.073)	-0.044(0.036)
BAL	0.103(0.119)	0.294(0.546)	0384(0.359)
Number of obs.	207	207	207
Adjusted R^2	0.67	–	–
Within R^2	–	0.60	–
Pseudo R^2	–	–	0.49
Hansen test *(p-value)*	–	–	0.191
A–B AR(1) *(p-value)*	–	–	0.047
A–B AR(2) *(p-value)*	–	–	0.142

Table 3: Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in brackets. Hausmann test rejects the random effects model. Response variable: FDI/VA.

the current value of *FDI/VA* to close. We can make analogous conclusion in the case of models (b) and (c) (Kinoshita and Campos, 2003).

The results of regressions (a) and (c) indicate that physical capital and labor play an important role in the decision of foreign investors where to place their investment. It seems that in recent years investors have preferred the cheaper alternative – investments into labor-intensive sectors while investments were shunning off from the capital-intensive industries. This result agrees with the findings of other studies (Savary, 1997 or Benáček and Víšek, 1999) and also is consistent (in accordance) with our expectations.

The variable describing profits in sectors is significant in all regressions with positive signs. According to our hypothesis, profits in industries attracting FDI should be greater than profits in industries with home-owned enterprises. The results of our tests are consistent with these expectations. In regressions (a) and (b), foreign investors put an accent on research and development. The results corresponds to our expectations: higher number of workers in R&D means higher investments on the part of foreign investors or higher number of research workers can spill over to higher expenditures on R&D. This variable is significant on the level of 10% only. Although these result are not very strong and conclusive, generally we can believe that R&D is important for investors.

The variable describing energy requirements is significant with the positive sign of the estimated parameter. The prices of energy have risen in recent years, but these changes concerned countries all over the world. The Czech Republic was characterized by lower prices of energy at the beginning of the period under our consideration compared to some other European countries and the continued tradition of investments into energy-intensive industries. On that account, we conclude that the Czech Republic has a comparative advantage in energy requirements.

Relative unit labour cost is significant (and negative) only in regression (a). It means that increases in relative production costs in the Czech manufacturing industry compared to EU15 countries are expected to have a negative effect on investments into these industries. The variable describing gross monthly wage is significant for the models (a) and (c). Also these results conform to our expectations. The variable describing the efficiency of factor usage, total factor productivity, is not significant in any model. Surprisingly, variable PPI, describing inflation rate, is significant only in regression (a) with negative sign. Our data and these results can be mispresented by some heterogeneous pattern of foreign investors in some industries. We will try to eliminate this influence by using LTS.

As mentioned above, there exists a certain possibility that our data come from two or more different sectors where investors behave differently. Moreover, some variables are not significant and other results of fixed effects regression are not very good. Thus, we tried to apply least trimmed square estimator on our data and we monitored these industries which were deleted from most of the observation by the algorithm. Pursuant to the results, it comes into question to drop subsequently tobacco (industry 2) or motor vehicles, trailers and semi-trailers (industry 20). Afterwards we estimated these reduced data sets by using pooled OLS, fixed effects panel estimator and system GMM.

The results of these estimates are in Tables 4 and 5. In terms of economic explanation, the manufacture of tobacco products is specific: there have been no workers employed in research and development, on the other hand the ratio K/L and profits per labor are very high compared to other industries. The sector of motor vehicles, trailers and semi-trailers has a specific position in the Czech Republic and has a cardinal importance for the whole Czech economy. The flows of FDI in this industry are extremely high as this sector put the stress on research and development, and the profits are higher than in other industries.

After the exclusion of industry 2 (tobacco), some of the results of regression (d) and (f) have changed. The coefficient of determination for the model (d) and (e) increases (72% and 64%). This means that models fit the data well. As well as in previous analysis according to the Arellano-Bond test, a second order correlation does not detect problems and the Hansen test rejects the null hypothesis on the level of 5%. It means that the validity of instruments is correct. Overall, the comparison between OLS and GMM results shows a bias that in most variables is not great as seen in similar sizes of coefficients in both specifications. With the LLC test we reject the null hypothesis of a common unit root.

Variable K/L has a negative sign and is significant in models (d), (e) and (f). This result supports our previous findings. Investors probably avoid being involved in industries the expansion of which would require a large financial investment into their capital revamping. The alternative is to start expansion in labor-intensive and profitable industries, because variable profits per labor is also significant and positive (in all three models). The p-value of R&D in all regression has decreased. Results support our hypothesis that foreign investors put accent on research and development. Variable $RULC$ which describe competitiveness is significant in all three regressions with negative sign. This implies that investors tend to invest into industries with low labour costs related to productivity.

	OLS (d)	FE (e)	GMM (f)
Lagged FDI/VA	0.529***(0.097)	0.223**(0.109)	0.470***(0.121)
Capital per labor	-0.067**(0.027)	-0.093**(0.041)	-0.080**(0.038)
Profits per labor	1.505***(0.310)	0.786*(0.437)	1.107***(0.434)
R & D	10.165**(4.928)	39.698**(20.004)	4.431**(2.214)
Energy intensity	0.107***(0.029)	0.105***(0.036)	0.091***(0.034)
Wage	0.007***(0.001)	-0.026(0.052)	0.031*(0.017)
PPI	-0.012***(0.004)	0.007(0.008)	-0.001(0.003)
TFP	-0.020(0.119)	-0.104(0.152)	-0.002**(0.001)
RULC	-0.140***(0.053)	-0.013**(0.005)	-0.944**(0.474)
BAL	0.091(0.125)	0.135(0.625)	-0.033(0.509)
Number of obs.	198	198	198
Adjusted R^2	0.72	–	–
Within R^2	–	0.64	–
Pseudo R^2	–	–	0.55
Hansen test *(p-value)*	–	–	0.059
A–B AR(1) *(p-value)*	–	–	0.017
A–B AR(2) *(p-value)*	–	–	0.209

Table 4: Industry 2 tobacco is excluded. Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in brackets. Hausmann test rejects the random effects model. Response variable: FDI/VA.

The variable describing inflation (*PPI*) is significant only for regression (a). However, the estimated parameter has a negative sign. According to our expectation, the sign should be positive. By a clear look at the data, we can see that this price index is decreasing for several industries, especially those where FDI flows are high during recent years. In industries with higher FDI, the prices can be pressed down and the negative sign can be the effect of presence of FDI. There is also a statistical explanation of this problem. In general, if the sign of estimated parameters does not correspond to our expectations, this variable could compensate for the non-linearity of some other variable. It means that the "bad" sign of parameter is not necessarily a problem and we should not rely only on signs of estimated parameters. In any case, we will monitor carefully the results of estimating this parameter in the following regression (without industry 20).

The rest of variables are unchangeable. We can conclude that excluding industry 2 (tobacco) from our data set brings an interesting changes in significance of some variables: R&D, wages, relative unit labor costs. Moreover, the coefficients of determination have also improved. Thus we believe that using of robust method leads to results which are more conclusive.

We will now comment on brief results of the last estimated model where industry 20 (vehicles, trailers and semi-trailers) is excluded. Results are summarized in Table 5.

Coefficients of determination of model (g) and (h) are 75% and 64%. Two specification tests of the GMM show a satisfactory result. With the Hansen test we do not reject the null hypothesis that the instruments are well specified and the Arellano-Bond test does not detect second-order serial correlation. In other words, the model is correctly specified. LLC test rejects the null hypothesis and we can conclude that individual series in the panel data are stationary.

Let us control the most problematic variables – *PPI*, *TFP* and Balassa index. *PPI* variables in regressions (g) and (h) are significant on the level of 5% and 10%, respectively, *TFP* is not significant in any model. Moreover, *PPI* is significant with a positive sign in regression (b). It means that the higher this index is, the higher the potential for the growth of the industry and investments into this industry. On the other hand, results from regressions (a) – (f) do not bring any similar conclusion. Thus we suppose that this factor is not important for investors. The variable describing Balassa index is not significant and we conclude that this factor is not important for investors in their decision. The remaining variables are significant and the conclusions are similar to the previous. As well as in previous case (excluding of Tobacco) we presume that results obtained with the aid of LTS are more conclusive and unambiguous, estimates are characterized by lower p-values and coefficients of determination improved as well.

	OLS (g)	FE (h)	GMM (i)
Lagged FDI/VA	0.522***(0.094)	0.244**(0.104)	0.460***(0.126)
Capital per labor	-0.094***(0.031)	-0.008(0.136)	-0.095**(0.041)
Profits per labor	0.447***(0.086)	0.379**(0.152)	0.404***(0.155)
R & D	7.100**(3.130)	41.688**(20.971)	1.762***(0.578)
Energy intensity	0.138***(0.031)	0.118***(0.023)	0.096***(0.037)
Wage	0.022**(0.010)	0.080**(0.040)	0.038**(0.020)
PPI	-0.10**(0.004)	0.011*(0.006)	-0.001(0.003)
TFP	-0.065(0.115)	-0.072(0.149)	-0.001(0.002)
RULC	-0.096**(0.045)	-0.101*(0.070)	-0.091**(0.042)
BAL	-0.029(0.132)	0.379(0.581)	-0.437(0.905)
Number of obs.	198	198	198
Adjusted R^2	0.75	–	–
Within R^2	–	0.64	–
Pseudo R^2	–	–	0.57
Hansen test *(p-value)*	–	–	0.261
A–B AR(1) *(p-value)*	–	–	0.056
A–B AR(2) *(p-value)*	–	–	0.290

Table 5: Industry 20 motor vehicles, trailers and semi-trailers is excluded. Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in brackets. Hausmann test rejects the random effects model. Response variable: FDI/VA.

5. Conclusion

This paper analyzes some aspects of the behavior of foreign investors in the Czech manufacturing industry to learn about the mechanism of allocation of FDI as descriptive analysis of the decision-making process of investors who discriminate between manufacturing sectors in one single country. Therefore we focused on sectoral analysis and estimated a panel data of 23 sectors of manufacturing industry over 9 years (2000–2008) by using different techniques of estimation: OLS, fixed effects and primarily by using the GMM estimator. Together with the GMM estimator, we provided several statistical tests controlling the validity of the instruments used. One of the most important weaknesses of this paper, the relatively short time series, is eliminated by certain sensitivity analysis – we estimated nine different regressions, all with the same regressors. The results obtained by simple techniques of estimation mostly correspond to those obtained by GMM.

One of the most important results is the suggestion that the abundance of labor with technical skills is still a comparative advantage in the Czech Republic while the physical capital is relatively more scarce and thus a more expensive factor. Foreign investors prefer industries with a higher quality of labor and flows of foreign capital are closely associated with the number of research workers employed in research and development. We conclude that higher number of these employees affects higher flows of FDI. Foreign capital is also positively associated with energy usage as foreign investors tend to invest into industries with higher energy requirements. In addition, our hypothesis about profits in these industries was also confirmed in all regression models: industries with higher profits per labor have higher flows of FDI. We suppose that higher profit is the effect of the presence of FDI in industry, which has the circular effect of attracting further investments. Relative unit labour cost is also an important determinant of FDI in Czech manufacturing.

Although there would be more possibilities of excluding the industries out of our data set (we could take into account also industry 13 – basic metals or industry 18 – radio, television and communication; on the other hand, after excluding one of these industries the results are very similar to the previous two following regression models), in our analyses we tried to drop 2 different industries out of the model according to results of LTS applied on data: tobacco (no workers employed in research and development, on the other hand the ratio K/L and profits per labor are very high compared to other industries) and transport equipment (where flows of FDI were extremely high). This exclusion brings improvement of the significance of R&D, wages or relative unit labour costs. However, parameters TFP and Balassa index remain insignificant.

In conclusion, it is very important to note that at the present time the conditions of the Czech economy are changing. These changes will probably also cause changes in the structure of industries and the drain of foreign capital.

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III. The Factors of Growth of Small Family Businesses. A Robust Estimation of the Behavioral Consistency in Panel Data Models

Abstract:

The paper quantifies the role of factors associated with the growth (or decline) of micro and small businesses in European economies. The growth is related to employment and value added in enterprises as well as to ten institutional variables. We test the data for consistency of behavioral patterns in various countries and gradually remove outlying observations, quite a unique approach in panel data analysis that can lead to erroneous conclusions when using the classical estimators. In the first part of this paper we outline a highly robust method of estimation based on fixed effects and least trimmed squares (LTS). In its second part we apply this method on the panel data of 28 countries in 2002–2008 testing for the hypothesis that micro and small businesses in Europe use different strategies for their growth. We run a series of econometric tests where we regress employment and total net production in micro and small businesses on three economic factors: gross capital returns, labor cost gaps in small relative to large enterprises and GDP per capita. In addition, we test the role of 10 institutional factors in the growth of family businesses.

Keywords: Family business, robust estimator, LTS, fixed effects

JEL classification: C01, C23, C51, C82, F21, F40

1. Introduction

The recent worldwide financial and economic crisis has undermined the confidence in the economic leadership of large corporations, self-enforcing efficient markets and uninterrupted high growth. As a consequence, there is a universally rising renewed interest in the performance of small and family businesses which for many researchers and politicians present a crucial vehicle for rising both employment and competition in the world economies. This research is a follow-up to the analysis of Benáček and Michalíková (2010), where we assessed the role of economic and institutional factors on the rise and decline of family businesses and applied them on the analysis of data on micro and small businesses in 28 countries of Europe by means of panel data for 2002–2008. We discovered that unique data on micro and small businesses in so many different countries did not represent a homogenous pattern of behavior in firms that differ not only in sizes but also in institutional setups that also change in time. Thus mixing together of firms subject to different incentives could potentially lead to behavioral patterns that are not compatible and, in extreme cases, it can strike a bias in estimating the factors of decision-making and policies leading to high employment and output growth. In this research we have tested the potential for such a heterogeneity in the behavior of small family businesses in various countries that could be even reflected in separating the original panel data into two subpopulations that are not compatible in their reaction to entrepreneurial stimuli. Hence, we have concentrated in our analysis on the techniques of robust estimation.

Although the methods of robust regressions have been applied over the past 50 years and many researchers were aware of the problem of outlying observations which can completely damage the quality of estimators, scarce reference in literature exists on the use of robust estimations of the parameters in panel data models. This is one of our innovations in this research. The other innovation deals with the design and testing of economic motives on the supply-side and institutional barriers to the growth of family businesses.

In this paper, we apply a robust version of the classical within-group estimators on data of two groups of family businesses. In section 2 we present and describe this approach. Instead of centering the separate time series for each country by mean (and then estimating this centered data by simple ordinary least squares) we transform the data by the subtraction of country-specific median, which is more robust. Then, instead of OLS, a robust estimator is applied on centered data. Among all the possibilities we choose least trimmed squares, which are based on the minimization of h smallest residuals.

To give this approach a practical test, we decided to apply this method on economic data relating to family businesses grouped by company size. In section 3 we describe the role of family businesses in present economies and we work out theoretical vantage points for assessing the factors associated with the growth (or decline) of micro and small businesses in Europe.

In section 4 both these theoretical considerations (robust method for panel data and incentives of family businesses) are merged together. We apply robust version of the within-group estimator on data for 28 European countries in 2002–2008 and we examine how employment and net production in family businesses depend on two relative indicators representing benefits and costs: on the measure of gross capital returns per value added and the relative gap between labor costs in small (or micro) and large enterprises. Additional explanatory variables include the GDP per capita and ten institutional variables. Apart from the economic interpretation of results, we focus on the properties of estimators and how the estimated parameters vary as the number of deleted outliers increases. Section 5 summarizes our findings.

