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TECHNOLOGY TRANSFER: WHAT IS FDI INFLUENCE ON TOTAL FACTOR PRODUCTIVITY IN LATVIAN ECONOMY SECTORS

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Technology Transfer:
What is FDI Influence on Total Factor Productivity in Latvian Economy Sectors

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Abstract

This paper aims at finding the impact from foreign direct investment to total factor productivity in Latvian economy sectors. The study covers a period from 1^{st} quarter of the year 1996 until the 4^{th} quarter of the year 2007. Econometric time-series analysis is performed in order to evaluate the causal link between TFP as a dependent variable and FDI, its origin, as well as volume of imports as explanatory variables. Relationship between foreign direct investment flows and total factor productivity in Latvia is revealed. Country of FDI origin is found to significantly influence TFP only in some sectors of the economy. Furthermore, the authors test whether imports are consistent alternative to FDI channel of ITT, but the results are ambiguous.

Keywords: Foreign Direct Investment, International Technology Transfer, Total Factor Productivity, Latvian Economy sectors, Solow residual

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List of Abbreviations

ADF – Augmented Dickey-Fuller test

CEE – Central and Eastern Europe

CSB – Central Statistical Bureau of Latvia

FDI – Foreign Direct Investment

GDP – Gross Domestic Product

HAC – Heteroskedasticity- and Autocorrelation-Consistent Newey-West standard errors

NACE – Statistical classification of economic activities in the European Community

OECD – Organisation for Economic Co-operation and Development

OLS – Ordinary Least Squares

R&D – Research and Development

TFP – Total Factor Productivity

ITT – International Technology Transfer

1 Introduction

Since the restoration of independence of the Republic of Latvia in 1991, the country has experienced several economic shocks and subsequent periods of volatile economy development. Early nineties were characterized by hyperinflation, accompanied by negative real gross domestic product (GDP) growth rate (Godmanis, 2007; Ilarionov, 1996). This period was further proceeded with a phase of price stabilization, moderate economic growth and expectations towards the accession to the European Union. The latter target was successfully achieved in 2004 and has been the main reason for the following flourishing growth, which has beaten a two-digit annual percentile level during four consequential years up until 2007. Recently, Latvia's economy once again has demonstrated a rapid change of the development trend direction and entered a phase of negative economy growth (Central Statistical Bureau of Latvia, 2009). As a response to the rapid changes, on December 11, 2008, the Parliament of Latvia accepted a stabilization plan with the main aim to foster the economy movement towards its natural level of output. The plan, however, did not include any long term implications that would ensure steady growth, in addition to the aforementioned stability itself (*Latvijas ekonomikas stabilizacijas*, 2008).

Global studies suggest that one potential source of long-term productivity growth (thus, output growth as well) is to be found in *FDI-caused technology change*. Authors employ neo-classical growth model framework to derive a measure of total factor productivity, often referred as "Solow residual", and econometric time-series techniques in order to find, whether Latvian economy sectors have been gaining from foreign capital inflows in past and whether they potentially can benefit in future. To the authors' best knowledge, this study is one of the first attempts to perform cross-industry analysis of the above mentioned effect in Latvia; hence, the main purpose of this study is to find FDI impact, if any, on productivity growth of Latvian economy sectors. The research question is formulated as follows: "**To what extent do foreign direct investments influence productivity in sectors of Latvian economy?**" Additionally, authors explore whether origin of FDI matters, i.e. do foreign direct investments from different regions of the world influence Latvian productivity differently. Authors extend analysis to control for trade experience of Latvia, as imports are recognized as an alternative to FDI as a source of international technology transfer. Therefore additional sub-questions of the study are formulated:

- "Do foreign direct investments with different country of origin influence productivity in sectors of Latvian economy in a different way?"
- "Does import related trade experience contribute to explanation of FDI caused productivity growth in sectors of Latvian economy?"

This paper is organized as follows: in the succeeding part, background of the study is provided. "Literature Review" introduces a reader to the previously published studies that has been developed with respect to the topic of discussion. "Methodology" explains the methodology employed, describes data and its transformations. "Results of Econometric Analysis" is devoted to the empirical findings of the study. In the succeeding section the authors analyze and discuss the results. Further the authors conclude and summarize the paper. Finally, policy implications from the results of the papers are discussed and suggestions for further research presented.

2 Background of the Study

As suggested by Solow-Swan neo-classical growth model, the long-term growth is subject to the set of three variable inputs: capital, labour force and technological progress; "capital" being the stock of machinery, buildings, vehicles and other means of production within the observable entity, "labour" - volume of labour employed in it (Kim & Hyunjoon, 2004; Solow, 1956) and "technological progress" – ways of managing economic activities that allow entity to maximize its output and production factors' utilization level, without changing the base of inputs (O' Sullivan, Sheffrin, & Perez, 2007). It can be summarized in a production function as shown in the first equation, where Y stands for GDP, A - for technological progress, K – for stock of capital and L – for labour:

$$Y = f(A, K, L) \tag{1}$$

Slightly transforming the first equation, the authors get:

$$\frac{Y}{L} = \frac{f(A, K)}{L} \tag{2}$$

The second equation shows important property of income per capita – it is dependent on only two inter-related inputs. A convenient reasoning for that is provided by Lewis, who suggests that capital alone can not substantially increase productivity of labour force (2004). According to Lewis, increasing capital alone would not increase total output, but rather would create *a potential* for growth through added, but unused capacity. At the same time, raising labour productivity, i.e. following technical progress alone, would decrease total employment, unless additional capacity would be provided simultaneously. Thus, technical progress and the amount of capital are both inseparably important determinants of stable growth of income per capita level.

These implications are useful for country’s policy makers. On the one hand, capital side of growth suggests that policymakers should find an optimal rate of marginal propensity to save, discussed by Ramsey (1928) and Phelps (1961); then come up with policies that would encourage people to fit their savings towards such a rate and, finally, create a system of institutions that would allow accumulated capital to be effectively employed. On the other hand, policy makers should decide on how to stimulate technological progress. This may seem to be more difficult task than setting target of savings rate and, consequently, rates of capital usage intensity, since technological process can not be observed directly and is difficult to quantify (Hejari & Safarian, 1999; Keller, 2004).

As broadly discussed in academic literature, one of the sources for technological progress is international technology transfer (ITT). The concept of the technology transfer does not have one unified definition, as the term is used by academics in different fields of economic studies (Waroonkun & Stewart, 2008). Still, majority of them agree that ITT does involve transfer of, primarily, intellectual property (licenses, patents, brand names) from the one party (an owner of knowledge) to the other party (a recipient), who can valuably use this knowledge (Chen & Dunning, 1994; Sullivan, 1995). ITT may, however, influence productivity of a recipient party by means other than allowance to use intellectual property as well – Lumenga-Neso, Olarreaga, and Schiff (2001) have found evidence of indirect R&D spillovers between trading partners.

Generally, foreign direct investment (FDI) is recognized as one of the key, if not the most important potential source for international technology transfer - an excessive scope of literature exploring this field gives such evidence (for example, surveys by Contractor & Sagafi-Nejad, 1981; Keller, 2004). The reason for this can be found in International Monetary Fund definition of FDI, stating that compulsory property of such investment is “lasting interest and significant degree of influence exercised by an investor in the foreign enterprise” (International Monetary Fund, 1993). This also gives an incentive to think that through active involvement in management process, FDI suppliers provide their investment targets with knowledge that potentially can increase value of these investments.

Another issue that should be considered within this study is spillover effect, which has been detected in the vast majority of previously published studies. The term *spillover*, in productivity context, means that the FDI host company is not the only one to gain from foreign presence – knowledge is predicted to spill over the borders of recipient company and facilitate to the whole industry's productivity growth (Gorg & Greenway, 2003). At the beginning of the 21th century, Morgan has come up with a comprehensive set of case studies, successfully identifying existence of aforementioned spillovers (2001). Besides, Larrain, Lopez-Calva and Rodriguez-Clare have suggested that countries of a small size are more likely to be subject to productivity spillovers (2000). In this study the authors rely on the common experience and aforementioned research papers, and assume intra-industry productivity spillovers in sectors of Latvian economy to be the actual case on the company level.

3 Literature Review

Over the last decades, a lot of studies have been devoted to investigate FDI effects on productivity of domestic enterprises. Influential researchers of this field, Blomstrom and Kokko have stated that the effect of FDI depends on the country and industry of the recipient (1998); indeed, according the global experience this is true. Since nineteen seventies, when FDI's as a source of technology transfer importance have boosted as a topic for academic papers, several analytical models have been designed, suggestions for avoiding biases made and various opposite conclusions drawn.

3.1 Global Experience

The international, FDI-caused technology transfer has been widely studied all around the world. In the UK (Haskel, Pereira, & Slaughter, 2002; Harris & Robinson, 2003; Liu, Siler, Wang, & Wei, 2000) and Sweden (Karpaty & Lundberg, 2005) FDI has been discovered to have a positive impact on the productivity of domestic companies. On contrary, in Spain no evidence of technological change arising from FDI has been found, once other factors had been properly controlled for (Barrios & Strobl, 2002). Furthermore, FDI in Morocco (Haddad & Harrison, 1993), India (Kathuria, 2000) and Venezuela (Aitken & Harrison, 1999) has been correlated with lower domestic company productivity.

Absorptive capacity. International studies have found that knowledge transfer that boosts long-term growth in the recipient economy does not happen by itself. For example, a comparison of OECD and non-OECD countries reveals that it depends on the degree of substitution and complementarity between FDI and domestic investment (Mello, 1999). Studies of Spain (Barrios & Strobl 2002), Sweden (Karpaty & Lundberg, 2005) and the UK (Liu et al., 2000) show that absorptive capacity of domestic companies increases the magnitude of technological transfer. In general, active learners are described to catch up with technological development faster than passive watchers (Blomstrom & Wang, 1989).

Regional effect. Several research papers suggest that the effect of FDI on TFP at least to some extent is determined by the geographic region of parties participating in the transaction. As for the recipient, an important property of country's potential to learn from external sources is its initial level of TFP; the larger is the total factor productivity gap between two countries involved, the faster is the predicted convergence (Bijsterbosch & Kolasa, 2009). Similarly, the authors of this study find that various studies (for example, Ford, Rork, & Elmslie, 2007; Kim, Lyn, & Zychowicz, 2003) suggest that FDI effects on productivity vary depending on the origin of investment. FDI originating from developed countries in general are found to be more effective in generating technology transfer. Theoretically, these findings show that emerging countries tend to be more interested in attracting foreign capital than industrial countries; it causes faster productivity increase in relatively less developed countries.

Some authors extend their studies even further and analyse whether enterprises' regional belongingness within the recipient country has deterministic power predicting impacts of FDI on TFP. However, results of these papers are ambiguous – in case of the UK, the region in which a domestic enterprise is situated has no significant effect on productivity spillovers (Haskel et al., 2002), while Chinese provinces tend to react on FDI inflows statistically differently from each other (Ozyrut, 2006).

Besides, cultural differences, as well as country's policy preferences towards openness to capital flows might be important determinants of beneficial FDI effect on TFP (Vahter, 2004).

Time effect. Another aspect that researchers have studied is timing of knowledge transfer. The transmission of knowledge is found to have both instantaneous and continuing effects on productivity during its life cycle (Mayanja, 2003). In China international knowledge sharing for domestic industries is characterized by diminishing nature (Buckley, Clegg, & Wang, 2006). Moreover, in the UK after FDI have caused development of the domestic industry, it has catalyzed the removal of foreign presence over a longer period, because the domestic market has become strong enough to reduce the position of foreign companies (Markusen & Venables, 1997).

Controversies. Not all studies have supported the idea that FDI is the largest contributor to the changes in TFP. It has been found that in the USA, correcting model for capital utilization has important implications for the characteristics of the Solow residual, a numerical measure of technical progress (Burnside, Eichenbaum, & Rebelo, 1996). Similarly, a recent studies of Australia (Otto, 2008) and Korea (Kim & Hyunjoon, 2004) provide evidence that fluctuations in the Solow residual series do not exclusively reflect technology shocks; and the growth rate of the residual is not a strictly exogenous variable. According to Kim and Hyunjoon (2004), demand shocks are the primary sources of fluctuations in capacity utilization. This shows that stronger predictive content for the Solow residual in Australia is related to the terms of trade and a measure of the term spread, rather than to broadly discussed FDI. Imports are broadly recognized as a powerful channel of international technology diffusion (Boernsztein, Gregorio & Jong, 1998). Therefore, shocks other than technological innovations alone are affecting the standard measure of the Solow residual for the country (Otto, 2008).

3.2 CEE Transition Economies' Experience

In 1990s, after the collapse of the so-called "iron curtain", CEE countries have liberalized their markets. During those years FDI has been flooded in this part of Europe (Damijan, Knell, Majcen, & Rojec, 2003). Hence, researchers have studied FDI impact on productivity and tried to measure the spillover effect towards domestic companies in CEE countries. Reasonable effort towards research in this region has been made by Beata Smarzynska Javorcik, who has pointed out that international technological transfer in CEE countries could be taking place through backward linkages - contacts between domestic suppliers of intermediate inputs and their multinational clients (2002). Direct effects of FDI are found to provide an impact on company's productivity in 10 CEE countries; all of them are recently admitted in the European Union (EU) (Damijan, et al., 2003). FDI effects on productivity in CEE countries, similarly to global experience, are ambiguous and vary across countries. For instance, studies of Lithuania (Javorcik, 2002) and Slovenia (Vaher, 2004) reveal the existence of FDI-caused knowledge transfer. Similar to the above mentioned global studies, the results of these studies have been challenged by authors, who have found the opposite phenomenon to be true. In an analogous study FDI caused spillovers to domestic companies are not detected in Estonia (Vahter, 2004). On contrary, a company level study of five CEE countries (Czech Republic, Poland, Hungary, Romania and Bulgaria) shows that FDI have either negative or insignificant impact on productivity of domestically owned companies (Torlak, 2004). Furthermore, in a study of ten CEE economies Gersl, Rubene and Zumer (2007) have found out that in several cases the technology transfer effect is negative.

3.3 Baltic States' Experience

It is proved that magnitude of knowledge transfer depends on a number of factors other than FDI. These factors include: the initial technology level, structural differences between domestic companies and companies with foreign presence, export versus domestic market orientation and the size of a company (Gersl et al., 2007). In Lithuania (Javorcik, 2002) and Estonia (Vahter, 2004) greater productivity benefits are associated with domestic-market, rather than export-oriented, foreign affiliates.