2. Robust Estimators and Robust Estimation of Panel Data Models

2.1 Robust Estimators – an Overview

Classical methods of estimation rely heavily on assumptions, which are often not met in practice. Unfortunately, some values of variables often happen to fall far away from other observations in the sample. These discrepant values might be the result of reporting errors, different methodologies used by the reporters or idiosyncraticy in the behavior of observed agents. The risk of incidence of all these disturbances is quite high in panel data where the time and the geographic discontinuity may lead to data inconsistency. In robust statistics the assumption is that the major part of the data follows a certain specific distribution F, while a certain small percentage of the data takes values unlikely to come from that distribution. Observations of the latter sort are referred to as *outliers*. They often occur by errors and omissions in the collection of data. However, outliers can also be generated when the reporters mix up two or more subpopulations of data that represent agents whose behavior is mutually inconsistent. An example of this can be the case when the analysts presume that micro businesses (such as self-employed persons) and businesses up to 50 employees follow identical strategies for their growth in all studied countries, irrespective of the varying institutional arrangements.

Both these kinds of inconsistency in carrying out observations are our main concern. In contrast to medium or large enterprises that have systematic accounting and whose annual balances are subject to external audits, small family businesses are subject to specific circumstances that increase the uncertainty and inconsistency of their reported data. Firstly, their accountancy need not always be done by professionals and thus more open to errors and omissions. Secondly, their true production, employment and costs can be rigged due to much easier tax evasion. Thirdly, reporting to statistical offices is irregular, relying on random (often non-representative) samples and the feedback on its accuracy is limited as well, varyring by countries. Last but not least, our study is comparative across many countries and the behavior of businesses among countries is not homogenous. There are cultural idiosyncracies in the objectives or traditions in running small businesses, as well as different institutions guiding the incentives of small entrepreneurs and workers. Thus we are convinced that a comparative analysis of the behavior of family businesses across countries and time is open to so many contingencies and behavioral inconsistencies that a robust technique of their estimation is a necessary and adequate approach in order to avoid the trap of data bias.

Since robust estimation has not been the standard technique of analysis in this kind of panel data we will describe first our approach to data processing where the central issue rests in outliers. There are several types of outliers in the cross-sectional regression analysis according to Rousseeuw and Leroy (1987). Contamination in the error term (so called *vertical outliers*) are observations outlying in the y-dimension that affects the estimation of both the intercept and the slope while the effect on the latter is milder. Contamination in the explanatory variables (called *bad leverage points*) affect severely the coefficients. The third type of outliers is referred to as *good leverage points* that lie far from the values of other explanatory variables but are located close to the regression line. Their influence on the estimation of the intercept and other coefficients is marginal. In this work, particular consideration is given to *block concentrated outliers* that are characteristic for situations in which most of the outlying observations are concentrated in a limited number of time series that belong to different countries.

The naive belief in the unimpeachability of statistical observations may end up in conclusions where outliers inflict a series of blows to standard least squares analyses. Not only may some coefficients false but many variables virtually lose significance. To solve this problem, special regression diagnostics have been constructed from the data with the purpose of locating the points of qualitative break-even, after which some outliers can be removed or corrected, followed by least squares analysis on the remaining data. Some of these methods can work well as long as there is only a random outlier. However, it is more difficult to diagnose outliers that pollute the data set systematically. Then the approach of robust regression comes into question (Rousseeuw and Leroy, 1987)

The term *robust estimator* denotes an estimator that is not strongly affected by outliers. It means that the main aim is to fit a regression to the dominant inter-relations in the data and then discover the outliers for future treatment. As a measure of robustness we can consider the existence of the *breakdown point* of estimators. Generally spoken, the breakdown point of an estimator is defined as the smallest fraction of outlying observation that can cause a breakdown of the estimator. The seminal technique of their estimation is described in Rousseeuw and Leroy (1987).

Most robust statistical estimators can be grouped into one of the following three categories: generalized M-estimates that follow from maximum-likelihood arguments and are usually the most relevant class for model-fitting, i.e. for the estimation of parameters. The problem of this estimator is in the low breakdown point equal to $1/p$, where p is the dimension of model (Marona and Yohai, 1981). R-estimates are estimates based on rank tests: this estimator involves the ranking of residuals and the ranks are used to calculate weights. L-estimates involve a linear combination of order statistics and are most applicable to estimations of central value and central tendency, though they can occasionally be applied to some problems with the estimation of parameters. An L-estimator with high breakdown point is e.g. the least median of squares (LMS, see Rousseeuw, 1984) – the first really applicable 50% breakdown point estimator. This method involves finding beta coefficients that minimize the median squared residual. It is true that M-estimators are more efficient than L-estimators. Moreover, much attention has been paid to them. On the other hand, classical M-estimator is not scale- and regression- equivariant and it is complicated to treat generalized M-estimator theoretically. We have to have corresponding estimator of the standard deviation of disturbances scale- equivariant and regression invariant. Thus it is preferable to use such estimators of regression coefficients which are directly scale- and regression-equivariant as LMS or LTS estimator. Since LMS is only $\sqrt[3]{n}$-consistent, it is not asymptotically normal and not easy to evaluate, we will focus on the second applicable 50% breakdown point estimator – the least trimmed squares (LTS, Rousseeuw, 1983).

2.2 Robust Within-Group Estimator in the Context of Our Model

Robust methods date back to the history of statistics and the first basis for a theory of robust estimation was formed in the 1960's. Huber (1964) introduced a flexible class of M-estimators and Hampel (1968, 1971, 1974) designed the approach based on influence function. On the other hand, still few references in literature are available on robust techniques applied to econometrics (Zaman et al. 2001, Bramati and Croux, 2004). Many statisticians believe that outliers can be identified simply by eye by using graphs. However, it is difficult to diagnose outliers by eye, especially in the case of panel data because large panels of countries, companies or other agents may contain atypical observations or gross errors subject to a multitude of exogenous variables. Unfortunately, econometrics is limited to a scant amount of literature describing robust methods for panel data. This paper is an attempt at contributing to these techniques by focusing on the simple fixed effects panel data model of small businesses. We will try to find a robust alternative to the Within-Group estimator[1] which can be affected by the presence of outlying observations. The breakdown point is the measure of robustness and the least trimmed squares is the estimator with high breakdown point. Thus we will describe a high breakdown point estimator for the fixed effects panel data model based on LTS as an estimation procedure, which is less sensitive to the presence of aberrant observations.

We consider the following form of the fixed effects linear panel data model:

$$y_{it} = \alpha_i + x_{it}^{'}\beta + \varepsilon_{it} \qquad i = 1, \ldots, N \qquad t = 1, \ldots, T \tag{1}$$

where i denotes the cross-section dimension (number of countries) and t denotes the time-series dimension (number of years). x_{it} is a column vector of explanatory variables

[1] Since our panel contain all countries of interenst, the fixed effects model is more appropriate than a random effects models for our dataset.

with dimension $K \times 1$ while β is a $K \times 1$ vector of regression parameters. α_i denotes the unobservable time-invariant individual fixed effects and ε_{it} denotes the error terms or disturbance terms, uncorrelated through time and through cross-sections.

The classical Within-Group estimators for fixed effect panel data models is based on centering within every time-series:

$$\hat{y}_{it} = y_{it} - \frac{1}{T}\sum_{t=1}^{T} y_{it}$$
$$\hat{x}_{it} = x_{it} - \frac{1}{T}\sum_{t=1}^{T} x_{it}$$

and then the basic form of the fixed effects panel data models, described in (1), can be expressed as:

$$\hat{y}_{it} = \hat{x}_{it}^{'}\beta + \hat{\epsilon}_{it} \qquad i = 1, \ldots, N \qquad t = 1, \ldots, T \tag{2}$$

and the fixed effects α_i have disappeared from the model (2) by the centering operation. Then we can regress $\hat{y}_{it}$ on $\hat{x}_{it}$ by OLS and we will get Within-Group estimator denoted by $\hat{\beta}_{WG}$. Of course, fixed effects parameters can be estimated as well (Baltagi, 1998). Centering has a crucial advantage because it reduces the number of parameters enormously.

Thus the idea underlying Within-Group estimator is to center the series when applying the within transformation. In order to get a *robust* version of this estimator we have to center the time series (in both the dependent and the explanatory variables) *robustly* and then a robust regression will be applied to the centered data. The difference between these two approaches is that the time-series must be centered by removing the median instead of mean because the mean is largely distorted by outliers since the median is known to be min-max robust (Huber, 1981). We will get:

$$\begin{aligned} \tilde{y}_{it} &= y_{it} - med_t(y_{it}) \\ \tilde{x}_{it}^{(j)} &= x_{it}^{(j)} - med_t(x_{it}^{(j)}) \end{aligned} \tag{3}$$

where $1 \leq i \leq N$, $1 \leq t \leq T$ and $1 \leq j \leq K$. $x_{it}^{(j)}$ denotes the j-th explanatory variable measured at time t in the i-th time-series. The number of parameters is reduced as in the case of de-meaning. This implies that computation time for robust regression algorithm remains feasible (Bramati and Croux, 2004). Therefore we can run a robust estimator (and regress $\tilde{y}_{it}$ on $\tilde{x}_{it}$ to identify the outliers). For this purpose we will apply the LTS estimator on centered data. LTS estimator is defined as $\hat{\beta}_{LTS}$ which minimizes the sum of the smallest h squared residuals:

$$\hat{\beta}_{LTS} = arg \min_{\beta} \sum_{k=1}^{h} [(\tilde{y}_k - \tilde{x}'_k \beta)^2]_i,$$

where

$$[(\tilde{y}_k - \tilde{x}'_k\beta)^2]_1 \leq [(\tilde{y}_k - \tilde{x}'_k\beta)^2]_2 \leq \ldots [(\tilde{y}_k - \tilde{x}'_k\beta)^2]_i \leq \ldots \leq [(\tilde{y}_k - \tilde{x}'_k\beta)^2]_{NT}$$

are ordered squared residuals (Rousseeuw, 1983). The value $1 \leq h \leq NT$ is a trimming value. As mentioned before, this estimator has a breakdown point attaining 50%. Moreover, for $h = [NT/2] + [(K + 1)/2]$ the LTS reaches the maximum possible value for the breakdown point. However, in practice it appears that we do not need maximum breakdown point and we can select h larger. A default choice can be $h = [3NT/4]$ or $h = [4NT/5]$, making it possible to cope with up to 25% of outliers (or 20%, respectively) or we can select h sufficiently small to reach an acceptable coefficient of determination of the model. The LTS estimator in its basic version is regression, scale and affine equivariant. However, due to the nonlinearity of the centering transformation by the median β_{LTS} is only scale equivariant (Bramati and Croux, 2004)[2]. While this method's extreme demands on both the memory and the speed of computers was the reason why it was not used very much in the past, at present evaluation of this estimator is usually not difficult thanks to new speed-improving computer technology.

Our technique as well as LTS in its basic form can be used in many different ways. We can use it directly: centering the data by median, using least trimmed squares and

[2]Bramati and Croux (2004) have presented an improvement of our LTS estimator in order to increase the statistical efficiency and employed the Within Group Generalized M-estimator (WGM) and With Group MS estimator (WMS). WGM estimator applies LTS regression for the studentization. WMS estimator uses alternately the M-estimators for the categorical variables and S-estimators of regression for the continuous ones. In contrast to the WGM estimator it is also affine and regression equivariant and is suitable for panel data. Full algorithm can be found in Bramati and Croux (2004).

discovering the outliers. Then we can work with the rest of the data and regress dependent variable on other regressors (Benáček and Víšek, 1999; Benáček and Víšek, 2000; Verardi and Wagner, 2010). However, it can also be employed in a different way by using outliers only as a diagnostic tool to recognize a "suspicious" behavior of an agent. In other words, we can drop out whole groups of agents (firms, countries, etc.) where most of the observations are earmarked as outliers and work with the rest of observations (Michalíková and Galeotti, 2010). In this paper we will identify the outliers in centered model, separate them and then use the LTS on the rest of data.

The final focus will be on the question what is expected of our new method. Firstly, this technique makes it possible to recognize outliers which are not able to be detected by eye or by means of traditional regression diagnostics. Once we have separated the observations (considered to be outliers), we can monitor if this subpopulation of data is subject to certain systemic regularity. We may e.g. be primarily interested if a group of countries behave in an idiosyncratic way. These findings can help to draw conclusions about specific behavioral patterns in analyzed agents. Secondly, we may be watching if the removal of outliers brings some improvement in the estimated regression model. For example, we may monitor the decrease in the residual sum of squares, the increase in the coefficient of determination and thus an improvement in the quality of the basic model. Furthermore we may monitor the stability of estimated regression coefficients in the case of increasing h. Last but not least, we wonder if p-values of estimated regressors are improving as the outliers are dropped out from the model.

3. The Factors of Growth of Family Businesses

3.1 Family Business and Small and Medium-sized Enterprises

Up to the 1930s, family businesses were the dominant form of capital ownership throughout Europe. As one half of our analyzed countries are post-Communist ones, we must be aware of their specifics. Shaken by the Great Crisis, the rise of Communism, the Second World War and the post-war waves of nationalization and government interventions, these businesses in a large part of Central Europe declined in importance as the attention of policy-makers hinged on corporations. An important break occurred in the early 1990s with the fall of the Communist empire.

Family-led enterprising was supposed to get a new boost as the pro-market forces triumphed. This was an error in judgement: since the 1990s, incumbent and emerging large-scale capitalism throughout the world has received a special spur from globalisation. Authentic small-scale family businesses were often squeezed out of the space for rapid development by surviving, former state-owned enterprises which were converted to corporations owned formally by thousands of petty stock-owners and a thin class of insiders with dominant stakes (Benáček, 2006). Post-communist countries in Europe were obsessed with the privatization of inefficient state monopolies, thus establishing recourse to a new primitive accumulation of capital that did not relinquish the resources of labor and capital so necessary for the rise of family business. The parallel opening-up of globalisation offered new windows of opportunity to large enterprises dominated by managers. In the late 1990s the floodgates to expansionary monetary policy opened up and government debt grew. In parallel, entrepreneurship in the majority of advanced capitalist countries led by large financial institutions turned either to assets whose prices could rise in a vicious circle of supply and demand or to an alignment with public administrators where achieving social efficiency was an objective that could be sacrificed, which was a move similar to the development in post-Communist countries. This was a very different style of management compared to small businesses.

Both bubbles finally burst, which drove the economies in both developed and post-Communist countries into a lasting recession. It ended in another unexpected event: fiscal rescue packages of an unparalleled size, a credit crunch, liquidity trapped in savings and bureaucratic interventions which handed over the initiative in entrepreneurship in many large enterprises to governments. Governments became the crucial agents for sustaining aggregate spending. Rising taxes, as a consequence of interventions, discriminated against small family business and the middle-classes. The natural expansionary drive in post-Communist small and medium-sized enterprises (SME)[3] that was apparent in the 1992–

[3]In order not to confuse the reader, we will use the following acronymes in this paper: SME – small and medium-sized enterprises that include firms from 1 up to 250 employees. There are two categories of SME that we will test empirically: micro businesses (MB, with 1 to 9 employees) and small businesses (SB, with 10 to 50 employees). We will also talk about small "family businesses" (FB) that relate to a consolidated set of micro and small businesses (firms). It is merely for practical reasons since the union of MB and SB does not have an easily recognized common name and a lot of our statements relate to both groups of enterprises.

2006 period (Benáček and Zemplinerová, 1995) was also influenced by the government policies that were biased in favor of large businesses, thus checking the SME' profit rates.

There is one current problem in all advanced economies: all are faced with the need to revive authentic entrepreneurship in the form of family businesses and to provide incentives for innovative growth and investment in place of government expenditures that became, due to worldwide financial crisis, the most relied-on driver of aggregate demand. In other words, the expectation is that the turnaround in the present recession should come from an increase in domestic aggregate spending and employment in SME dominated by family businesses, which in almost every country have been the main source of employment and job creation, but not the engine of spending dynamics. The main objective of this paper is to address the following question: which economic and institutional factors are associated with the development and growth of family businesses?