In Estonia it has been found that the impact of the international knowledge spillover effect depends on two factros: characteristics of the local company that receive the investment and characteristics of the incoming FDI. Accordingly, own resources of domestic companies do not increase their ability to experience productivity spillovers in Estonia (Sinani & Meyer, 2004).

3.4 Studies of Latvia

The scope of the literature devoted to the interdependence of FDI and productivity in Latvia is very limited. Some of the cross-country studies include Latvia as one of the countries to be analyzed – Gersl et al. have identified negative productivity spillovers arising from FDI in Latvia (2007). Similarly, an earlier study made by Damijan et al. also reports the same effect (2003). On contrary, Bijsterbosch and Kolasa (2009) in their upcoming paper that makes comprehensive evaluation of the FDI and TFP relationship in three different industries across eight CEE countries, find that Latvia's TFP is positively related to FDI inflows. Same results are derived by Kairys and Urba (2005), who, putting analysis in a company-level framework, found positive results, i.e. positive FDI impact. As aforesaid, this study is one of the first attempts to perform cross-industry analysis of the discussed topic in Latvia. The authors find this appropriate, as country level analysis might be too broad and, in a sense, useless for further policy making or any other practical application. At the same time, the company-level analysis might be too specific and, again, lacking practical application.

3.5 Hypotheses

Given the background of the topic and the overview of the previously published studies, the authors of this study formulate three hypotheses that help answering the research questions.

Firstly, hypothesis to test the general impact of FDI on productivity is generated. Even though studies are contradictious with respect to the direction of the aforementioned impact (positive or negative), majority of the results turn out to be positive. Accordingly, the authors propose the first hypothesis (H1): **Increase in accumulated FDI flows has a positive impact on productivity growth.**

Secondly, the possible differences in the extent of the FDI impact on TFP between investments coming from various regions are tested in this study. Hereby, the following hypothesis is formulated (H2): **Increase in accumulated FDI flows originating from different regions influence productivity growth differently.**

Thirdly, since both imports and FDI flows are sources of exogenous technology progress, it is necessary to include both variables into the analysis. Due to this, the authors come up with another hypothesis (H3): **Increase in trade openness positively influences productivity growth.**

4 Methodology

In this part of the paper the authors introduce a reader to the methodology. First, general view of the econometric model is introduced. After that, derivation of total factor productivity, in this study measured as Solow residual, is presented. Finally, measures and description of all variables used for the TFP growth estimation and econometric analysis of its determinants is presented.

4.1 Model Specification

Using an internationally employed experience (for example, Bijsterbosch & Kolasa, 2009, Sattaphon,2004), the authors develop an econometric model that allows evaluating the relationship between productivity of Latvian economy sectors and factors that influence it through international technology transfer. The general view of regressions is shown in equation three:

$$\Delta r_t = \alpha + \sum_{n=1}^{p} \beta_n \Delta r_{t-n} + \sum_{l=1}^{i} \sum_{k=0}^{m} \gamma_{l,k} \Delta x_{l,t-k} + \varepsilon_t \qquad (3)$$

In the third equation Δr_t stands for the total factor productivity, or Solow residual, growth, $\sum_{n=1}^{p} \beta_n \Delta r_{t-n}$ denotes a sequence of lagged values of the TFP growth, and $\sum_{l=1}^{i} \sum_{k=0}^{m} \gamma_{l,k} \Delta x_{l,t-k}$ represents a polynomial containing *i* explanatory variables *x* and their lagged values.

The authors include lagged values of dependent variable, as time series theory claims that lagged values may contain some information about current value of the variable (Gujarati, 1995, pp. 585-590; Stock & Watson, 2003, pp. 530-531). Besides, the nature of technology transfer is said to be dynamic, therefore current values of technology change are very likely to influence this process in the next periods (Felipe, 1997). Furthermore, in order to include only necessary lags of variables, the authors use the Akaike information criterion approach (Akaike, 1973), as it is considered to be “softer” than alternative approaches and may allow for more lags to be added into regression analysis. By applying this method the authors ensure that the study does not miss any of the potential findings.

The key explanatory variable, in whose effect the authors are interested the most, is FDI - as it has already been mentioned, that majority of studies devoted to identify the sources of ITT recognize FDI as the most powerful tool for the international exchange of knowledge. Besides, authors run additional regression analysis in order to control for country of origin effects of FDI, since this FDI property might be important when predicting FDI effect of productivity (Fortainer, 2007). The authors also include the lags of the FDI proxies into the model, allowing for possibility of FDI inflow taking longer time span to have its effect on the total factor productivity increase.

An alternative source of international knowledge spillovers is also tested by including into the research the effect suggested by Lumenga-Neso et al. (2001), who identify international trade as a potential source of technology transfer. Acharya and Keller (2007) explain existence of such ITT channel by applying informational content property to the each unit of imports and identifying a flow of imports as a diffusion of internal R&D. Therefore, this variable is included in the research.

4.2 Derivation of Solow Residual

The dependent variable in the regression analysis is the total factor productivity growth. As this variable is not observable directly, it should be estimated. The common way to do this is to derive a production function. In order to do that the authors employ the production function shown in the third equation, suggested by Solow in 1957, when he first publicly derived the so-called Solow residual:

$$Q = A(t)\, f(K, L) \tag{4}$$

In the fourth equation Q stands for output, which is a function of K - capital, L - labour and $A(t)$ - TFP at given time. Here, for simplicity of analysis, the authors assume, as suggested by Solow (1956), that technical change is “neutral”, hence, substitution rate between capital and labour is independent of technical progress. Next, the authors derive total derivative of the production function, rearrange the equation and assume that the factors are paid their marginal products (Filson, 2008). Then the result can be expressed as in equation 5.

$$\frac{\dot{Q}}{Q} = \frac{\dot{A}}{A} + \frac{wL}{Q}\frac{\dot{L}}{L} + \frac{rK}{Q}\frac{\dot{K}}{K} \tag{5}$$

Superscripts ($^{\bullet}$) denote change in the variable over a particular period; $\frac{wL}{Q}$ and $\frac{rK}{Q}$ represent aggregate income of labour, and aggregate income of capital. Denoting these values as β and α, the authors interpret them as a share of GDP from labour and capital respectively (Filson, 2008). Due to the neutrality of the technical change and consequential production function’s property of constant returns to scale, elasticities can be rewritten as $\beta = (1-\alpha)$. Inserting modified elasticities into equation (5) and rearranging it one more time the authors get the following expression:

$$\frac{\dot{A}}{A} = \left(\frac{\dot{Q}}{Q} - \frac{\dot{L}}{L}\right) - \alpha\left(\frac{\dot{K}}{K} - \frac{\dot{L}}{L}\right) \tag{6}$$

Equation (6) states that any increase in output that is not explained by increase of amount of labour force or increase of capital stock can be attributed to shifts of total factor productivity, or technical progress[1].

---

[1] The complete derivation of the technology transfer effect measure is presented in Appendix A.

4.3 Empirical Data: Solow residual

The following section describes the data and its transformation process for this study. The time frame covers a period from 1996 until 2008. In practice, it would be more valuable to perform analysis starting with year 1991, but sufficient data for all input variables is not available for earlier periods (see subsection *"Capital"*). Therefore, the authors involuntary delimit the study.

In order to obtain more precise statistical inferences of FDI effects on productivity, the authors compile a data set segregated into quarterly periods, instead of gathering often used annual data. As mentioned above, the analysis is carried out on the industry level; therefore, all the necessary data is collected, and split by kind of activities according to the NACE 1.1 classification (see Appendix B).

All variables are measured in monetary terms and are adjusted to comparable prices of benchmark year 2000. This is done in order to be able to simultaneously apply the data that originally was pegged to different benchmark years. Measures of variables employed in this study are presented in the subsequent paragraphs.

Gross domestic product is the total value added of goods and services produced in a given time period and expressed in monetary terms. The authors obtain the data on this variable from hard-copies of quarterly statistical bulletins of CSB (*Latvijas Makroekonomiskie Raditaji*, 1996 - 2008). To the extent it is possible, the data for earlier periods covered in the research is collected from bulletins as recent as possible – this is done as CSB often makes precisions to the recently published data.

Capital is the amount of non-financial investments made in particular sector of economy during any given time period and, similar to output, expressed in monetary terms. Even though there are certain alternatives to this measure, majority of researchers indicate that the measure should include only "productive capital", i.e. fixed assets (Kim & Hyunjoon, 2004).

Alternatives may include the total value of assets' side of balance sheet, or even use estimates based on shareholders funds and financial indebtedness as a proxy for *"capital"* (Vanags & Bems, 2005). Obviously, these are worse proxies of "productive capital" than the value of fixed assets, as they are not necessarily close measures of productive capital. At the same time, an exception from this rule are financial intermediation sector companies ("J" in NACE 1.1.), as they primarily earn profits by issuing financial products, which require very little involvement of fixed assets, compared to other industries. For this reason, the authors exclude financial intermediation sector from the analysis.

In order to estimate the volume of productive capital as precise as possible, the authors obtain two sets of variables. The first one contains the quarterly data of non-financial investment into sectors of Latvian economy throughout the periods of interest (*Latvijas Makroekonomiskie Raditaji*, 1996 – 2008; *Investicijas un Buvnieciba Latvija*, 1996), and the second one - the aggregated value of fixed assets within each industry of the authors' interest as of January 1 of each year from 1995 to 2007 (Central Statistical Bureau of Latvia, 2009; *Uznemumu un Uznemejsabiedribu*, 1996-2000). The figures of non-financial investments include long-term investment in intangible assets, residential houses and other buildings and structures, cultivated assets, technological machinery and equipment, inventory and other fixed assets; it also refers to the fixed asset formation and the costs of unfinished construction and capital repairs.

An important property of fixed assets is depreciation. As the gathered data originally is not adjusted to this factor, the authors transform it using a general formula (see equation 7) suggested by Vanags and Bems (2005):

$$K_{t+1,i} = (1-\delta_{t,i})K_{t,i} + I_{t,i} \tag{7}$$

In equation 7, K_t represents the initial capital stock at the beginning of the period t, K_{t+1} stands for the capital stock value at the end of this period, δ represents the depreciation rate, and I_t shows new investments in capital stock during the period. This means that the value of the assets at the end of a period should be equal to the value of these assets at the beginning of the period, less depreciation over the period, and adjusted for positive investments, i.e. new fixed assets.

It is assumed that assets depreciate at a constant rate, specific to each particular industry, throughout one economic year. As there is no data calculated in publicly available data bases for the depreciation coefficients, the authors estimate an effective depreciation rate for every year in every sector of Latvian economy, using the data available and rearranging equation 7 into equation 8, and choosing such depreciation rate that yields precisely as much value of assets, as is needed to fit annually obtained values of aggregated fixed asset value:

$$\delta_{t,i} = 1-(K_{t+1,i} - I_{t,i})/K_{t,i} \tag{8}$$

The capital stock at the end of the first quarter of each year is estimated by taking the initial capital stock obtained from the CSB, subtracting the depreciated value during the period (using depreciation coefficients calculated in the eighth equation), and adding non-financial investment during the first period. The procedure of calculating capital stock value for the second, third and fourth quarter is similar to calculus for the first quarter, but instead of the actual CSB data of the initial stock value, the authors use the one calculated for the end of the previous period.

Labour force is an average amount of all full-time and part-time workers that did any work either as employees, self-employed, or any other type of paid labour during a particular period. Quarterly data from 2002 until 2008 is obtained from the electronic CSB online database (Central Statistical Bureau of Latvia, 2009). Earlier information (1996 – 2001) is collected from brochures available at CSB Information Centre (*Darba Speks Latvija*, 1996 - 2001). Labour force data for four economic sectors – fishing ("B" in NACE 1.1.), mining ("C" in NACE 1.1.), activities of households ("P" in NACE 1.1.) and extra-territorial organizations and bodies ("Q" in NACE 1.1.) to the authors' best knowledge does not exist. Therefore, those four sectors are excluded from the study. However, this should be a minor disadvantage, as omitted industries constitute small fraction of total Latvian GDP - altogether, about 0,4% of GDP in 2007 (Central Statistical Bureau of Latvia, 2009).

Wages – the authors use average monthly gross wages and salaries of employees presented in the CSB data base for years 2001 - 2008 (Central Statistical Bureau of Latvia, 2009), and figures from quarterly publications (*Darba Speks Latvija*, 1996 - 2001) for earlier years. In order to obtain an aggregated quarterly wages of all employees of sector the authors multiply obtained average wage by the number of workers in a respective industry.

Solow residual is calculated simply by inserting the estimated measure of variables into the equation 6 ($\dot{A}/A$ stands for the measure of Solow residual). Changes in labour force, output and stock of capital are calculated using the variables described above. The α term is calculated as suggested by Filson (2008) -dividing total labour income by GDP. Total labour income for every industry is calculated taking average gross salary in sectors during the particular time period, multiplied by the average employment within this sector.

4.4 Empirical Data: Explanatory Variables

Foreign direct investment - a full set of the ready-to-use data breakdown of cross-industry, quarterly FDI inflows, grouped by their country of origin is not available in any public source. Thus the authors use the Lursoft data base on FDI movements (*Arvalstu Tieso*

Investiciju, 2009) to adjust the data in a form necessary for this study. The Lursoft data base offers a full track of FDI movements on a company level starting from 1991, with total amount of entries close to 105 thousands. Each entry of this dataset contains information on identity of recipient company, minor information on financing provider, and its country of origin, exact date and sum of the transaction. In addition to this data set, the authors create a list of unique FDI recipient parties and purchased information on these companies' belongingness to economic sectors from CSB and Lursoft. It is important to note that CSB provided us with information according to the NACE 1.1 classification, and Lursoft – with NACE 2.1 classification of economic sectors. Thus the authors convert NACE 2.1. into NACE 1.1 nomenclature using guidelines and legislature as shown in Appendix B (*Correspondence Table*, 2007; *List of NACE Codes*, 2009; *Regulation*, 2006). Thereby, the authors arrange all the entities by one classification to be able aggregating the data to dimensions required by this research – quarterly, cross-sector split and according to country of origin.

Additionally the authors should note that the amount of FDI received by public administration, defence, and compulsory social security industry ("L" in NACE 1.1.) and health & social work ("N" in NACE 1.1.) is virtually zero (10^{-4} % of total net cumulative FDI for year 2005 for "L" and 10^{-5} % for "N"), thus the authors exclude those industries from further analysis.