3.2 Economic and Institutional Factors of Development of Small Family Businesses

A firm is considered to be a family business if a member of one or more families is its controlling owner, implying a managerial commitment toward the business' overall performance. It includes also the case of ownership by shares when the family controls at least 20% of voting rights and that 20% is the highest percentage compared with other aligned shareholders. The main strength of a family business is the direct accountability and enforcement of property rights, without recourse to moral hazard and asset stripping. It also results in high wage flexibility and effective personal commitment to the wellbeing of the firm. Other advantages are higher ability of family businesses to withstand economic shocks, the commitment to high investment by relying on the family's own savings and to net job creation. In this paper we will use micro and small businesses as proxies of small family businesses. The choice of MB and SB as proxies thus kills two birds with one stone: a) it helps operationalise the basic subject of this study with a very high degree of overlapping; b) it offers a name for the union of MB and SB that does not have an easily recognised common name when a lot of our statements relates to common finding related to both groups of enterprises. At the same time it keeps large family businesses aside because they differ in their managerial operation from MB and SB, which was also not our concern.

It was generally believed that even though SME could provide the majority of jobs, their role in the progress of economies was just of subsidiary importance (Schumpeter, 1942). For a long time, the dominant presumption was that employment in small businesses was negatively related to GDP per capita, causing a bias toward larger enterprises (Lucas, 1978; Acs et al., 1994). We think that these presumptions should be re-considered because they are not consistent with empirical observations. Very similar arguments were used by central planners whose bias towards centralization and monopolization and opposition to entrepreneurship were paramount.

Acs and Audretsch (1988) reached the conclusion that innovations were negatively related to concentration and that innovation increased with the R&D expenditures at a less than proportional rate. Symeonidis (1996) concluded his extensive survey of empirical literature on the alleged advantages of large over small firms with the finding that 'literature survey suggests that there seems to be little empirical support for the view that large firm size or high concentration are factors generally conducive to a higher level of innovative activity' (p. 33). The outbreak of the world financial and economic crisis in 2008 brought a new wave of attention to facts refuting the validity of the so-called Schumpeterian hypothesis about the demise of small entrepreneurship (Schumpeter, 1942: 134–143).

Micro and small businesses (i.e. MB and SB) cover 98.7% of all EU enterprises. In addition, approximately 50% of MB in the EU are formed by the self-employed. Thus, only a negligible number of family businesses (FB) rank in the categories of medium-sized or large firms. Therefore, for a high behavioral correlation between a union of MB with SB and the FB, in the rest of this study we shall use micro and small businesses as a proxy category for family businesses. We will thus distinguish between two types of FB: those ranging in size from self-employed individuals to enterprises with 10 employees (i.e. MB) and enterprises with 10 to 50 employees (i.e. SB). It is necessary to note that we will work with the non-financial private sector only, thus we will analyze an incomplete part of national economies in Europe. For example, our employment statistics (including medium-sized and large firms) represent 61% of all employment in the EU–27 in 2008.

Our objectives in this research will have to be closely linked to examining how FB could contribute to Europe's economic revival and what factors determined their development in the recent past. The macroeconomic conditions for fast growth are associated with two strategies: external and internal. Export-led growth is the most typical and the most successful type of development. The external growth strategy was the main engine of prosperity in post-war democratic Europe and Japan. Later this strategy was adopted in successful countries such as the NICs of South-East Asia, Ireland and post-Communist China, and in nearly all other transition countries.

The internal growth strategy, bearing signs of autarchy, was the crackerjack of Communist economies where high taxation and intensive government spending concentrated on local industries catering for local markets. The internal strategy of development under central command brought them neither growth nor prosperity, even though its main success was in securing extremely high employment rates.

With respect to how the two mentioned strategies relate to private businesses, export-led growth is the driver of expansion in large enterprises, because they are significantly more export-oriented than SME. For example, Eurobarometer (2009) reports that only 8% of all SME were engaged in exports and their income from exports made up less than 5% of their turnover. On the other hand, the majority of large enterprises were engaged in exports and their income formed 20% of the turnover. Generally speaking, SME can be important subcontractors for exports, but their role in direct exports is subsidiary. In contrast, SME are at the core of domestic aggregate demand in the non-traded sectors that generate most of the GDP.

Breaking away from the present sluggish aggregate demand and credit crunch in nearly all European countries is conditioned by finding a self-sustained replacement for the present reliance on government fiscal and monetary injections into private resources and intermediation. The revival of corporations and their exports, shielded by the dismal Schumpeterian hypothesis, is an important but not sufficient strategy. It is necessary to find a new class of innovatory agents, close to economic grassroots, whose activities would be conducive to a break-through in growth and employment, similarly as it happened in China. We presume that European FB are largely destined for this kind of a mission.

A successful model of development leading out of recession can be thus outlined as follows: internationally open large enterprises which are also the bearers of domestic comparative advantages provide domestic economies with their primary impetus for strong growth via a revival in international trading. As a secondary repercussion, their outsourcing and consumer spending is then transformed by means of a multiplier into the performance of non-traded sectors which are represented primarily by FB. In order to adjust to rising aggregate demand, all enterprises have to invest – which initiates a tertiary boost to growth. Thus, the success in development is characterized by an interaction of large plus medium and family businesses, all of which play a specific role in the process. In all of them the decisive engine are entrepreneurs that are able to make up for both the emerging market and government failures.

The world economic crisis slashed the EU exports of goods and services from previous annual growth rates close to 6% to a mere 1.6% in 2008 and a decline of -14% in 2009 (Eurostat, 2010). This severely damaged the trust in the growth leadership of large businesses. Government deficit spending compensated partially for the missing exports, but there was no other segment of economy capable filling the looming gap in both aggregate demand and efficiency. With the exception of Poland, nowhere was the private sector able to act as an agent of sustained growth. Nevertheless, SME have saved many European economies from drastic falls in employment.

The expected mild economic recovery of the GDP growth of 1.6% in EU–27 in 2011, driven mainly by exports, will require that a complementary resource be started up to substitute for the fading and inefficient government deficit spending. We predict such a resource to be in the revival of authentic entrepreneurship that used to be represented by FB. That revival should actually be traced back to 1948–1965, when internally driven development in FB was still dominant and had not yet been crowded out by globalized businesses.

This paper will analyze which factors helped SME in micro and small categories achieve growth in the past. We will measure the growth of MB and SB by their employment figures or, alternatively, by their net output. In our view, the expanding FB will have to take over some of the resources relinquished by large businesses that were not able to use them efficiently.

3.3 Factors Favorable or Adverse to Family Business Development

Blau (1987) found in his empirical study that the self-employed, numerically the largest group among FB, grew in importance since the 1970s. Later research into SME development concentrated mainly on the differences in self-employment rates among countries or regions. It drew on cross-sectional techniques of estimation that helped explain the differences in employment accrued in time as a result of local specificities, such as different structures in national factor requirements (and endowments), GDP per capita and a series of country-specific institutional factors. Torrini (2005) estimated that the intensity of self-employment depended inversely on the local capital/labor ratio and public sector size. The factors enhancing self-employment were low tax and social security wedge, rising income per capita, high unemployment rates, product market regulation, labor market protection, low fiscal discipline and perceived corruption.

SB development thus appears to be the result of market distortions and as the second best solution to problems of inefficient public administration, it became a heaven for entrepreneurs with tainted managerial capacities. Explaining SB as the outcome of a suboptimal market structure does not in our view seem persuasive, even though the cited factors might play a role. We will try to test a hypothesis that the development of SB could have deeper microeconomic foundations. We traced them to wage and profit structures, and to the competition with large enterprises which pressed 'fringe competitors' to respond with strategies idiosyncratic to smallness that allowed them to withstand the competitive race.

The following theoretical assumptions will be used as guidelines for hypotheses in our empirical tests[4]:

a) General benchmarks for the analysis of efficiency and growth are derived from production functions with labor and capital serving as factors. By applying the cost-benefit principles on factor allocations, entrepreneurs consider their Pareto-efficient outcomes subject to various scopes of activities. Their outcomes have direct repercussions on the growth of output and employment.

b) The objective function of entrepreneurs is profit maximization. Even though entrepreneurs maximize net profits for making their decisions about production, the maximization of gross capital returns per value added (KR/VA), where capital K is defined by reducing total labor compensation (W) from the net income of enterprises (VA)[5], is still a plausible criterion because it represents a social efficiency of capital allocated among businesses of various scales.

[4] A more detailed theoretical explanation of these theoretical undeprinnings can be found in Benáček and Michalíková, 2010, available at `http://www1.ceses.cuni.cz/benacek/SME_2010_Benacek.pdf`

[5] Net income (i.e. the value added) of enterprises is defined as difference between sales S and material inputs M.

c) We could set up a hypothesis that countries with higher KR/VA in any group of FB could also see the stronger development of FB. If the space for $K = VA - W$ increases (e.g. as a result of innovation or lower transaction costs), it will induce the entrepreneurs to expand their employment in order to bolster the sales and net output. This will result in an increase of labor income W and a raise in the wage rates per labor W/L. Nevertheless, is such a behavioral hypothesis valid for both employment and net production in reality? A very high KR/VA may also imply a shortage of capital (undercapitalization and/or too expensive capital). Then high capital returns could act as an impediment to FB growth, i.e. KR/VA could be negatively related to growth in employment.

d) FB development is not autonomous in isolation within their own SME categories because what also matters is an FB's relative performance vis-a-vis large businesses (LB). Small FB compete with LB for limited nationally available economic resources. Assuming the prices of products and capital for FB are exogenously given, the competition lies in costs and relative productivities. We can describe two specific 'imperfections' of the factor markets in FB: the access to capital is more expensive for FB than for LB. This is in fact a normal arrangement that reflects higher transaction costs of FB in their access to money market. Therefore FB must compensate for this defficiency by reducing some other costs. This will fall on lower wages in FB, which is their second specificity.

e) Thus the cost competition between FB and LB will depend on how well FB are able to depress wages, thus creating a wage gap relative to LB in order to gain a cost advantage once the prices of products are given. We will test whether (lower) wages per worker in FB related to (higher) wages per worker in LB are associated with higher growth in FB. Thus we can raise a hypothesis for empirical testing of FB development assuming that L_{FB} is a negative function of relative wage rates $(W_{FB}/L_{FB})/(W_{LB}/L_{LB})$. It is an outcome of an assumption that LB and FB differ in their micro-technologies, which are driven by different relative factor prices, i.e. different ratios of wage rates per capital rental rates. Thus the isoquants in FB tend to be capital-saving while in LB are labor-saving that at the end makes the former net job creators.

f) Another hypothesis about the determining factors of growth in FB that we will test concerns the degree of general economic development represented by GDP per capita. We could then verify whether rising prosperity is a factor that enhances or retards the development of FB.

g) Contemporary economics stresses the importance of institutions, as administrative bodiesdefining the 'rules of the game' or incentives whose purpose is to reduce uncertainties and transaction costs in business interaction (Stiglitz, 1998). National institutions are important factors that may have both positive and negative impacts on businesses of different sizes. They can be associated with excessive regulation, barriers to trading freely on markets, volatile currency, high taxes, public spending rigged by corruption, inflexible labor market, and more. The analysis by Torrini (2005) confirmed that the development of MB closely depends on the institutional setup but such a dependence is country-specific.

Thus three economic indicators related to internal rates of gross capital returns (KR_{FB}/VA_{FB}), relative wages rates $(W_{FB}/L_{FB})/(W_{LB}/L_{LB})$, and GDP per capita, plus ten institutional indicators are selected as causal factors related to the growth of FB, i.e. the MB and SB.

4. Results of Econometric Tests

4.1 The Review of Variables and Models for Empirical Testing

In this chapter we will test empirically the extent to which the growth in FB in 28 European countries was influenced during 2002–2008 by the three above-described economic factors and by the risks or benefits associated with ten country-specific and time-specific socio-political institutions. Our estimations will search for common behavioral characteristics of sub-panels of countries and their observations in a sequence of time. Our data cover the non-financial business economy. Sources of the data are: Small Business Act Factsheets (Eurostat and DG Enterprises and Industry); GDP statistics of the World Bank; Database on the Economic Freedoms (The Heritage Foundation). The robust version of the fixed effect panel data model will be used for the estimation of coefficients.

Our dependent variables are computed from aggregated data of production statistics for MB, SB and LB, representing the indicators of FB growth in observed countries related to FB employment and the FB value of net output (i.e. value added). We assume that the smaller the business is, the more labor-intensive is its production and the lower is its net productivity per worker.

Dependent variables

- L_{it}^{FB}: Employment in $FB = \{MB, SB\}$ quantified by the number of workers in country i and year t.

- VA_{it}^{FB}: The value of net output (i.e. the value added) in MB or SB in country i and year t.

Economic explanatory variables

- $KR_{it}^{FB}/VA_{it}^{FB}$: Gross capital returns in analyzed businesses per value added
- $LC_{it}^{FB}/LC_{it}^{LB}$: Relative rates of full labour costs ($LC = W/L$), i.e. total labor compensation per worker in FB divided by similar compensation in LB
- GDP_{it}/PC_{it}: GDP per capita in purchasing power parity.

Institutional explanatory variables

- $Regul_{it}$: Business freedom (regulation) index
- $Trade_{it}$: Trade freedom (trade barriers) index
- $Monet_{it}$: Monetary freedom (inflation and price control) index
- $Govern_{it}$: Freedom from government (public spending) index
- $Fiscal_{it}$: Fiscal freedom (taxation) index
- $PropR_{it}$: Property rights index
- $Invest_{it}$: Investment freedom (capital controls) index
- $Financ_{it}$: Financial freedom (private banking security) index
- $Corrupt_{it}$: Freedom from corruption (perception) index
- $Labour_{it}$: Labor freedom index

N.B.: Institutional variables are the proxies of economic "freedoms" ranging in their values $\langle 0, 100 \rangle$. The higher the percentage index, the more liberal and pro-market the local institutional arrangement.

The selection of 28 countries of Europe is highly representative, covering nearly all of the EU and potential accession countries (see Table 1). The estimation will point to

ALL	Advanced Europe (14) + Emerging Europe (14)
Advanced Europe (14)	Austria, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom
Emerging Europe (14)	Albania, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia

Table 1: List of countries included in the analysis

potential factors and their effects on augmenting or diminishing the SME roles in European economies.

The first two explanatory variables are relevant for decision-making in enterprises. Gross capital returns are closely related to profits and profits form the basis for investments into physical capital and R&D. High profits also motivate FB owners to increase the scope of their production and gain in scale economies which should imply growth. Reasons for having a high share of gross capital returns on the value added can be: a) Increasing labor productivity without compensating workers at a proportionally higher wage rate – that would imply high profits; b) Decreasing the marginal product of labor by overstaffing, which is reflected in disproportionally lower average wages in the enterprise. That would imply a high cost of capital that burdens the firm; c) Hiring and paying labor outside official contracts, which slashes total labor costs.

As a result of the existenece of wage gap, FB are pressed by the very nature of their businesses to move between all three strategies, which brings an outcome that gross capital returns per value added are higher in MB than in SB and higher in SB than in LB. For different reasons that drive KR/VA upward, we cannot be sure whether this variable is related to FB growth negatively or positively.

The second variable LC^{FB}/LC^{LB} tests the relevance of low (reported) wages and of the gap in FB wage rates trailing behind LB. We can expect to observe a wide range of cross-country differences in that relationship. What matters is whether higher labor cost gap in FB is a driver or a retarder of FB growth. Once again we cannot be sure a priori about the nature of its sign.

The third variable points to a general trend in development. Our only macroeconomic indicator is substantiated on theoretical grounds elaborated by Lucas (1978), and followed by Acs et al. (1994) and Torrini (2005). In our case this variable proxies the purchasing power, instead of a supply-side variable representing the capital endowments. Then we should expect its sign to be positive.