The authors include two different variables as FDI inflow measure. The first one is inflow of FDI, not corrected for outflows (Campos & Kinoshita, 2008; Rojas-Romagosa, 2006). The other one is the amount of net FDI movements that takes into account also negative FDI flows (Ihrig & Marquez, 2006; Fernandes & Paunov, 2008). There exist different views on how the measure of FDI should be technically included into regression analysis. The authors use technique employed by Buckley, Clegg, Forsans, and Reilly (2004) and Haskel et al.(2007), who suggest taking the growth of FDI flows instead of using levels data. The reason for that is often observed non-stationarity of such time series and consequent wrong and misleading results of regressions.

Country of FDI origin – once total FDI flows to particular industries are calculated, authors split them according to the origin of a host country to test the second hypothesis. According to Fortanier (2007), for this purpose all countries could be split to five general regions – Developed, CEE and Post Soviet, Asia, Latin America, and Africa and Middle East (see Appendix C). Due to the data not being dynamic for country groups "Asia", "Latin" and

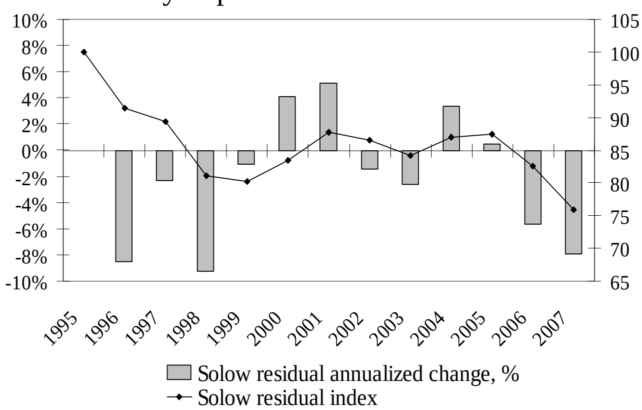
"Africa" (see appendix C), FDI influence on TFP can not be estimated. Therefore, those particular groups are not analysed for all the economic sectors (see appendix D).

Imports - to test the third hypothesis, the authors include variable of imports measured as a ratio of Latvian imports of goods produced by foreign industries (classified uniformly with this study's nomenclature) over total output of corresponding local industries, as suggested by Ciruelos and Wang (2005). The reason behind choosing exactly this proxy is its good representation of trade experience relative to total production of the country. Besides, such transformation again allows avoiding potential biases and non-stationarity problems caused by levels data.

4.5 Results of Solow Residual Estimation

Disaggregation of the Latvian economy sectors' value added production growth into three main components reveals dynamics of Solow residual in Latvia. At first the authors describe results obtained on the whole economy data, after that focusing more specifically on each industry's particular Solow residual changes.

Figure 1. Solow residual for total Latvian economy in period from 1996 until 2007

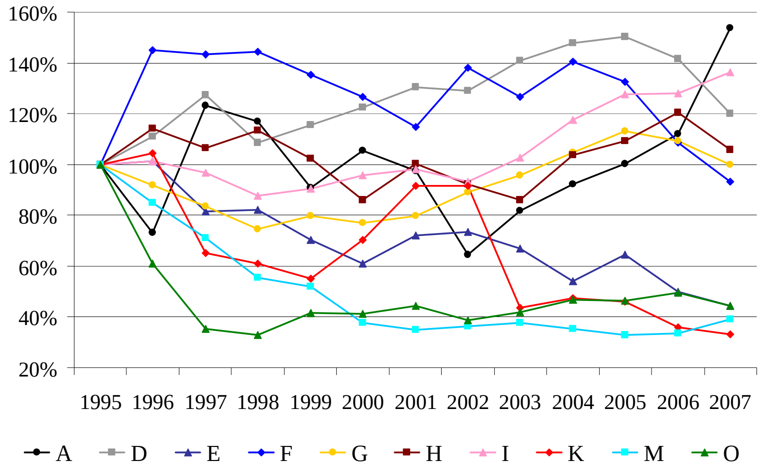


Source: Composed by the authors

It appears that throughout the last decade TFP of the whole Latvian economy has fallen by approximately quarter – from the benchmark of 100 points as on January 1, 1996, to as low as 76 points on December 31, 2007 (see Figure 1[2]). The most dramatic fell has been experienced in the period from 1996 until 1999, when TFP has decreased over four consecutive years. Afterwards there has been period from 1999 until 2005, which was characterized by relative stability of TFP. Finally, since 2005 Solow residual again has been falling for two years in a row.

[2] Data presented in Figures 1 and 2 is annualized. This is done for readers' convenience, as quarterly line graphs are not as foreseeable as annualized ones.

Figure 2. Solow residual for sectors of Latvian economy (NACE 1.1. A – O) in period from 1995 until 2007



Source: Composed by the authors

On the industry level, the pattern of productivity changes is very different for each particular entity. In four out of ten economic sectors, analyzed within this study, TFP have increased over the period of analysis, sector "Agriculture, Hunting and Forestry (A)" being the leader having an index of productivity as high as 154 at the end of year 2007 (see Figure 2). In addition to this sector, industries "Manufacturing (D)", "Hotels and Restaurants (H)", and "Transport, Storage and Telecommunication (I)" have experienced total growth of Solow residual, amounting to indexes of 120, 106 and 136 respectively. There is only one industry – "Wholesale, Retail Trade..(G)" – that has managed to keep its total factor productivity on exactly the same level as it used to be in the benchmark year.

All other sectors have experienced negative total factor productivity growth. As it can be seen in the second figure, some economic sectors have grouped around a level of 50%, meaning that on average during the period analysed in this research, considerable fraction of Latvian economic sectors have lost a half of their total factor productivity.

Such a dramatic fall of total factor productivity for some of the industries during the last several years might be a sign of overinvestment of economy overheating. According to Ludmila Melihova and Martins Kazaks (personal communication, April 24, 2009), these were the years when substantial amount of gross capital formation growth was not attributable to investment into fixed assets that are commonly considered as very productive. For example, new luxury cars put on corporate balance sheets, or new real estate objects could not meet enough demand to be filled on balance sheets of developer companies could skew to some extent the authors' chosen estimate of the "productive capital". It might also be true that due to the high inflation (a two-digit number at majority of that time), remuneration to the employees have been increasing faster than their productivity. However, the latter reasons for the dramatic productivity crush are only speculative and should be put under further investigation.

5 Results of Econometric Analysis

In order to answer the research questions, the authors perform time series regressions in STATA for each of 10 economic sectors separately and one with aggregated figures on the whole economy.

Firstly, Augmented Dickey- Fuller (ADF) stationarity tests are used for each of regressions to find out whether the variables are stationary, i.e. whether the mean and the variance change in time. Further, based on the results of ADF test the authors proceed with a two-step Engle-Granger co-integration test. This is done in order to identify the existence of long-term relationship between the variables and to avoid making conclusions based on spurious regression output. After that, the authors perform the Akaike information criterion test, allowing for maximum of five lags for each variable and keeping other variables of an upcoming regression exogenous. The limit of five lags is chosen for three reasons, two of whom are structurally the same, but have different causes. Firstly, inclusion of too many lags of some variable would possibly lead the study to serious data set contraction and mis-estimation of significance levels, as for this purpose in small statistical samples (under 30 observations, thus in regression with less than 30 degrees of freedom) it is common to use Student's t-distribution instead of normal distribution (Stock & Watson, 2003, p. 88). Secondly, inclusion of many lags, combined with extended versions of regressions that include control variables, could again lead to a number of degrees of freedom in regressions below 30 without reducing the data set, thus confidence level would be again specified incorrectly. Thirdly, the authors find five lags for quarterly data to be enough to fully cover a one-year period, thus avoiding biases possibly arising from seasonal effects (Stock & Watson, 2003, pp. 530-531).

After estimating the number of lags to be included into regressions the authors run ordinary least squares regressions and further specify them using the "general-to-specific" approach - dropping one by one the most insignificant lags of the variables, but not the entire variables themselves. Finally, the authors evaluate models' normality by testing regressions residuals' using the heteroskedasticity White test and the autocorrelation Breusch-Godfrey test. In cases when error terms appear to be heteroskedastic, but not autocorrelated, the authors re-estimate the regression using heteroskedasticity-robust White standard errors.

Similarly, in cases when standard errors appear to be autocorrelated, the authors re-estimate regressions using Newey-West heteroskedasticity- and autocorrelation-consistent (HAC) standard errors.

After specifying regressions and choosing the most appropriate standard errors, the authors perform regression analysis and estimate the actual betas of the dependent variables and their lagged values. Later, in order to evaluate whether the total effect of variables, whose several lagged values appear to be significant determinants of technological change, is statistically different from zero, the authors employ the Wald test (Gujarati, 1995, p. 269). Similar test is performed in order to evaluate whether the influence of FDI flows from different regions is statistically significantly different from each other.

In the subsequent parts of the paper the authors present results of econometric analysis for the each entity analyzed separately. In addition, the authors omit description of step-by-step final regression specification process and present results that are generated only by running the last, specified regression. The authors create eight different model specifications. This is done because two fundamentally different measures of FDI flows are used. Same variable is separately tested, being either aggregated, or split according to the region of origin. Then, regressions are re-estimated with measure of imports being included as a control variable. Finally, if any variable’s multiple lags are found to be individually statistically significant determinants of TFP growth, authors evaluate their joint importance using joint significance test. The entire variable and all its significant lags are tested jointly, while insignificant lags are left out of the test, since their inclusion would simply add “noise” to the test and would artificially broaden the variability. This would increase probability of joint significance falling out of at least a 10% confidence level.

Regression results of all specifications for all industries covered within the study are summarized in Appendix D.

5.1 Whole Economy

All results of econometric analysis for the whole Latvian economy can be found in Appendix D, Table D1. It appears that for the whole economy using all model specifications, the 4^{th} lag of the dependent variable is statistically different from zero at 1% significance level. For models using measure of positive-only FDI flows, coefficient of 4^{th} lag of dependent variable is around 0.5, meaning that 1% increase in TFP four quarters, or a year ago, cause on average 0.5% increase in TFP during the period of interest. Similarly, for the model using net changes of FDI stock, the 4th lag of TFP explain as much as from 0.56% to 0.67%, depending on the model specification. The authors find such a relationship feasible, because the productivity increase during previous periods are very likely to be utilized over the forthcoming periods due to learning curve effects, discussed by Petrakis, Rasmen, and Roy (1995), but the scale is likely to be smaller.

Regression analysis reveals that in line with numerous studies exploring the field of FDI influence on total factor productivity (for example Haskel, Pereira, & Slaughter, 2002; Karpaty & Lundberg), TFP of the whole Latvian economy indeed is positively related to changes in the stock of FDI. The timing of the transmission effect and the scale is slightly different, depending on which measure of FDI is used. Regression model estimation indicates that when FDI is measured as stock of positive-only flows (Model specification 1, Table D1), i.e. cumulative Latvian experience of foreign presence in local companies' ownership, one percent increase in FDI turnover during any period would explain as much as 0.61% increase of TFP two periods later. When FDI is measured as a change of *de facto* scope of foreign ownership of local companies, instead of increase in accumulated experience of foreign presence (Model specification 5, Table D1), 1% increase in such FDI measure in the whole Latvian economy during any period throughout time line analyzed would simultaneously increase TFP by only 0.30%.

Splitting the total FDI stream into five subgroups, based on their host country properties, reveals that FDI from various countries influence Latvian productivity differently. Discovered differences are not only technical – statistical tests show that FDI-embedded productivity potential from different sources fundamentally are not equal to each other. Moreover, FDI turnover increase, rather than the net FDI increment, is more likely to cause significant impact on TFP. One percent increase in inward FDI (Model specification 2, Table D1) from the group of developed countries throughout the analyzed period is associated with increase in TFP of Latvian economy by 0.68% two quarters later, while comparable percentile increase of inward FDI from Latin countries in total raise TFP of the whole economy of Latvia by only 0.05% over two quarters. Increase in Asian FDI by 1% improves TFP of Latvia by only 0.01%, while investments from CEE and Post-Soviet countries appear to have insignificant effect. The authors identify that once the net figure of accumulated FDI is used in the analysis (Model specification 5, Table D1); FDI flows from the developed countries' region remain significant determinants of TFP growth. At the same time individual effects of other countries' FDI (Model specification 6, Table D1) vanish across series of individually significant, but jointly statistically not different from zero quarterly lags of explanatory variables.

Proceeding with model specifications, imports are included to the model specifications tested earlier. The effect of imports appears to be ambiguous. In model specifications with positive-only FDI flows, imports empirically are important determinants of changes in Solow residual - in the specification with total aggregated values of inward FDI (Model specification 3, Table D1) the net effect of imports is negative, while the effect of FDI drops out of 10% significance level and out of the list of deterministic variables. The impact is negative also for the explicit model specification, where FDI is controlled for its country of origin (Specification 4, Table D1). In line with other variables' total effect, two separately significant lags of imports have coefficient with different signs and are insignificant jointly. Other results are as follows – Asian FDI drop out of the scope of statistically significant TFP determinants, while total effect of developed region's and Latin countries' FDI increases by 0.23% and 0.15% respectively.

Finally, model specifications 7 and 8 again provide ambiguous results on the influence of imports on TFP of the whole Latvian economy, because none of the explanatory variables has any significant influence on Latvian TFP. Statistical insignificance is often caused by too broad confidence levels, which in turn might be in consequence of data variability. It might be the case for Latvia – the history of FDI flows is not long enough to clean out temporary vulnerabilities reflected in the net FDI stock changes, as they account not only for Latvia's historic attractiveness to foreign investors, but also reflect periodical threats faced by these investors at their home countries.

As a result of the findings presented in this section, the authors in two cases out of four fail to reject first hypothesis of FDI having significant positive effect on TFP growth. None of the findings contradicts the second hypothesis, which predicted different effect on TFP from FDI originating in different socio-economic regions. Therefore, authors fail to reject the second hypothesis. The effect of imports increase on changes in TFP is very ambiguous, thus the third hypothesis is rejected.

5.2 Agriculture, Hunting and Forestry (A)

Similar to the results obtained for the whole economy, the 4^{th} lag of the dependent variable, growth of Solow residual, is statistically significantly different from zero also for the Agriculture, Hunting and Forestry sector, with coefficients being positive and on average floating around .80.

Model specifications 1 and 5 (Table D2) reveals that there is a significant relationship between FDI flows and TFP dynamics, irrespective of which proxy for FDI is employed. However, the relationship is negative – one percent increase of inward FDI flows decrease TFP in the sector by 0.44%, while an increase in the net stock of FDI reduce TFP by 0.29%. Results for model specifications 2 and 6 generate no additional information, as none of the explanatory variables turns out to be significant.