The remaining ten institutional variables are relevant for government policy-making. The central idea behind the choice of institutional variables is that institutions as man-conceived factors can have a two-pronged impact on businesses: as public goods or as public bads. The departure from largely macroeconomic to microeconomic explanatory variables representing incentives or policy instruments, became recently a standard tool of econometric analysis (Blau 1987; Robson and Wren 1999; Davis and Henrekson 1999). All our institutional variables are based on their perceived qualities of allowing for market and entrepreneurial freedom, once the coefficient is positive. Even though we can assume that more liberal economies grow faster, some studies of SME have revealed that very small businesses are not related to all indicators of free market economy in a positive way (Torrini, 2005).

Now we will present the results of our robust regression analyses. The test consist of four models related to micro and small enterprises, whose specifications are as follows:

$$\begin{aligned}
L_{it}^{micro} &= \alpha_1 (KR/VA)_{it}^{micro} + \alpha_2 LC_{it}^{micro}/LC_{it}^{large} + \alpha_3 GDP_{it}/PC_{it} + \\
&+ \alpha_x (INSTIT_{it}^{var} x) + \varepsilon_{it} \\
L_{it}^{small} &= \beta_1 (KR/VA)_{it}^{small} + \beta_2 LC_{it}^{small}/LC_{it}^{large} + \beta_3 GDP_{it}/PC_{it} + \\
&+ \beta_x (INSTIT_{it}^{var} x) + \varepsilon_{it} \\
VA_{it}^{micro} &= \gamma_1 (KR/VA)_{it}^{micro} + \gamma_2 LC_{it}^{micro}/LC_{it}^{large} + \gamma_3 GDP_{it}/PC_{it} + \\
&+ \gamma_x (INSTIT_{it}^{var} x) + \varepsilon_{it} \\
VA_{it}^{small} &= \delta_1 (KR/VA)_{it}^{small} + \delta_2 LC_{it}^{small}/LC_{it}^{large} + \delta_3 GDP_{it}/PC_{it} + \\
&+ \delta_x (INSTIT_{it}^{var} x) + \varepsilon_{it}
\end{aligned}$$

where $i = 1, \ldots, 28$ are countries, $t = 2002, \ldots, 2008$ are the observed years, $x = \{4, 5, \ldots, 13\}$ indicates the respective number of institutional variable 4 through 13.

4.2 Comments on the Econometric Results

As has been mentioned, our panel data will be estimated with our own robust version of fixed effects. Since our data contains almost all European countries, it can be presumed that fixed effects are a suitable technique of estimation. In Tables 2 and 3 we report the results of four regressions specified above[6]. In each regression we included three economic explanatory variables plus some relevant institutional explanatory variables. These variables were chosen according to the level of significance in individual models. The non-significant institutional variables were dropped from the model. In the first column for each regression we report results of fixed effects model, which was estimated by OLS from the data centered by median. In the following columns, we report the results of Least Trimmed Squares regression, applied on the data centered by median, with regard to different choice of h.

In our analytical tasks we are firstly interested in the technical improvement of models after the outliers were removed. We focus especially on the extent to which the quality of estimation progressed (e.g. how the residual sum of squares decreased and the coefficient of determination increased). We also monitor the stability of estimated coefficients – whether the sign of parameters has changed with increasing h. Also p-values of coefficients may be interesting – are the results more significant with decreasing h? Last but not least, we focus on eliminated outliers – what is their origin and is there a common property among them?

With regard to the results of our estimation in Tables 2 and 3, our first general observation is that parameters are mostly significant. In all four cases, the coefficient of determination (R-squared) has been increasing and thus quality of model improved. In the case of first two models the R-squared moves around 52% (63%, respectively). This is not a sufficiently satisfactory result. Nevertheless, with deleting 5% and 15% of observations in the model for L^{micro} the R-squared shoots up markedly. In the case of model 2 for L^{small} the R-squared increases even more and gets over the value of 74% after deleting mere 10 observations (which corresponds to 5% of the data). This means that in the core of our model, 74% of its variability is explained. In the case of models 3 and 4 the results are even better. After deleting their 25% of observations (which corresponds to 30 observations out of 196) R-squared moves over 93%.

[6] All estimates were obtained by Stata and Matlab

Model	1				2			
Dependent variables	L_{it}^{micro}				L_{it}^{small}			
$h\%$	–	95%	85%	75%	–	95%	85%	75%
Economic								
KR/VA_{it}^{micro}	-0.080*	-0.329***	-0.210***	0.009				
	(0.043)	(0.053)	(0.047)	(0.017)				
KR/VA_{it}^{small}					-0.164***	-0.157***	-0.166***	-0.005
					(0.021)	(0.015)	(0.010)	(0.051)
$LC_{it}^{micro/large}$	-0.346***	-0.398***	-0.318***	-0.157***				
	(0.062)	(0.051)	(0.039)	(0.025)				
$LC_{it}^{small/large}$					-0.330***	-0.167**	-0.016***	0.016
					(0.091)	(0.074)	(0.054)	(0.049)
GDP/PC_{it}	0.509***	0.419***	0.405***	0.377***	0.541***	0.496***	0.407***	0.423***
	(0.039)	(0.029)	(0.021)	(0.018)	(0.035)	(0.026)	(0.003)	(0.017)
Institutional								
MONET	0.003**	0.0003	-0.001*	-0.003***				
	(0.001)	(0.001)	(0.001)	(0.001)				
FINANC	0.001**	0.002***	0.0006**	0.0004**	0.001**	0.001**	0.001**	0.001
	(0.001)	(0.001)	(0.0003)	(0.002)	(0.001)	(0.0004)	(0.0003)	(0.001)
LABOR					-0.001	-0.001	-0.002**	-0.001***
					(0.001)	(0.001)	(0.001)	(0.0004)
Number of obs.	196	187	167	147	196	187	167	147
Adj. R^2	0.525	0.603	0.700	0.772	0.634	0.748	0.751	0.837

Table 2: Robust fixed effects regressions - models 1 and 2. Notes: The value for $h\%$ denotes how many observations were included into data set. * significant at 10%; ** significant at 5 %; *** significant at 1 %. Standard errors are in brackets. Fixed effects are not reported. Variance inflation factor does not suggest any problems with collinearity in regressions. Dependent variables and GDP per capita are in logarithms.

The convergence of all models testifies that there exists a dominant pattern of behavior among European FB that offers a valuable description of their growth mechanism. Let us turn our attention to individual models in more detail. We wonder if the estimated coefficients are significantly modified with increasing h. We can see that it is not always the case. If we focus on the signs of parameters, only in one case – in that of the coefficient of KR/VA in model 4 – the sign is unstable. Such a counter-intuitive reversal in sign could be, hypothetically, a result of multicolinearity, but variance inflation factor (VIF)[7] refuted that possibility. Therefore, we can infer that among small businesses there was a small (but highly influential) subpopulation of agents whose output responded to capital returns in an inverse direction from the majority of firms, which is a paradox. In the rest of regressions the values of estimated parameters differ with decreasing h only slightly and the majority of coefficients seem to be stable (relative to the threshold of tolerance).

As has been mentioned, parameters in models are mostly significant, namely in the initial models where all observations are included. In four models we use altogether 11 different variables. All three economic variables prove their clear dominance. The role of institutional factors seems to be only subsidiary, which is an unexpected finding of high importance. It signals that small family businesses are deeply dependent on market performance and policies are not so important in changing their strategic behavior.

Only four out of the total of 13 selected explanatory variables have problems with complete insignificance. All of them are institutional factors. On the other hand, we are fully satisfied with the significance of variables in the case of economic explanatory variables. Exceptions are in model 2 for SB where deleting 25% of observations destroys the significance of two economic variables and in model 1 for MB where after deleting 25% of observations the variable KR/VA becomes insignificant. It seems that our data in models of employment are not strictly homogeneous. The remaining economic variables in models 1 and 2 are highly significant.

Variables KR/VA and LC have negative signs in models 1 and 2. This implies that job creation in small FB is conjoined with low pretentions to both capital returns and wage requirements. Reversing the argument, high wages and high capital yield requirements are impediments to higher employment in FB. It is obvious that an intensive mechanization

[7]Variance inflation factor (VIF) is common way for detecting multicollinearity. VIF is computed from the covariance matrix of parameter estimates (O'Brien, 2007).

crowds out workers similarly to rising wages. Thus saving on machines and prudent wage policy are traditional recipes for high employment in FB. There is also an important proviso to be added: a sustained or even widening gap in labor costs relative to large enterprises combined with lower capital endowments is a knife-edge enterprise strategy for gaining competitiveness in the short term that calls for low costs and prudence in expenditures on the one hand. On the other hand, too much of both endangers the quality of investments and the availability of skilled workers that cut on productivity growth in the long term. Our results reveal a possibility for a paradox of development: measures for a high employment growth can be in conflict with high output growth. A crucial piece of information is added by the third economic variable: rising GDP per capita enhances the employment in both types of FB. We can see that FB were the leading drivers of job creation throughout Europe during the observed period.

As far as institutional variables are concerned, their importance was found to be much weaker when compared to economic variables. The conditions for job expansion in micro business are also in the prudent monetary policy (that sustains low inflation) and in the existence of efficient financial services. A similar conclusion can be drawn about easy access to financial intermediaton in model 2 for small businesses. On the other hand, high labor market flexibility is not compatible with employment growth in the majority of SB.

The three most powerful findings occurred in models 3 and 4 (Table 3) explaining the mechanism of growth in net production in MB and SB. Firstly, our models point to the existence of a trade-off between employment and output expansion because the signs for the first two economic variables reversed from negative to positive. Secondly, the coefficients for GDP per capita increased approximately three-fold in their value, pointing to a high elasticity of FB output growth to aggregate demand. Thirdly, the results in Table 3 imply that value added VA is more sensitive to low labour costs LC (and with it to labour efficiency) than to high capital returns (capital efficiency). Therefore, by consolitating these results, we can draw an implication that increasing aggregate demand is driving production (and therefore probably also the profits) in FB more than its employment. Thus the natural market forces keep the FB biased more towards the net output than to the net employment growth. A social preference to reverse this bias (especially in times of crises with rising unemployment) implies the need for policy measures that would give the price of labour relative to the price of capital a higher cost advantage. In contrast to

Model	3				4			
Dependent variables	VA_{it}^{micro}				VA_{it}^{small}			
$h\%$	–	95%	85%	75%	–	95%	85%	75%
Economic								
KR/VA_{it}^{micro}	0.301***	0.299***	0.277***	0.503***				
	(0.072)	(0.064)	(0.044)	(0.073)				
KR/VA_{it}^{small}					-0.105***	0.052	0.456***	0.452***
					(0.032)	(0.148)	(0.128)	(0.098)
$LC_{it}^{micro/large}$	0.448***	0.376***	0.388***	0.575***				
	(0.103)	(0.087)	(0.061)	(0.063)				
$LC_{it}^{small/large}$					0.631***	0.408***	0.410***	0.478***
					(0.138)	(0.129)	(0.108)	(0.083)
GDP/PC_{it}	1.736***	1.552***	1.404***	1.528***	1.737***	1.576***	1.507***	1.386***
	(0.067)	(0.060)	(0.045)	(0.036)	(0.054)	(0.045)	(0.038)	(0.033)
Institutional								
MONET	0.004**	-0.001	-0.002	-0.003**				
	(0.002)	(0.002)	(0.002)	(0.001)				
CORRUPT	0.005***	0.003**	0.001	0.001				
	(0.001)	(0.001)	(0.001)	(0.001)				
GOVERNMENT					0.002*	0.002**	0.001	-0.0001
					(0.001)	(0.001)	(0.001)	(0.001)
INVEST					0.001	0.001	0.0003	0.0007**
					(0.001)	(0.005)	(0.0001)	(0.0003)
Number of obs.	196	187	167	147	196	187	167	147
Adj. R^2	0.823	0.825	0.880	0.938	0.866	0.877	0.909	0.934

Table 3: Robust fixed effects regressions - models 3 and 4. Notes: The value for $h\%$ denotes how many observations were included into data set. * significant at 10%; ** significant at 5 %; *** significant at 1 %. Standard errors are in brackets. Fixed effects are not reported. Variance inflation factor does not suggest any problems with collinearity in regressions. Dependent variables and GDP per capita are in logarithms.

that, policies offering the FB an easier access to capital will not boost the job creation.

The growth in net output in FB is underpinned by high gross capital gains per value added, which should be complemented in the medium-run with upward wage concessions (i.e. pay-rises), thus forming a virtual circle of investments, output growth, high returns and rising wages. High GDP per capita is a crucial catalyst for such development accompanied by low corruption in the case of model 3. The constraints on monetary policy are not compatible with output growth in the 75% of micro business. Our last model deals with output growth in SB and the role of three economic factors is similar to the previous case. However, institutional variables are not significant with the single exception of high government spending. Thus corruption or financial intermediaton are not found to be a significant factor of FB development.

Finally we will focus on observations which have been dropped out from the model. Table 4 and Table 5 compare some outliers excluded from estimation by LTS. There are six countries that are generating the majority of outliers: Albania, Croatia, Greece, Latvia, Romania and Slovakia. With the exception of Greece they belong to countries of emerging post-Communist Europe that in the past had problems with macroeconomic stability and EU accession. Let us look more closely at their most apparent similarities that relate to FB. These countries differ in their high growth of employment. Thus job creation in FB during 2002–2008 was faster in these emerging countries compared to other countries. Such a growth can be explained by their lagging in FB development prior to 2002. In the case of value added this growth was even more significant. Revealed heterogeneity in data can be caused by a different method of measurement of economic or institutional variables, or by a very different pattern of behavioral patterns of FB in the countries mentioned.

It is possible to separate the original data into more subpopulations and run additional analyses to get information about countries with different behavior. One possibility is to segregate observations which were identified as outliers and estimate the factors of development of this smaller sample. In this case we run 4 additional regression analyses with 25% of observations (=49 observations) which we excluded out of data set for each dependent variable. Countries which were included into these additional regressions can be found in Table 4. The second possiblity is similar but in this case we take the subset of countries which have been excluded out of data set the most often. These countries are summarized in Table 5 and include Albania, Croatia, Greece, Latvia, Romania and

	Model 1			Model 2			Model 3			Model 4		
$h\%$	95	85	75	95	85	75	95	85	75	95	85	75
Albania	2	5	6	1	5	6	1	3	3	2	2	3
Bulgaria				1	2	4				2	3	5
Croatia	1	2	2		3	3		4	5	1	1	2
Cyprus						1			5			
Czech Rep.		4	5			2						1
Denmark			1					1	3			
Estonia		1	3	1	1	2		1	1		1	2
Finland											4	4
Germany								1	2			2
Greece				2	6	6			1		3	6
Hungary			2									1
Ireland			2	3	3	3		3	5			
Italy						1						
Latvia		3	5			2		3	4	1	2	3
Lithuania			1								1	3
Malta						1						
Netherlands	1	1	4		3	3					1	2
Norway						1	4	4	7		2	2
Poland						1					2	2
Portugal	2	3	3		1	3			2			
Romania	2	3	3		2	4	3	5	5	3	5	6
Slovakia	1	4	4	1	2	2	1	4	4		2	4
Slovenia			3			2						
Spain		1	2			1			1			
Sweeden		1	2		1	1			1			
UK		1	1									1

Table 4: : Comparison of outliers. The number denotes how many years in a given country has been dropped for selected $h\%$.