As suggested in literature, imports in this sector contribute to TFP growth in three specifications out of four. A percentile increase of imports positively influence TFP – model specifications 3, 4 and 7 reveal that on average 1 % increase in FDI stock increases local productivity by 0.1%. The last, 8^{th} model specification does not indicate any new or more precise determinants for TFP.

Overall, the authors neither reject nor fail to reject the first hypothesis for agriculture and related industries, since no uniform result is formed based on econometric analysis. Similar results are collected to the second hypothesis – absence of more than one significant region makes it impossible to make any statistical comparisons. The authors fail to reject the third hypothesis, as in all regressions, where imports measure has been included - it appeared to be significant determinant of TFP changes.

These findings generally are not in line with the international experience. For example, Msuya (2007) has found that in Tanzania, FDI has positively influenced local agriculture sector; moreover, the effect of TFP growth in this sector has been outstanding, if compared to other sectors of the Tanzanian economy.

A possible explanation for negative relationship between FDI and TFP may be caused by a *too large* gap in productivity between two countries. This may lead to a dominating position of an FDI recipient company in market share and bankruptcy of relatively ineffective competitors (Bielik, Pokrivcak, Qineti, & Pokricakova, 2006).

5.3 Manufacturing (D)

Manufacturing sector, similar to Agriculture, Hunting and Forestry sector, proves to follow certain learning curve – the percentage increase of TFP 4 quarters ago positively influences the analyzed quarter's TFP dynamics.

Analysis of time series information content helps to reveal a substantial positive impact of FDI on the Solow residual in this particular sector – an increase in FDI turnover by 1% two periods ago raise TFP of the sector by more than 2.2%. More detailed information regarding different region's different productivity potential of FDI can not be retrieved, as coefficients of the model specification 3 (Table D3, Appendix D) appear to be insignificant, therefore no conclusion can be made.

Testing the model specification 6 the authors discover that one percent increase of the FDI stock originating from developed countries' region would decrease TFP by almost 0.90%. On contrary, FDI originating from Latin America countries increase productivity on average by 0.07%.

Summing up, even though that the general specification reveal substantial effect of FDI on TFP growth, no uniform conclusions that would satisfy all hypotheses in all model specifications with respect to this industry can be drawn, as there is not enough number of significant variables to make any broad statistical inferences.

Therefore, all three hypotheses are neither rejected, nor have experienced failure to be rejected.

In the set of global studies, manufacturing industry is the most discussed and explored sector of economy, with different countries reporting different scale of FDI impact. A very strong relationship is found in the UK – an increase of 0.1% of foreign presence is said to increase TFP by 0.5% in the manufacturing sector of that country (Haskel, Pereira & Slaughter, 2007). Nadiri (1992) has also reported that FDI related R&D has positively influenced productivity of manufacturing sectors in Japan, Germany, France and the UK in the post war period.

Most importantly, the authors' findings stay in line with investigations done on manufacturing sector in Latvia so far - paper by Kairys and Urba (2005) have proved that manufacturing sector companies gain benefits from FDI. Moreover, Bijsterbosch and Kolasa (2009) find that FDI effect of TFP of manufacturing sector is positive and is highest relative to other sectors; finally, their findings with respect to role of imports in ITT of this sector are also inconclusive.

5.4 Electricity, Gas and Water Supply (E)

Electricity, Gas and Water Supply sector's TFP growth relies on previous periods' productivity growth heavily –a change of one percent in TFP of this sector four periods ago would cause almost equal TFP increment this year as well –nearly 0.95 to 0.97 percent of today's increase per 1% of former increase. Model specifications from 1 to 8 (Table D4, Appendix D) provide a reader with only some minor factors that are part of full pattern of inter-relationships between TFP and FDI. It appears that on average 1% increase in the net FDI accumulated value negatively influences TFP – decreasing it by 0.06%.

Therefore, once again, no conclusions can be done and none of the hypothesis can be uniformly accepted or fail-to-rejected.

As this industry is usually not so big relative to the total size of economy, to the authors' best knowledge there are no research papers that would evaluate effect of FDI inflows of this industry's TFP separately. Often Electricity, Gas and Water Supply industry is either omitted because of its small size, or is merged with other industries, for example with construction industry (Sabelo, 2004; Chen & Demurger, 2002). Therefore, comparison to other countries cannot be done.

5.5 Construction (F)

Construction sector, similar to previously described industries, is associated with very significant lagged values of the dependent variable, and with majority of coefficients of explanatory variables being insignificant. There is, however, a clear insight that origin of FDI in this particular economic sector plays an important role – only CEE region's FDI has an influence on productivity. For model specifications 2 and 4 (Table D5, Appendix D) the estimated influence is 0.21% for every 1% increase in FDI cumulative experience, and 0.186% respectively. Once the models are re-estimated using only net FDI flows, results change, but only to a small extent and fall to 0.15% and 0.16% for model specifications 6 and 8.

Paprzycki and Fukao (2008, p. 244) has reported that in Japan, construction sector has suffered a negative TFP growth, this tendency being caused by FDI flows. These findings contradict to the findings of this study for Latvia. Nevertheless, Japanese case might be considered as a special, since, as Paprzycki and Fukao discuss, "cultural differences between Japan and its partner countries could be too broad". Controversially, Tondl and Fornero (2008) find that Latin America countries has experienced FDI caused productivity growth in virtually all sectors of the economy, including construction sector.

5.6 Wholesale, Retail Trade and Related Industries (G)

The data of wholesale and related industries provides the authors with quite inconclusive estimates, especially for the first two model specifications (Table D6, Appendix D). The third model specification introduced effect of changes in imports and effect of these changes of TFP. Employing the fourth specification, with import effect controlled for, the authors reveal that increase in inward FDI from developed countries by one percent improves productivity of the respective sector by 0.57%. If the alternative measure of FDI is used, total FDI raise by 1% increase TFP by the same 0.57%. When disaggregating FDI data according to the regions of origin, FDI from CEE and Post-Soviet countries increase Solow residual by 0.28% if tested alone, and by 0.34% if the model is controlled for imports.

5.7 Hotels & Restaurants (H)

Hotels and Restaurants sector is the only one, whose TFP does not fully depend on its own history – at least not in all of the model specifications (Table D7, Appendix D). It has a very similar pattern of interdependency between TFP and FDI, as compared to the Wholesale, Retail Trade and Related Industries: majority of variables are not statistically significantly different from zero, and even fully generalized model specifications do not contain jointly significant lagged values of explanatory variables. Still, from model specifications 6 and 8 (Table D7, Appendix D) the authors obtain results of changes in CEE and Post-Soviet countries' cumulated net stock of FDI being important determinants of positive increase in TFP within the sector.

5.8 Transport, Storage and Telecommunication (I)

Value of the 4th lag of Solow residual change has statistically significant influence on the Solow residual change, as it has already been observed almost in all the economy sectors. Moreover, majority of the variables turn out to be insignificant. In model specifications 5 and 6 (Table D8, Appendix D) value of previous period's accumulated net FDI change has a negative impact on productivity, around -0.47%. Unfortunately, due to the lack of significant coefficients for almost all of the FDI measures, the authors can not draw meaningful conclusions for hypotheses 1 and 3. Nevertheless, country of origin matters: FDI incoming from developed countries in transportation, storage and telecommunication decreases the

TFP, whereas FDI from CEE group creates the opposite effect. Therefore the authors fail to reject the second hypothesis

5.9 Real Estate, Renting and Business Activities (K)

Information content of time series analysis helps to reveal a substantial positive impact of FDI on Solow residual in this particular sector – an increase of FDI turnover by 1% in the same period increase TFP of the sector by more than 0.23% (Model specification 3, Table D9). Significant results could be drawn from various model specifications. Unfortunately, variables that are statistically significant alone, jointly do not have a significant impact on TFP growth. Therefore, the authors can not provide a clear answer to the hypothesis one. Further describing the results retrieved for the sector K, the authors observe positive FDI impact from region-grouped-FDI measures. Yet, again there is no clear answer to the hypothesis 2 for this particular sector.