	I h%=95	II h%=85	III h%=75	IV maximum for all h%	V minimum for all h%
1	Romania (8)	Albania (15)	Albania (18)	Romania (41)	Italy (1)
2	Albania (6)	Romania (15)	Romania (18)	Albania (39)	Malta (1)
3	Norway (4)	Slovakia (12)	Latvia (14)	Slovakia (29)	UK (2)
4	Bulgaria (3)	Croatia (10)	Slovakia (14)	Croatia (24)	Hungary (3)
5	Ireland (3)	Greece (9)	Greece (13)	Greece (24)	Germany (5)
6	Slovakia (3)	Latvia (8)	Croatia (12)	Latvia (23)	Poland (5)

Table 5: A comparison of certain countries with maximum and minimum number of outliers. The number in brackets denotes how many years in a given country have been dropped in all four models (1–4) together for selected h% in columns I, II and III. Column IV denotes countries with maximum number of outliers in all four models and all three choices of h. Column V denotes countries with minimum number of outliers in all four models and all three choices of h.

Slovakia and we run 4 regression analyses only with these 42 observations (6 countries x 7 years).

The results of these 8 additional regression analysis confirm our hypothesis that both micro and small enterprises can be characterized by diferenct behavior: a) with regard to development of employment or net output; b) with regard to the number of employees (micro vs. small FBs); c) within the subpopulations of outliers. Within of these subpopulations employment is negatively correlated with capital returns and relative labour costs in both MBs and SBs. On the other hand higher net output is joined with higher capital returns and wage requirements in micro family businesses. GDP is significant and possitive in all regressions. These results inside of subpopulations suggest that the estimated paraemters differ rather in the estimated intensities than in signs of parameters. Moreover inside of the subpopulations of outliers we did not confirm significant heterogeneity. Results of all estimated additional regressions can be found in Appendix in Table 6.

5. Conclusion

In this paper we have analyzed the factors that were instrumental for growth in two types of small firms in 28 European countries. It has been revealed that growth related to employment and to net production was conditioned by very different internal incentives. As has been found, schemes (or incentives) targeting high employment can be in conflict with schemes concentrating on the growth in value added.

We have also tested the stability of behavioral patterns in FB throughout Europe. For that purpose we applied a robust methodology for fixed effect panel data models which allowed us to estimate a model where data were contaminated by outliers. Thus we were able to separate the "hard core" of firms grouped by countries from firms subject to different behavioral pattern. The robust method was based on two steps: firstly we had to center the data by median (which is more robust than mean), secondly we applied the Least Trimmed Squares technique with high breakdown point as a robust method of estimation on the centered data.

The third section is a description of the potential role of family businesses in European economies recovering from the financial crisis that forced them to restructure both their internal mechanisms of decision-making, and the organization of industries and public finance. We concentrated on the specificities in the management of micro and small businesses. Several general characteristics related to growth and competitiveness were incorporated in our tests. Family businesses play an irreplaceable role in the provision of employment in national economies. They are the decisive net creators of new jobs and the main absorbers of unemployment – an objective that has been rising in importance recently. Family businesses have lower wages (at least lower reported wages) than in the rest of national economy. Finally, businesses have higher gross capital returns per unit of capital than large businesses, which is a reflection of their more difficult access to financial capital burdened with higher transaction costs.

Based on data for 28 European countries in 2002–2008 we ran a series of econometric tests in which we analyzed how two groups of businesses with up to 50 employees evolved over time by quantifying their growth in employment and net production. We regressed these two alternative indicators of development to a measure of gross capital returns per a unit of value added (as a proxy for profitability, investment and capital intensity) and to the relative gap between labor costs (wages) in small and large enterprises (as a proxy for cost advantages in order to gain competitiveness). In addition, we tested the role of GDP per capita in the development of family businesses and the significance of several institutional variables that represented government policies relevant for the viability of small entrepreneurship. In our econometric analyses we used a robust fixed effect estimator. Our tests concluded with the finding that our three economic explanatory variables were highly statistically significant. With rising h(the number of deleted observations) results have been generally improving as the residual sum of squares was decreasing, the coefficients of determination were rising and the explanatory power of the model was gaining in strength. In the majority of cases the significance of explanatory variables after deleting outliers was improving, pointing to a high degree of homogeneity in the behavior of European firms.

We can conclude from the results of four regressions that job creation in micro and small family businesses depends on a low pretention on capital returns. However, narrowing the gap in labor costs in family businesses relative to large corporations is negatively correlated with employment. In sharp contrast with this, both these economic variables are positively connected with the value added in micro and small business. The higher the gross capital gains per value added and the higher the relative labor costs in FB, the higher their growth in net production is.

Rising GDP per capita enhances both employment and value added in FB, even though the impact on the net output is markedly more intensive. We have also discovered that some less developed post-Communist countries (particularly Albania, Romania, Croatia, Latvia and Slovakia) were subject to highly different behavior of family businesses related to growth than the core of European family businesses which was represented by Germany, United Kingdom, Italy, Denmark and Spain, joined also by Hungary, Poland, Lithuania and Slovenia. In all our sample of countries institutional factors play a marginal role only. Policies for the enhancement of employment in family businesses include low inflation, efficient banking and financial intermediation. On the other hand, corruption is detrimental to the growth in output in the sector of micro firms.

As a final point for discussion, our results imply that after all, hard economic fundamentals (factor costs, labour efficiency and the aggregate demand) are much more important for the development of small family businesses than soft institutional factors. This is in sharp contrast to the performance of large businesses, whose activities are found to be strongly influenced by policies and vertical transfers at the level of public administration, as was observed by Alfaro et al. (2008) or Benacek et al. (2011). Therefore we can presume that the development of small businesses is handicapped vis-a-vis the corporate sector in countries where the government is active in exercising various policies of development and where the conditions for market competition, contestability and low transaction costs are infringed by market power and/or government capture. Therefore, lower exposure of entrepreneurs to industrial policies and to government "favours", and less of government hyper-activity in fiscal transfers, constitute an environment that supports the growth of family businesses. However, once there is a social demand for policies supporting the creation of new jobs, the choice of policies should target the measures decreasing the transaction costs of family businesses for hiring labour and the costs of labour in general.

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Appendix

Model	with excluded observations				with mostly excluded countries			
	I	II	III	IV	V	VI	VII	VIII
Dep.variables	L_{it}^{micro}	L_{it}^{small}	VA_{it}^{micro}	VA_{it}^{small}	L_{it}^{micro}	L_{it}^{small}	VA_{it}^{micro}	VA_{it}^{small}
Economic								
KR/VA_{it}^{micro}	-0.314**		0.356***		-0.231**		0.645***	
	(0.126)		(0.134)		(0.097)		(0.182)	
KR/VA_{it}^{small}		-0.134***		-0.085		-0.024		0.379**
		(0.046)		(0.053)		(0.107)		(0.168)
$LC_{it}^{micro/large}$	-0.794***		0.733**		-0.421***		0.634***	
	(0.206)		(0.360)		(0.069)		(0.133)	
$LC_{it}^{small/large}$		-0.549**		0.550		-0.280***		0.635***
		(0.256)		(0.370)		(0.095)		(0.144)
GDP/PC_{it}	0.687***	0.568***	1.798***	2.001***	0.480***	0.502***	1.521***	1.533***
	(0.088)	(0.106)	(0.197)	(0.134)	(0.037)	(0.037)	(0.072)	(0.056)
Institutional								
MONET	0.010***		0.009		-0.001		-0.003	
	(0.003)		(0.006)		(0.001)		(0.002)	
FINANC	0.005***	0.004**			0.001	0.001		
	(0.002)	(0.002)			(0.001)	(0.001)		
LABOUR		0.016				-0.002*		
		(0.010)				(0.001)		
CORRUPT			0.019***				0.001	
			(0.005)				(0.001)	
GOVERNMENT				0.008*				0.001
				(0.004)				(0.001)
INVEST				0.005				0.001
				(0.005)				(0.001)
Number of obs.	49	49	49	49	42	42	42	42
Adj. R^2	0.719	0.663	0.812	0.886	0.547	0.545	0.804	0.838

Table 6: Additional robust fixed effects regressions with excluded observations. In columns I–IV models with excluded outliers from Table 4, in column V–VIII models with mostly excluded countries from Table 5. Notes: * significant at 10%; ** significant at 5 %; *** significant at 1 %. Standard errors are in brackets. Fixed effects are not reported. Variance inflation factor does not suggest any problems with collinearity in regressions. Dependent variables and GDP per capita are in logarithms.

IV. Credit Support for Export: Robust Evidence from the Czech Republic

Abstract:

The topic of the paper is quite a novel one – it is one of a few empirical academic papers dealing with export credit available in economic literature. Moreover, it is the first analysis of this kind which focuses on transition economies. The paper deals with export credit promotion in the Czech Republic. The development and structure of Czech trade and export support is presented first, followed by an econometric analysis of the gravity model of Czech trade. A panel of 160 countries in 1996–2008 is analyzed and two gravity models of exports in the Czech Republic are estimated, the static model by fixed effects (LSDV estimator) and the dynamic model by System-GMM. Due to ambiguous conclusions we assume that the pattern of behavior of our explanatory variables is not uniform and our data set behaves as a mixture of countries with heterogeneous behavior. This means that traditional techniques of estimation which include all observations into one model do not give significant results. Thus, we use robust techniques of estimation that solve the problem of heterogeneous patterns in data sets. Out of several possibilities we use the Least Trimmed Squares estimator (LTS) with a leverage point. We show that variable guarantees is a significant factor that influences positively the volume of exports in the Czech Republic. Moreover, there exist more variables that affect the size of exports in the Czech Republic. Market forces described by GDP, distance, political risk or gross fix capital formation are significant in our econometric model. We find that higher GDP, short distance or lower political risk have positive impact on Czech exports.

Keywords: export, government promotion, gravity model, panel data

JEL classification: F14, G28, C23

1. Introduction

An important feature common for all former socialist economies was the drastic change in the patterns of their international trade. At the start of economic transition in the early Nineties, all these economies sharply reoriented their trade away from their former Comecon partners (The Council for Mutual Economic Assistance, 1949—1991, was an economic organization comprising the countries of the Eastern Bloc along with a number of communist states elsewhere in the world). They also politically rejected former state-directed and subsidized trade in favor of a free-trade approach. However, in the mid-Nineties the early free-trade sentiment was gone and also a battle for the return to lost markets started. This was the time for new government policies of export support to appear.

This paper deals with this new export support in advanced transition economies using the example of the Czech Republic. Our analysis covers the period from 1996 to 2008. We show that the export credit support provided by state-owned Czech Export Bank (CEB) exercises a significant positive influence on the growth of Czech export while controlling for political risk, trade costs and size of the trading economies.

Our results are based on the gravity model of international trade which has been introduced by Tinbergen (1962) and Pöyhönen (1963). According to the gravity model, trade flow between two countries depends on the economic size of the countries and on "trade resistance" (especially geographical distance) between them. Anderson (1979), Bergstrand (1985), Anderson and van Wincoop (2003) and many others provided theoretical foundations of gravity relationship in the general equilibrium framework instead of the initial motivation based on the physical law of gravitation.

Since "the gravity equation has dominated empirical research in international trade" (Helpman, Melitz and Rubinstein, 2008, p.442), it is natural that it was used by Egger and Url (2006), Moser, Nestmann, and Wedow (2008) and Baltensperger and Herger (2009) in their empirical papers dealing with public export promotion. Baltensperger and Herger (2009) analyze public export insurance in OECD countries and they reach the conclusion that this support promotes exports to high and middle-income countries instead of politically and commercially unstable low-income countries. Egger and Url (2006) concentrate on public export guarantees in Austria between 1996 and 2002. They show that public export credit guarantees have less than proportional positive effect on international trade volume. They predominantly affect the country structure of foreign trade but leave the industry specialization almost unchanged. Moser, Nestmann and Wedow (2008) analyze the influence of export promotion on export in Germany between 1991 and 2003. They conclude that export promotion has a positive influence on export. They also show that the lower the political risk of the target country, the more export it gets.

This paper´s point of departure are the static and dynamic models of Moser, Nestmann and Wedow (2008). In applying their models on data of the Czech Export Bank, we do find some statistical evidence on the effectiveness of public export credit support. A possible weakness of their econometric model (and all other models mentioned in the previous paragraph) may be the assumption of equal importance of all observations in their sample. This assumption is relaxed by the use of robust statistic methods. When robust Least Trimmed Squares (LTS) approach to identifying influential data points is implemented, we conclude that the gravity equation is the appropriate model for the analysis of the export flows and government support in the case of a transition country such as the Czech Republic. LTS approach also confirms that credit support increases export, but distance is still a more influential factor.

The remainder of this paper is organized as follows: In the second section, we provide an overview of Czech export promotion. In the third section we describe the data and the estimation strategy. The fourth section presents the results. In section 5 we discuss the possibility of use of robust estimation and the final section concludes the paper.

2. Czech Export Promotion

Up to the beginning of economic transition in 1990, Czech export was primarily oriented to Soviet Union and other socialist or Soviet Bloc sympathizing countries. The Czech Republic (together with the German Democratic Republic) was the country with the highest standards of living and the best technological traditions in the whole Soviet Bloc. This relative position determined its trade patterns. The release from political dependence on Soviet Union in 1990 led to the break-up of Comecon and to a strong trade reorientation to Western markets. In the case of Czech Republic, the trade flows were also influenced by the break-up of Czechoslovakia and the establishment of independent Czech and Slovak

Republics in 1993.

Between 1993 and 2001, Czech exports to EU countries increased from USD 6.7 billion to USD 22.9 billion. This is an annual growth of 16.2%, while exports to countries outside EU grew only by 2% yearly. At the beginning of the economic transition the Czech balance of payments kept worsening, but between 1997 and 2008 the balance of payment improved. The year 1997 is an important benchmark since it was a year of major changes in Czech economy and politics. The main factors promoting the growth of export after 1997 were foreign direct investment growth and extensive privatization of major state-owned firms in financial and real sectors. In the following years the deficit of the Czech balance of payment was declining and in 2004 the balance of payment achieved a surplus. The annual export of CR has risen from USD 14.4 billion in 1993 to USD 65.7 billion in 2007. The most important changes are connected with machine production, electricity equipment and motor vehicle industries. The balance of these industries got out of deficit into a relatively significant surplus. Moreover, these industries represent the biggest share of total foreign trade.

After the few initial years of economic transition when the emphasis was on dismantling the old system of centrally planned trade and introduction of free trading possibilities, Czechoslovakia and the Czech Republic started to introduce new export promotion system established by Western standards. In 1992 the Export Guarantee and Insurance Corporation (EGIC) was established. In 1995 it was followed up by Czech Export Bank (CEB) and the export support system was completed in 1997 by the creation of the Czech Trade agency.

The Export Guarantee and Insurance Corporation (EGIC) was founded in June 1992 as a state-owned export credit agency insuring credits connected with exports of goods and services from the Czech Republic against political and commercial risks. EGIC as part of the state export support program provides insurance services to all exporters of Czech goods irrespective of their size, legal form and volume of insured exports.

EGIC offers long-term insurance of commercial and territorial risks. Since 2005 short-term credit insurance is covered by its subsidiary Commercial Credit Insurance Company of EGIC. Commercial risk of export is characterized as such risk which is subject to influence from credit recipient's behavior. This risk results from a debtor's financial and economic situation and includes factors such as nonpayment of debit, delay of payment due to insolvency or declaration of insolvency proceedings on the holding of firm. The territorial risk derives from political, macro-economic and financial situation of a debtor country. From the point of view of foreign buyers such risks are out of their control. These risks include, for example, political events such as wars, revolutions, revolts, strikes, problems with transfer of finance to lender, political or administrative procedures that restrain the payment, or natural catastrophes. EGIC abides by the common classification of territorial risks according to the OECD Consensus which classifies countries into 8 categories according to the height of territorial risk. The lowest risk is represented by the group marked as "0" where essentially no territorial risk exists (including USA, Japan, the industrialized economies of EU and, as of 2008, the Czech Republic). On the other hand the highest territorial risk belongs to the number "7" group (including Lebanon, Nepal, Ecuador etc).

The other Czech export credit agency, Czech Export Bank (CEB), is a specialized banking institution for the state support of exports. The CEB mission is to provide state support for exports through the provision and financing of export credits and other services connected with export. CEB thus supplements the services offered by the domestic banking system by financing export operations that require long-term financing at interest rates and in volumes that are not available to exporters on the banking market under current domestic conditions. This allows Czech exporters to compete on international markets under conditions comparable to those enjoyed by their main foreign competitors. The government support of CEB exists in three different forms (government contribution to basic capital of CEB, state guarantees of provided export credit, subsidies from state budget for coverage of differences between accepted and provided credits).

CEB is a member of a working group for export credits OECD and is obliged to follow international rules for government-supported export financing. These rules include e.g. environmental impact assessment, strict requirements within the framework of anti-corruption struggle and rules of IMF on funding of export into low-income countries. The volume of concluded contracts in any single year is influenced by macro-economic development both in the Czech Republic and abroad. Quite naturally, in the years of economic growth the volume of closed contract has been higher. Significant influence also is exercised by the exchange rate. CEB offers a wide variety of credits and supporting services for export promotion. The most frequent type of credit are export buyer credit,

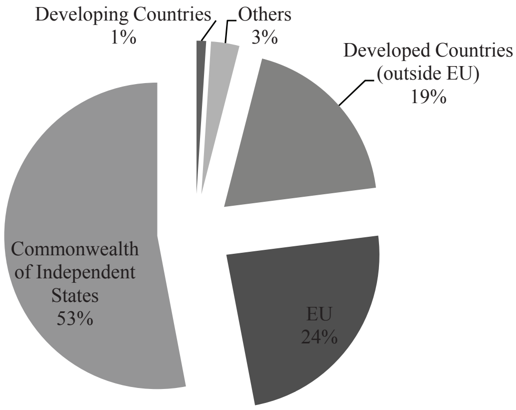

Figure 1:Export Guarantees - Type of Economy of Importing Country

direct export supplier credit or refinancing of export credit.

The youngest of Czech export promotion institutions, Czech Trade, was founded in 1997 by the Czech Ministry of Industry and Trade. Since 1999, Czech Trade has built the network of its own foreign agencies. The main purpose of the Czech Trade agency is the assistantship to Czech companies with their entry to foreign markets, provision of information about these markets, information about the conditions of entry to these markets, information about demand, competition and price levels. Czech Trade also supports the specialized Euroservice department whose principle task is dissemination of information about EU and about the access to help and assistance from EU resources. Czech Trade also organizes export seminars and Export Academy which is one of the tools of the Czech Export Strategy.

The whole system of export promotion is summarized in a governmental document named Export Strategy of the Czech Republic. This strategy is inspired by the systems of export promotions in countries of EU and USA and it reflects the demands of Czech firms which have export-related interests as well. Current Export Strategy for the period 2006–2010 is part of economic policy of the Czech government and is related to the Czech

Strategy of Economic Growth and the Export Strategy of the Czech Republic for the period of 2003–2006. The basic goal of the strategy is the improvement of the country's image, the increase of competitiveness of Czech enterprises and their success on foreign markets and the assertion of economic and business goals of the Czech Republic abroad.

Export (millions USD)						
year	Developed countries	European developing countries	Commonwealth of Independent States	America	Africa	Asia
1996	14 322	5 446	1 079	164	333	647
1997	14 738	5 382	1 157	149	166	610
1998	17 964	5 676	1 042	158	185	602
1999	19 392	4 987	643	121	163	518
2000	21 825	5 282	725	159	140	732
2001	25 103	6 104	850	188	164	951
2002	28 697	6 962	892	182	192	981
2003	36 667	8 879	1 001	190	220	1 301
2004	49 343	13 137	1 637	313	343	1 907
2005	56 136	15 933	2 455	463	549	2 247
2006	67 881	19 881	3 243	532	695	2 450
2007	85 554	26 687	4 548	714	915	3 397
2008	99 111	32 847	6 248	801	1 104	4 001

Table 1: Czech exports by regions.

The evolution and territorial structure of Czech export and export promotion provided by CEB is covered in Tables 1 and 2 and Figure 1. The data in the Tables show that Czech export goes mainly to developed countries – in 2008 the share of export into industrial countries reached almost 70% of total export. On the other hand, export promotion is concentrated more on developing countries exports. Figure 2 shows the ration of newly covered business over goods exports in the case of Czech Republic, Figure 3 shows export guarantees (as newly covered business). The share of export promotion in export into developed countries is on the average only 0.33%, while the share of export promotion in export into developing countries is 3.14%. The other important destination of the Czech

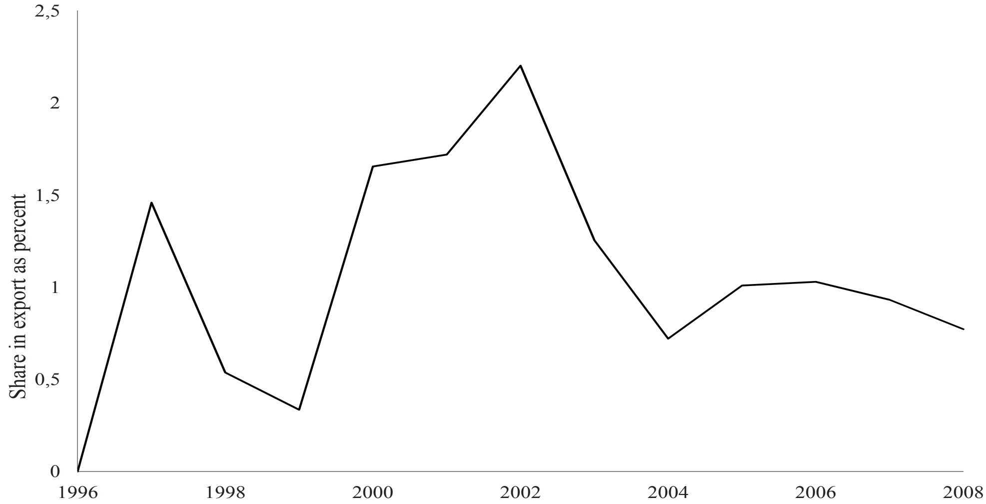

Figure 2: Export Guarantees (Newly Covered Business) as a Shares of Goods Export, Czech Republic

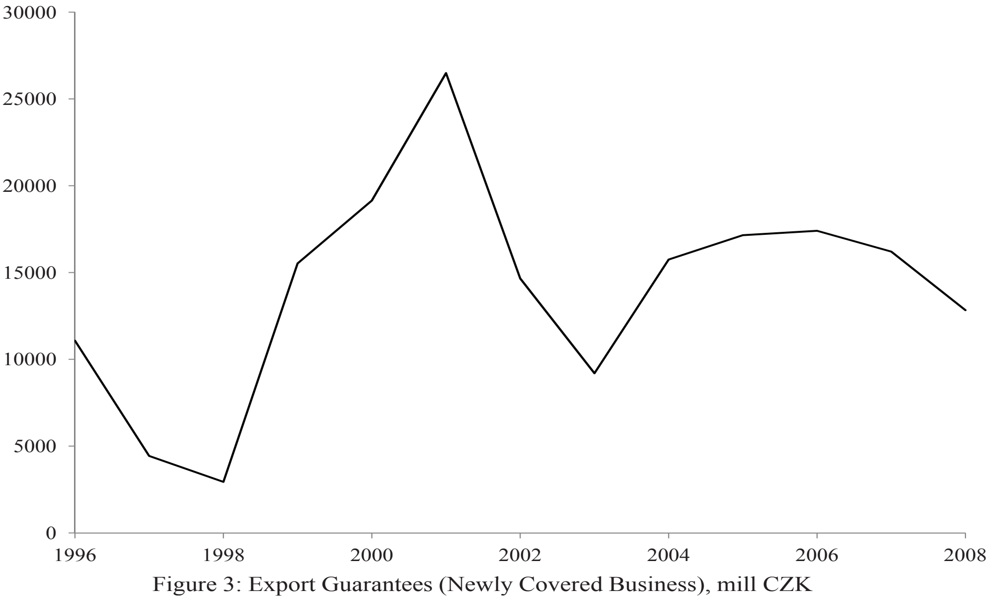

Figure 3: Export Guarantees (Newly Covered Business), mill CZK

	Guarantees (millions USD)					
year	Developed countries	European developing countries	Commonwealth of Independent States	America	Africa	Asia
1996	0	196	0	0	57	66
1997	22	1.5	2.24	0	0.99	108
1998	6	0.09	11.6	0	4.99	63
1999	172	9.57	89	1.3	0.79	208
2000	178	103	99	0.4	0	167
2001	141	120	249	0	0	218
2002	208	102	4	0.3	51.1	114
2003	20	98	11.6	0.2	0	217
2004	195	163	50	0	0	626
2005	449	40	278	0	0.08	33
2006	45	78	627	0	0	131
2007	69	9	618	0	0	243
2008	20	266	614	0	0	44

Table 2: Guarantees according to CEB.

Republic is Central and Eastern Europe (e.g. Slovakia, Poland and Hungary). The reason is the region's recent economic development as well as these countries' geographic proximity and historical ties. Export promotion leads mainly to countries of Commonwealth of Independent States where Russia has the major share. The classification of countries into regions can be found in the Appendix (Tables 7 and 8).

3. Data and Methodology of Estimation

We use an unbalanced panel of 160 countries between 1996 and 2008. The relatively short time series with respect to the relatively large number of countries in our sample must be taken into account. However, the panel data are appropriate for our study because cross-sectional data would make assessments of different changes in time impossible. The time series aspect of the analysis is very important. Economies in individual countries can go through comprehensive changes and reforms during the time periods and new exports can be a function of the past exports. However, the cross-sectional aspect of the present study is also important. The inclusion of more countries into the data is hoped to introduce more heterogeneity.

The data used in this paper come from various sources: the Czech Statistical Office (export), the Czech Export Bank (guarantees), the International Monetary Fund (GDP, population), World Development Indicators 2007 (gross fixed capital formation, manufacturing imports), the Euromoney journal (political risk).

3.1 The Gravity Model and Description of Variables

In this paper, the approach of Egger and Url (2006) and Moser, Nestmann and Wedow (2008) is followed. Parameters of the following modified gravity model are estimated:

$$\begin{aligned} \ln(Exports_{it}) &= \alpha_0 + \alpha_1 \ln(guarantees_{it}) + \alpha_2 \ln(GDP_{it}) + \alpha_3 \ln(dist_i) + \\ &+ \alpha_4 \ln(pop_{it}) + \alpha_5 \ln(risk_{it}) + \alpha_6 \ln(GFCF_{it}) + \\ &+ \alpha_6 \ln(MI_{it}) + \varepsilon_{it} \end{aligned}$$

Descriptive statistics (mean, standard deviation, minimum, maximum and number of observation) are summarized in Table 3. The measure of interdependence is described in correlation matrix in Appendix (Table 9).

The dependent variable is a logarithm of real exports from the Czech Republic to country i in year t. The explanatory variables are as follows:

$\ln(guarantees_{it})$ is a logarithm of real newly granted guarantees by CEB for country i in year t in CZK real prices. This variable describes the sum of all contracts across all products of CEB (different types of loans, guarantees etc). The value of this variable is zero if there are no contracts made. For these cases the logarithmic transformation does not work because logarithm of zero is undefined. A common practice is to remove zero observations out of data set. On the other hand, by removing observations with the value of zero the number of remaining observations would decrease substantially. Another common practice is to add a small value to the data before logarithmic transformation. However, different values can lead to different results (Jongman et al., 2002). Since our

	Mean	Standard deviation	Minimum	Maximum	Number of obs.
Export (mill. USD)	333	1 750	0.000032	35 400	2 043
Guarantees(mil. USD)	3.28	23.1	0	454	2 043
GDP (bill. USD)	233	941	0.000014	11 500	2 043
Population (mill.)	38.48	136.68	0.071	1 328	2 043
Distance (km)	5 477	3 638.95	247	18 197	2 043
Gross fixed capital formation (% GDP)	22.48	7.02	3.48	63	1 725
Manufacturing Imports (% of imports)	68.64	11.24	16.30	92	1 417
Political risk	12.25	6.68	0	25	2 028

Table 3: Descriptive statistics.

non-zero values are very large, we shall estimate three different models with three different constants (0.1, 0.5 and 1 according to Porojan (2001) and Burger, Oort and Linders (2009)) and we will test the hypothesis as to whether the coefficients are equal in different regressions. This variable is crucial for our analysis. The aim of the analysis is to test whether the guarantees provided by CEB support Czech exports. The main motivation for CEB guarantees is the realization of those effective exports which could not be carried out without the support. This variable is expected to be significant with the positive sign of estimated coefficient α_1.

$\ln(GDP_{it})$ is a logarithm of real GDP of country i in year t. This variable is used as a proxy for market size. We assume that the larger the country is, the higher is its export demand. Therefore we expect a positive sign of estimated coefficient α_2.

$\ln(dist_i)$ is a logarithm of distance between the Czech Republic and country i. Variable Distance is calculated as a distance between Prag and capital city of importin country. This variable is used as a proxy for transportation as well as information costs. According to Moser, Nestmann and Wedow (2008) the growing distance leads to the decrease of correlation between foreign and Czech business cycle and this variable is expected to be significant with a negative sign of estimated coefficient α_3.

$\ln(pop_{it})$ is a logarithm of population in country i in year t. The higher the population, the higher is the demand for exports. Thus we expect the significant variable with positive sign of estimated coefficient α_4.

$\ln(risk_{it})$ is a logarithm of political risk index in country i in year t. The value of political risk moves between 25 points (=minimum risk) and 0 points (=maximum risk). The source of our political risk index is Euromoney Country Risk index, which includes political risk as one of its components. Euromoney political risk covers major political factors that may influence the risk of investing in a given country. It is constructed as an average of following six indicators: corruption (ranging from no corruption up to endemical corruption which is a serious drag on stability and a major contributor of political risk); government non-payments/ non-repatriation, which is a measure of the risk government policies and actions pose to financial transfers; government stability (ranging from extremely stable government up to the country which has no functioning government and has already become a failed state); institutional risk, which is a measure of independenc e and efficiency of state institutions; regulatory and policy environment (ranging from extremely consistent, well-enforced regulatory environment and benevolent government policies up to the situation when no regulatory environment exists). All these indicators are evaluated by a large number of individual experts and the final value of political risk index is obtained as an average of those individual evaluations. Countries with higher political risk receive ceteris paribus less exports.The higher the value of variable political risk is, the higher the export to country. Thus we expect positive sign of estimated coefficient α_5. In two cases the value of this variable is zero. Since corresponding values of Manufacturing imports are missing, these two observations are not included into data set.

There are also two additional explanatory variables:

$\ln(GFCF_{it})$ is a logarithm of a country's gross fixed capital formation to GDP, the so called rate of investment. This variable is measured as total value of additions to fixed assets purchased by business, government and households minus disposals of fixed assets sold off or scrapped. Since the value for 2008 is missing, we will use time series merely between 1996 and 2007. We expect positive sign of this variable.

$\ln(MI_{it})$ is a logarithm of a country's share of manufacturing imports in overall imports. We set the hypothesis that countries with a similar factor endowment receive more exports. Since we do not include human capital and physical capital stocks variables, variable manufacturing imports serves as a proxy for a country's relative factor endowment. The higher is the physical capital per labour and human capital per labour variables, the higher is tha share of industry imports. Thus we expect positive sign of this variable.

According to Egger and Url (2006) we suppose that it is a random error term which consists of two parts. Therefore we can write

$$\varepsilon_{it} = \mu_i + u_{it},$$

where μ_i is an unobserved country-specific effect and u_{it} is an error term with zero mean and constant variance.

3.2 Methodology of Estimation

Firstly, we use a standard fixed effect model as a benchmark and estimate a static regression model. The fixed effects model is more appropriate than the random effects model because our panel contains most of the countries and not just a random sample of them (Judson and Owen, 1996). Moreover, the Hausman test rejects the random effect model (Hausman, 1978). As next step we assume that past values of export can be expressed as the process of partial stock adjustment. Therefore, dynamic estimation is used which can reflect the long- run impact and the influence of past values more appropriately. We suppose it takes time for export to adjust to equilibrium or desired level:

$$\begin{aligned} \ln(Exports_{it}) - \ln(Exports_{it-1}) &= \beta[\ln(Exports^*_{it}) - \ln(Exports_{it-1})] \\ \ln(Exports_{it}) &= (1-\beta)\ln(Exports_{it-1}) + \beta\ln(Exports^*_{it}) \qquad (1) \end{aligned}$$

where $\ln(Exports^*_{it})$ is an equilibrium level of the stock of exports and β is less than 1 for stability. The equilibrium level is determined by X_{it}, a vector of k explanatory variables that has been described earlier:

$$\ln(Exports^{*}_{it}) = \gamma X_{it} + e_{it}, \tag{2}$$

e_{it} is an disturbance term including two orthogonal components: the country specific effects and idiosyncratic shocks, $E[e_{it}] = 0$. By reformulating model (1) and model (2) we obtain:

$$\begin{aligned} \ln(Exports_{it}) &= \delta \ln(Exports_{it-1}) + \lambda X_{it} + \varepsilon_{it} \\ \varepsilon_{it} &= \mu_i + u_{it} \\ E[\mu_i] &= E[u_{it}] = E[\mu_i u_{it}] = 0 \end{aligned} \tag{3}$$

where $\delta = 1 - \beta$ and $\lambda = \beta \cdot \gamma$ are coefficients to be estimated, γ is a vector of dimension $1 \times k$, $\varepsilon_{it} = \beta \cdot e_{it}$, μ_i is country-specific effect. Since model (3) estimated by OLS is inconsistent (because $\ln(Exports_{it-1})$ and μ_i are correlated), we estimate the model in first differences:

$$\Delta \ln(Exports_{it}) = \delta \Delta \ln(Exports_{it-1}) + \lambda \Delta X_{it} + \Delta \varepsilon_{it} \tag{4}$$

and the country-specific effect will disappear. However, $\Delta \ln(Exp_{it-1})$ and $\Delta \varepsilon_{it}$ are still correlated. Therefore, we use the generalized method of moments (GMM). The Difference (DIFF) and System (SYS) GMM estimators are designed for panel analysis. They use several assumptions about the data-generating process. DIFF-GMM, proposed by Arellano and Bond (1991), is based on first-differenced variables, thus eliminating the country-specific effect, and instrumenting all potentially endogenous variables with their own suitably lagged levels. However, this estimator has been found to behave poorly in small samples where it is biased. It has also poor behavior in unbalanced panels where one can construct data sets that completely disappear in first differences and it is not possible to include time invariant variables into model. The SYS-GMM, proposed by Arellano and Bover (1995) and Blundell and Bond (1998) combines the standard set of equations in first differences with suitably lagged levels as instruments, with an additional set of equation in levels with suitably lagged first-differences as instruments (Roodman, 2006). The validity of additional instruments can be tested using standard Sargan or Hansen tests of over-identifying restrictions or using Haussmann comparisons between the DIFF and SYS GMM results (Arellano and Bond, 1991). For stationarity verification we apply LLC unit root test (Levin, Lin and Chu, 2002) which is modified for panel data and is derived from Dickey-Fuller test.

4. Empirical Results

This section presents the results of estimation. Table 4 presents the estimates of static model by pure fixed effects and the estimates of dynamic model. Unless noted otherwise, results are compared with significance level 5%. Zero values are replaced by number 1. Sensitivity analyses where zero values are replaced by constant 0.1 or 0.5 can be found in Appendix (Table 10). According to Chow tests the coefficients estimated over the data where zero values are replaced by constants 0.1 and 0.5 are equal to the coefficients estimated over the data where these values are replaced by 1. Since OLS of log-linear model can be biased and inconsistent, we also add Poisson pseudo-maximum likelihood estimator (Santos Silva and Tenreyro, 2006). These results are summarized in Table 10. Variance inflation factor (VIF, O'Brien, 2007) does not suggest any problems with collinearity.

Firstly, we comment on the estimates of static model. Since the coefficient of determination is about 95%, we see that the quality of the model from the point of view of the data variability is good.

The effect of guarantees on export is positive and is statistically significant. This result supports our hypothesis that higher guarantees lead ceteris paribus to higher exports. The variable describing GDP is significant and the parameter is positive. This is consistent with our expectations. The higher the GDP of the importing country is, the more exports it gets. Other significant and positive variables are gross fixed capital formation and population. The volume of export is positively influenced by the volume of population. The distance variable coefficient is significant and negative. This means that higher exports are associated with geographically close countries and that transportation costs are important in Czech international trade. On the other hand, variable manufacturing imports is not significant. We included also proxy variable describing political risk and this variable is significant in static model on the level of 10%. This result is not conclusive enough and it

	fixed effects	system GMM
$\ln(Export_{it-1})$	–	0.503***(0.079)
$\ln(guarantees_{it})$	0.011***(0.003)	0.032*(0.017)
$\ln(GDP_{it})$	0.230***(0.060)	0.270**(0.132)
$\ln(dist_i)$	-4.408***(1.075)	-0.694***(0.134)
$\ln(pop_{it})$	2.956***(0.457)	0.214 (0.169)
$\ln(GFCF_{it})$	0.426***(0.139)	1.090**(0.439)
$\ln(MI_{it})$	-0.368(0.254)	0.199(0.511)
$\ln(risk_{it})$	0.187*(0.112)	0.176(0.229)
Number of obs.	1429	1237
Adjusted/Pseudo R^2	0.950	0.19
Hansen test *(p-value)*	–	0.067
A–B AR(1) *(p-value)*	–	0.000
A–B AR(2) *(p-value)*	–	0.640
LLC test *(p-value)*	–	0.000

Table 4: Estimation of static and dynamic models. Notes: * significant at 10%; ** significant at 5 %; *** significant at 1 %. Robust (White heteroskedastic consistent) standard errors in brackets. Specific effects dummies are not reported. Hausman test rejects the random effects model. Response variable: logarithm of export. All variables are in logarithm. Zero values replaced by number 1.

does not correspond with the importance usually given to political risk in discussions on international trade and its government support.

As has been mentioned, dynamic models allow better understanding of the dynamic adjustment. If the data generating process is dynamic, estimates for both short and long-run effects will be biased (Egger and Pfaffermayer, 2005 and Moser, Nestmann and Wedow, 2008). However, if we test for agglomeration effect and relate current values of response variable to past value of response variable along with other explanatory variable, the OLS estimates of fixed effects estimates will be biased (Nickell, 1981, Baltagi, 1998 and Bond, 2002). Therefore we will use an instrumental variable approach described in the previous section. Following Blundell and Bond (1998) we will use SYS-GMM estimator which uses lagged levels as instruments in the difference equation and additionally first differences for the level equation. Moreover, the use of the SYS-GMM is also partly driven by the high persistence in the export series (Moser, Nestmann and Wedow, 2008). Blundell and Bond (1998) show that a high persistence in the series leads to weak instruments in DIFF-GMM estimator and can thus be subject to bias. The use of additional instruments under the SYS-GMM results in much smaller biases and greater precision in the estimates.

In Table 4 we present the results of System GMM estimates of our dynamic model. We can see that estimated coefficient of lagged variable is significant, positive and less than 1. Thus we can conclude that the data generating process is really dynamic. We check for the validity of instruments by several tests. Firstly, Hansen test rejects the null hypothesis of over- identification of parameters (Hansen, 1982). This result suggests that there are no problems with endogenity in our empirical model and instruments are valid. Moreover, Arellano-Bond AR(2) test does not suggest second-order serial correlation. LLC test reject the hypothesis of unit root (nonstationarity).

The guarantees variable is significant at the level of 10% and positive. This means that guarantees have a positive impact on export. We can express the estimated coefficient as an elasticity: a 1 percent increase in guarantees leads to a 0.064 percent increase in exports. (We are interested in coefficient γ in model (2) which we compute from the parameters in model (3). This coefficient can be expressed as $\gamma = \frac{\lambda}{\beta} = \frac{\lambda}{1-\delta} = \frac{0.032}{1-0.503} = 0.064$). We can compare this result with short-run effect from the previous analysis. Coefficient estimated by fixed effects has the value about 0.011, which is less. Short-run effects are typically substantially lower than the one given. Most guarantees are granted for periods longer than one year (Moser, Nestmann and Wedow, 2008). Since we expected that guarantees should be highly significant factor this result obtained in dynamic model is too inconclusive.

Commentary on the rest of results is as follows: As in the previous analysis, variable distance is significant and negative. As compared with static model, population is not significant. Variable GDP is significant and positive. Czech export is associated with countries with larger market size as measured by economic activity (GDP), not by the number of inhabitants. On the other hand, the negative coefficient of variable distance supports the fact that information costs or transaction costs are higher for countries far from the Czech Republic. Gross fixed capital formation is significant. Variables manufacturing imports and political risk are not significant. These findings indicate that export promotion brings some positive results. However, from the statistical point we cannot answer the question of influence of guarantees explicitly because of fluctuating p- values in both static (significant on the level of 1%) and dynamic model (significant on the level of 10%). Another problematic finding of our estimates is the low significance (or even insignificance) of some explanatory variables such as political risk or population.

5. Robust Model

The results obtained in the previous chapter are not conclusive: in two regression models we have reached p-values 1% and 10% for guarantees, respectively. Estimates obtained by GMM in particular do not give sufficiently significant results. This result is at odds with theoretical models and some empirical evidences which suggest that guarantees should be significant determinant of the international trade. Thus we will test our model through the set of additional regressions. We assume that the pattern of behavior of our explanatory variables in dynamic data generating process is not uniform and our data set behaves as data from a variety of countries with heterogeneous behavior (Benáček and Víšek, 2000 and Michalíková and Galeotti, 2010). This means that it is difficult to estimate our models by using an OLS estimator or by using GMM estimator which includes all observations into one model, in an attempt at obtaining unambiguous estimates. Our setting may be compared to Benáček and Víšek (1999) who analyzed 91 industries of the Czech economy and realized that this population appeared to consist of two segments. The first segment contained industries in which the majority of firms behaved like in a well-functioning market economy while the other segment contained industries where firms behaved still like under socialist paternalism. Therefore, in this section we use one of the robust techniques of estimation that solve the problem of heterogeneous patterns in data sets. Out of several robust estimators available we use the simple Least Trimmed Square estimator (LTS) with a leverage point which was originally developed by Ruppert and Carroll (1980). The advantage of this estimator is high breakdown point (which is the smallest fraction of outlying observation that can cause a breakdown of the estimator) on the one hand and the possibility of excluding whole polluting countries or couples of polluting years out of data set on the other hand. We can describe the algorithm of this estimator as follows.

We consider standard linear regression model

$$Y_i = \beta X_i + \varepsilon_i,$$

where Y_i is the response variable for the i-th case, $X_i \in R^p$ is the vector of explanatory variables for the i-th case, β is the vector of regression coefficients and ε_i is the error term of the i-th case. For an arbitrary $b \in R^p$ we shall denote by $r_i(b) = Y_i - bX_i$ the i-th residual at b. Further, we shall use $r^2_{(i)}(b)$ for the i-th order statistics among the squared residuals. Finally, let us define the LTS estimator by the following minimization:

$$b^{LTS} = arg \min \sum_{i=1}^{h} r^2_{(i)}(b)$$

where $n/2 \leq h \leq n$ and the minimization is performed over all $b \in R^p$ (Rousseeuw and Leroy, 1987 and Víšek, 1996). In other words, in this minimization we are looking for such an argument $b \in R^p$ for which sum of h smallest squared residuals is minimal. Finally, we built an OLS estimator for these h observations.

These methods were not much used in the past because of extreme requirements of the method on both the memory and the speed of computers. Even nowadays, each estimation can take minutes (especially for large data sets). Of course there is a question how to select h. Rouseseeuw and Leroy (1987) showed that putting $h = [(n + 1)/2] + [p/2]$ (where $[a]$ denotes the integer part of a), we obtain maximal breakdown point. However, in practice it appears that we do not need maximal breakdown point and we can select h larger.

Since we are limited by the dynamic form of model (2) (because of the presence of lagged value of response variable on the right side of the equation it is not so easy to exclude some observations out of the data set), we decided to exclude a whole country or countries. Therefore, we will use this technique only as a diagnostic tool and we will find out if the LTS estimator would systematically exclude (almost) a whole country or countries during the period of consideration.

In Table 5 we present results of experimentations with estimating static model using LTS. We decide to report results of LTS estimation with $h = 0.7$. This means that LTS algorithm excluded 30% of observations. On the basis of selected outliers we decided to drop out some countries where more than 60% of yearly observations within one country had been denoted as outliers. Results suggest that these most problematic countries are

	1a	1b	1c	2	3a	3b
$\ln(guarantees_{it})$	0.011***	0.011***	0.012***	0.012***	0.014***	0.013***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$\ln(GDP_{it})$	0.370***	0.175***	0.216***	0.255***	0.203***	0.246***
	(0.086)	(0.057)	(0.059)	(0.079)	(0.058)	(0.060)
$\ln(dist_i)$	-4.739***	-3.986***	-4.100***	-3.556***	-3.321***	-3.873***
	(1.290)	(1.091)	(1.082)	(1.328)	(1.200)	(1.119)
$\ln(pop_{it})$	2.828***	2.858***	2.847***	2.502***	2.581***	2.746***
	(0.521)	(0.469)	(0.461)	(0.550)	(0.522)	(0.477)
$\ln(GFCF_{it})$	0.397**	0.427***	0.434***	0.435***	0.411***	0.361***
	(0.130)	(0.142)	(0.134)	(0.134)	(0.142)	(0.131)
$\ln(MI_{it})$	-0.199	-0.413	-0.429	-0.367*	-0.690***	-0.557**
	(0.212)	(0.269)	(0.253)	(0.211)	(0.247)	(0.252)
$\ln(risk_{it})$	0.94*	0.259**	0.196*	0.292**	0.261**	0.201*
	(0.116)	(0.110)	(0.113)	(0.114)	(0.111)	(0.104)
Number of obs.	1224	1363	1363	1092	1173	1289
Adjusted R^2	0.95	0.95	0.95	0.96	0.95	0.95

Table 5: LTS estimation - static model. Notes: * significant at 10%; ** significant at 5 %; *** significant at 1 %. Robust (White heteroskedastic consistent) standard errors in brackets. Specific effects dummies are not reported. Hausman test rejects the random effects model. Response variable: logarithm of export. All variables are in logarithm. Zero values replaced by number 1.

	1a	1b	1c	2	3a	3b
$\ln(Export_{it-1})$	0.502***	0.523***	0.502***	0.529***	0.534***	0.579***
	(0.109)	(0.087)	(0.075)	(0.141)	(0.093)	(0.086)
$\ln(guarantees_{it})$	0.032**	0.044***	0.036**	0.028**	0.029**	0.029**
	(0.014)	(0.017)	(0.016)	(0.012)	(0.014)	(0.013)
$\ln(GDP_{it})$	0.407***	0.524***	0.607**	0.240**	0.290**	0.272**
	(0.112)	(0.163)	(0.142)	(0.105)	(0.136)	(0.116)
$\ln(dist_i)$	-0.469***	-0.272**	-0.333***	-0.526**	-0.506***	-0.451***
	(0.162)	(0.131)	(0.118)	(0.237)	(0.184)	(0.162)
$\ln(pop_{it})$	0.099	0.008	-0.041	0.391**	0.370*	0.333*
	(0.100)	(0.102)	(0.083)	(0.198)	(0.194)	(0.192)
$\ln(GFCF_{it})$	0.557**	0.839**	0.768**	0.710***	0.735***	0.647***
	(0.260)	(0.354)	(0.315)	(0.249)	(0.260)	(0.227)
$\ln(MI_{it})$	-0.514	-1.662*	-1.609**	-0.644	-0.946	-0.880
	(0.655)	(0.816)	(0.748)	(0.678)	(0.705)	(0.548)
$\ln(risk_{it})$	0.583**	0.612*	0.401	0.519**	0.461*	0.354**
	(0.300)	(0.316)	(0.286)	(0.246)	(0.249)	(0.240)
Number of obs.	1122	1179	1214	1041	1126	1156
Hansen test *(p-value)*	0.081	0.146	0.126	0.169	0.164	0.111
A–B AR(1) *(p-value)*	0.000	0.000	0.000	0.000	0.000	0.000
A–B AR(2) *(p-value)*	0.052	0.370	0.632	0.522	0.407	0.794
LLC test *(p-value)*	0.000	0.000	0.000	0.000	0.000	0.000

Table 6: LTS estimation - dynamic model. Notes: * significant at 10%; ** significant at 5 %; *** significant at 1 %. Robust (White heteroskedastic consistent) standard errors in brackets. Specific effects dummies are not reported.. Response variable: logarithm of export. All variables are in logarithm. Zero values replaced by number 1.

mostly located in Africa, Central or South America or Asia. Therefore, we first estimate separately three models in which these countries are excluded using fixed effects. In the first model we drop out from the data set some African countries[1] in which more than 60% yearly observations have been denoted as outliers by LTS algorithm with $h = 0.7$. Similarly, in the second model we drop out from the data set contaminated Central American countries[2] and in the third model we drop out contaminated Asian countries[3]. These models are summarized in Table 5 in columns 1a, 1b and 1c. We estimated also the model where we dropped out contaminated countries together from Africa, Central America and Asia mentioned above (column 2). Finally we drop out countries where more than 70%[4] and 80%[5] years have been deleted, regardless of type of country or continent (columns 3a and 3b).

Experiments with estimation of dynamic model by GMM using LTS as a diagnostic tool with $h = 0.7$ leads us to the same steps as in previous case and we drop similar countries: small or underdeveloped countries of Africa, Asia and Central America (or South America) with low volume of exports. The results are summarized in Table 6. As in the case of static model we decided to estimate six different models: in columns 1a, 1b and 1c we drop some countries of Africa[6], Central America[7] and Asia[8] (at least 60% of years deleted by LTS), in column 2 we delete countries from all three continents together (60% deleted by LTS). Finally we estimate two models (3a and 3b) where we delete countries in which more than 70%[9] years and 80%[10] years respectively have been

[1] Algeria, Burkina Faso, Burundi, Cameroon, Gabon, Guinea, Malawi, Morocco, Mozambique, Namibia, Niger, South Africa, Sudan, Tunisia, Uganda, Zambia, Zimbabwe, Madagascar, the Seychelles

[2] Barbados, Belize, El Salvador, Grenada, Jamaica, Nicaragua

[3] Brunei, Cambodia, Hong Kong, the Maldives, Mongolia, Oman, Qatar, Singapore

[4] Algeria, Burundi, Burkina Faso, Burundi, Cambodia, Cameroon, El Salvador, Gabon, Grenada, Hong Kong, Jamaica, Madagascar, Malawi, the Maldives, Mongolia, Morocco, Mozambique, Namibia, Niger, Oman, Singapore, Uganda, Zambia

[5] Algeria, Burundi, Cambodia, Cameroon, El Salvador, Grenada, Hong Kong, Madagascar, Malawi, Mongolia, Niger, Singapore

[6] Botswana, Burkina Faso, Cameroon, Central African Republic, Gabon, the Gambia, Guinea, Madagascar, Mauritius, Namibia, Niger, the Seychelles, Sudan, Uganda

[7] Antique Barbuda, Belize, Dominican Republic, Grenada, Nicaragua, Panama, Uruguay

[8] Brunei Darussalam, Cambodia, Oman, Qatar, Turkmenistan

[9] Antique Barbuda, Belize, Burkina Faso, Cambodia, Central African Republic, Dominican Republic, Gabon, Grenada, Guinea, Namibia, Niger, Panama, Qatar, the Seychelles, Sudan, Turkmenistan

[10] Antique Barbuda, Belize, Burkina Faso, Cambodia, Dominican Republic, Gabon, Grenada, Guinea, Niger, Qatar, the Seychelles, Turkmenistan

marked by LTS as outliers.

The tests for validity of instruments do not suggest the problem of over-identification. Hansen test rejects the null hypothesis and Arellano-Bond AR(2) test does not suggest second-order serial correlation.

Now we will comment on the results of both static and dynamic models. We can see that particularly in the dynamic model the significance of some estimated parameters increased. Our key variable export guarantees is significant in all cases. This conclusion is related to both static and dynamic model. We can conclude that after deleting polluting observations out of the data set the result changed and the statistical significance of some parameters increased. The percentage share of deleted states is always under 15%. These states represent small (but influential) subpopulation of countries which makes our data heterogeneous and behaves differently. As in previous case these countries mostly represents regions with low volume of Czech export or guarantees.

The significance of GDP and distance have not changed, these key variables in gravity model are still significant. Distance variable is negative and GDP is positive, which is consistent with our assumptions. An interesting increase of statistical significance occurred in the case of political risk. In half of all the estimated models this variable is significant. Moreover, the reached level of significance is at least 10% excepting one case. The estimated coefficients are positive. It means that countries with lower political risk receive more exports. With respect to the improvement in significance levels we can conclude that heterogeneity pattern of countries has been evidenced and the use of robust regression and elimination of polluting observations is well founded. Moreover, the problem of outlying observations in panel data models is still frequently disregarded. Although the usefulness of robust estimators in linear regression is well established, the development of robust procedures for panel data is still object of running research (Bramati and Croux, 2004).

6. Conclusion

In this paper we analyzed whether public export credit guarantees lead to a significant amount of additional export. Export promotion through export guarantees should mitigate specific frictions in international trade. This stimulates an effort to enhance exports by providing guarantees against export risks. With respect to relevant literature and theoretical models we expect a positive effect of guarantees. For example regions with a higher degree of insecurity should benefit more from insurance coverage. We focused on a case of Czech Republic as a representative of small open post-transition economy with small home market base. While Czech export goes mainly to developed European countries, export credit guarantees push exports mainly to European developing countries.

We estimated the gravity model where export is expressed as a function of country size and trades costs. In addition to basic explanatory variables of the gravity model we included also export guarantees as a measure for the reduction of border barrier trade costs and we also included several additional controlling variables. In comparison with previous empirical approaches we make several important extensions. We worked with unbalanced panel data including 160 countries between 1996–2008.

Firstly we estimated two gravity models of exports in the Czech Republic, static model by LSDV estimator and dynamic model by system GMM. We found out that guarantees is a significant factor that influences positively the volume of exports in the Czech Republic. We found out that our conclusions were ambiguous: while in static model guarantees is highly significant factor, from the results of dynamic model we could not answer explicitly whether the export promotion is successful. Since the estimated coefficients can be expressed as an elasticity, we estimated a short-run elasticity of 0.011. This suggests that increases in the newly covered business of one per cent create additional short-run exports in the range of 1 per cent. In comparison with the long-run (where estimated elasticity reached 6.4%) this effects is small. The explanation for this difference between effects of public export guarantees on export flows is the lag between the time when a promotion is provided and the actual shipment of the good.

There exist additional factors that affect the volume of exports in our model. We found out that market forces, described by GDP, distance, political risk or gross fix capital formation are significant in our econometric model. Specifically, higher GDP, short distance or lower political risk have positive impact on Czech exports. Higher market size offer more opportunities for exporters.

Since we expected that guarantees is significant factor and since the statistical significance of guarantees in the dynamic model was not really convincing, we decided to check by additional tests whether variable guarantees in both short-run and long-run really is (or is not, respectively) significant. Robust regression is an econometric tool suitable for this purpose. Robust estimators can solve the situations where data are polluted by some outlying observations and these observations can totally distort the significance of parameters. Our effort was to confirm or refute the conclusions obtained by LSDV and system GMM. We decided to estimate the gravity equation with the use of robust statistics technique.

Therefore in the second part of our econometrical investigation we used Least Trimmed Squares estimator. This estimator is based on the minimization of squared residuals but the largest residuals are not included in the minimization. This allows the fit to stay away from the outliers. We found estimates of several alternative models where we dropped certain countries out of the data set. These deleted countries denoted as outliers can be mostly characterized by low volume of received export and low volume of Czech export promotion. Geographically, they can be classified into three groups – states of Africa, states of Asia and states of Central America. After the removal of these countries the results were in general more statistically significant, especially in the case of dynamic model: variable guarantees is significant at the level of 1% or 5%. Therefore this set of additional regressions applied on dynamic model supports the conclusion that estimates obtained by system GMM in the first part of the paper were influenced by outliers. We conclude that we are not able to reject the hypothesis that export promotion is successful in both short- and long-run. Export guarantees can reduce the uncertainty of exports. This risk reduction increases exports to (risky) markets where exporting companies would not sell otherwise. Moreover, guarantees which enable an initial export to some country can make future exports to this country more likely. Public export agencies may also bring a positive effects by gathering information on foreign markets. Therefore, they can reduce entry costs.

Moreover, larger economies can be characterized as recipients of higher export and the volume of export declines with growing distance. Political risk variable is statistically significant in three dynamic models. Since the political risk represents an important friction to international trade, the positive sign of estimated parameters supports our hypothesis that countries with higher political risk receive less export. Countries with less stable governments or a higher level of corruption are less likely to attract Czech exports.

At this point we would like to stress the fact that although robust methods are well developed nowadays, there is still shortage of literature and practical implementation of robust methods on panel data. Some new possibilities for improving our analysis offers for example use of bootstrap method for LTS (Skuhrovec, 2010), robustification of GMM or robust methods for fixed effects (Bramati and Croux, 2004). Another obvious extension would be to investigate the effect of additional explanatory variables for our model: infrastructure, trade policy variables or border effects.

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Appendix

Afghanistan, Albania, Algeria, Angola, Antigua and Barbuda, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Belize, Benin, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Central African Republic, Chad, Chile, China, Colombia, Democratic Republic of the Congo, Costa Rica, Côte d'Ivoire, Croatia, Cyprus, Denmark, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Eritrea, Estonia, Ethiopia, Fiji, Finland, France, Gabon, Gambia, Georgia, Germany, Ghana, Greece, Grenada, Guatemala, Guinea, Guyana, Haiti, Honduras, Hong Kong SAR, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Korea, Kuwait, Kyrgyzstan, Laos, Latvia, Lebanon, Liberia, Libya, Lithuania, Luxembourg, Macedonia, Madagascar, Malawi, Malaysia, Maldives, Mali, Malta, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Montenegro, Morocco, Mozambique, Myanmar, Namibia, Nepal, the Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Panama, Paraguay, Peru, the Philippines, Poland, Portugal, Qatar, Romania, Russia, Rwanda, Saudi Arabia, Senegal, Serbia, the Seychelles, Sierra Leone, Singapore, Slovakia, Slovenia, South Africa, Spain, Sudan, Suriname, Sweden, Switzerland, Syria, Taiwan, Tajikistan, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Uzbekistan, Venezuela, Vietnam, Yemen, Zambia, Zimbabwe.

Table 7: List of states.

Developed countries:

Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong SAR, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, Taiwan, United Kingdom, United States.

Developing European countries:

Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Estonia, Hungary, Latvia, Lithuania, Macedonia, Malta, Montenegro, Poland, Romania, Serbia, Slovak Republic, Slovenia.

Commonwealth of Independent State:

Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan.

America:

Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad and Tobago, Uruguay, Venezuela.

Asia:

Afghanistan, Bahrain, Bangladesh, Brunei Darussalam, Cambodia, China, India, Indonesia, Iran, Jordan, Kuwait, Laos, Lebanon, Malaysia, the Maldives, Mongolia, Myanmar, Nepal, Oman, Pakistan, Philippines, Qatar, Saudi Arabia, Syrian Arab Republic, Thailand, Turkey, United Arab Emirates, Vietnam, Yemen.

Africa:

Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Central African Republic, Cameroon, Chad, Congo, Côte d'Ivoire, Djibouti, Egypt, Eritrea, Ethiopia, Gabon, the Gambia, Ghana, Kenya, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, the Seychelles, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe.

Table 8: Classification of states.

	$\ln(Export_{it})$	$\ln(guarantees_{it})$	$\ln(GDP_{it})$	$\ln(dist_i)$	$\ln(pop_{it})$	$\ln(GFCF_{it})$	$\ln(MI_{it})$	$\ln(risk_{it})$
$\ln(Export_{it})$	1							
$\ln(guarantees_{it})$	0.378459349	1						
$\ln(GDP_{it})$	0.7779372342	0.299686696	1					
$\ln(dist_i)$	-0.630496941	-0.322088079	-0.267252431	1				
$\ln(pop_{it})$	0.449185674	0.24500644	0.633508127	-0.000212602	1			
$\ln(GFCF_{it})$	-0.009038637	0.035554768	0.033928802	-0.034723538	0.032294721	1		
$\ln(MI_{it})$	0.180228497	0.077709193	0.232504017	-0.097227194	0.077092257	0.466766393	1	
$\ln(risk_{it})$	0.305275305	0.101035911	0.369156196	-0.093261758	0.033969997	-0.090451324	0.132170938	1

Table 9: correlation matrix.

	FE	System GMM	FE	System GMM	PPML (V)
	(I)	(II)	(III)	(IV)	(V)
$\ln(Export_{it-1})$	–	0.503***	–	0.503***	–
		(0.079)		(0.079)	
$\ln(guarantees_{it})$	0.010***	0.027*	0.011***	0.031*	0.029***
	(0.002)	(0.014)	(0.002)	(0.016)	(0.011)
$\ln(GDP_{it})$	0.230***	0.270**	0.230***	0.270**	0.166***
	(0.060)	(0.132)	(0.060)	(0.132)	(0.000)
$\ln(dist_i)$	-4.406***	-0.696***	-4.407***	-0.695***	-3.290***
	(1.075)	(0.135)	(1.075)	(0.135)	(0.125)
$\ln(pop_{it})$	2.957***	0.216	2.956***	0.214	1.199***
	(0.457)	(0.169)	(0.457)	(0.169)	(0.123)
$\ln(GFCF_{it})$	0.427***	1.096**	0.426***	1.096**	0.075***
	(0.139)	(0.439)	(0.139)	(0.439)	(0.234)
$\ln(MI_{it})$	-0.367	0.210	-0.368	0.203	-0.188
	(0.254)	(0.508)	(0.254)	(0.510)	(0.651)
$\ln(risk_{it})$	0.187*	0.175	0.187*	0.176	0.222*
	(0.112)	(0.229)	(0.112)	(0.229)	0.101
Number of obs.	1429	1237	1429	1237	1429
adj./pseudo R^2	0.95	0.19	0.95	0.19	0.93
Hansen test *(p-value)*	–	0.063		0.065	–
A–B AR(1) *(p-value)*	–	0.000		0.000	–
A–B AR(2) *(p-value)*	–	0.639		0.640	–
LLC test *(p-value)*	–	0.000	–	0.000	–

Table 10: Sensitivity analyses - zero observations. Static and dynamic models. Notes: Zero values replaced by 0.1 in models (I) and (II), zero values replaced by 0.5 in models (III) and (IV), Poisson pseudo-maximum likelihood (PPML) estimator (V). * significant at 10%; ** significant at 5 %; *** significant at 1 %. Robust (White heteroskedastic consistent) standard errors in brackets. Specific effects country dummies are not reported. Hausman test rejects the random effects model. Response variable: logarithm of export. All variables are in logarithm.