Results from model specifications with import over output ratio change clearly shows a negative impact on total factor productivity change during the same quarter. Therefore, the authors reject the hypothesis 3 for the sector of real estate, renting and business activities.

5.10 Education (M)

Education sector analysis, in line with others, is associated with very significant 4th lag values of the dependent variable on TFP change during the same time period.

As it can be observed from the model specification 1 (Table D10, Appendix D), the overall result from lagged values of FDI inflow, with coefficient 0.0408, positively influence TFP growth. Nevertheless, when controlling for import related trade experience, no significant coefficients can be acquired. Furthermore, as majority of variables necessary for answering the second hypothesis are with insignificant coefficients, the authors can neither reject nor fail to reject the hypothesis 2. Same implies for the first hypothesis.

Regarding the increase of imports as share of output ratio, results show significant positive influence on TFP in all model specifications where the variable has been included. Therefore the authors fail to reject hypothesis 3.

5.11 Other Community, Social and Personal Service (O)

This particular economic sector analysis, in line with others, is associated with very significant 4th lag values and majority of coefficients for variables being insignificant. Unfortunately, due to the insignificancy issue, no clear answers to hypothesis one and two for Latvian economy sector "O" can be given. Yet, increase in imports as share of output ratio clearly provide negative significant influence on TFP – 1% increase in the ratio decreases the growth of TFP in the same period by 18 basis points. Therefore, the authors reject the hypothesis 3.

In this study the authors conclude that for industries related to services (industries G, H, I, K, M, O) FDI either have no role, or influence TFP positively. There are relatively small amount of papers written in this fields; as it was already mentioned before, papers researching the present topic tend to focus on manufacturing sectors. Moreover, papers that cover service industries tend to merge industries and test them jointly. Still, results in majority of papers written on service industries are similar to the results derived in this paper. For example, Blind and Jungmittag (2005) conclude that for all Germany's service industries FDI took a positive role forming TFP.

6 Summary and Discussion of the Results

Before going further along the study, the authors would like to emphasize that the present paper's main task has been to detect a hypothesized existence of linkages between FDI and TFP. As discussed in earlier parts of the paper, the entire transmission mechanism from partial foreign ownership of a local entity to TFP growth might take different form, direct and observable, for example, patenting, licensing, or management transfer, and indirect, such as employee loyalty development programs. Therefore, in this part of the paper the authors would like to summarize and comment on the results retrieved throughout the study briefly.

The authors have empirically revealed the relationship between FDI flows and TFP in Latvia. Global studies recognize two measures of FDI – one being only positive inflows, second – net flows, which account for the negative FDI as well. Therefore, the first measure, assuming that the knowledge embedded in FDI and once shared with recipient is inalienable from it, can be recognized as scope of knowledge that has been transferred through local companies (Smeets, 2008). Second measure, on contrary, is rather a proxy to active involvement of foreign entrepreneurs in local business activities (Ihrig & Marquez, 2006).

It appears that, independently of the measure of FDI, foreign investments positively influence productivity of local economy. The main difference is in the scale of effect – either 0.61%, or 0.29% as a dynamic response to 1% increase of a one-of-a-kind FDI measure. Significant effects of FDI inflows are distributed among Latvian industries unevenly – manufacturing sector (D) gains as much as 2.2% of TFP increase per 1% increase of FDI; on contrary, some economic sectors do not enjoy benefits from the total flow of FDI and can gain only when FDI has some special properties. There is also one industry – agriculture (A) – which has, even though raising TFP faster than any other industry in Latvia, faced negative impact of FDI inflows. This might be a problem of lack of absorptive capacity (Liu et al., 2000), malevolent usage of dominant position in the market exercised by foreigners, or number of other factors' effects (Dudas, 2008). Generalizing the findings, the authors can state that Latvia have gained from FDI during the period from 1996 until 2007, and is very likely to gain in future as well – the co-integration test reveals long-term relationship.

Country of origin is a property of FDI being tested in a study of Bah and Brada (2008), indicating that the initial TFP of an investor, or provider of FDI, depends on his/her income level. In other words, the higher the initial income-level of an investor's home country, the higher scale of the technology transfer is predicted. Consequently, the broader is the difference between investor's TFP and the country he/she is investing in, the higher is the potential for a recipient country to gain from external company ownership. Indeed, for some economic sectors of Latvia, TFP has responded positively to FDI flows from economically developed countries. However, some sectors have responded negatively to FDI inflows from the same sources. Moreover, the effect of FDI inflows from Asia, Latin America, CEE and Post-Soviet area has been ambiguous, too. Still, given all the ambiguity, content of the FDI potential appears to be different depending on the origin of FDI, since effects of "different" FDI are statistically not equal to each other.

Finally, the authors have tested whether imports are consistent alternative channel of ITT. The authors do not find any uniform results neither with respect to the sign of influence, nor the scale of significance. Therefore, the authors suggest putting this topic for further study, as researchers of this field suggest performing deeper analysis and evaluate not only amount of imports, but also their composition, quality, cost, relative usage and other parameters (Kutan & Yigit, 2008).

7 Conclusion

The primary task of this study was the identification, if any, of potential causal link between FDI and TFP in sectors of Latvian economy separately, and in Latvian economy as a whole. If such links would be found, next step would have been evaluation of specific properties of FDI flows, and control quality of the results by inserting variable of imports as an alternative to FDI channel of ITT.

In order to fulfil the main task of the study, following steps have been performed. Firstly, a full track of data on FDI inflows on the firm level has been aggregated to the quarterly industry level data. Next, production functions of each of the Latvian economy sectors (except for those, where the data of necessary quality has not been available) has been estimated, and Solow residual, or measure of TFP growth derived. After that, econometric analysis has been performed, with TFP growth being the dependent variable, and FDI being the main explanatory variable. Finally, econometric analysis has been extended to include imports and a source of FDI as additional explanatory variables.

The authors find that in the majority of cases Latvian economy sectors have benefited from FDI though ITT linkages. The most significant effect has happened in the Manufacturing (D) sector, where 1% of FDI caused TFP growth of 2.2%. In addition, FDI flows have been split according to investor's host country belongingness to a particular socio-economic region. The test reveals that structurally FDI from different regions contains different productivity potential. However each industry's productivity responds to each region's FDI in a different way. Thus, a more in-depth analysis of each particular sector is suggested for further research.

Finally, effect of imports happens to be ambiguous, with no clear pattern of significance and sing of coefficient. Thus, no explicit conclusions on imports' influence on TFP and its inter-relation with FDI are made.

8 Policy Suggestions and Proposition for Further Research

According to some theorists, Solow residual might not be a perfect measure of TFP for two reasons. Firstly, theoretically it might be biased – for example, Hall (1989) points out invariance problems of the classic Solow residual. Secondly, it may contain all the data noise and market imperfections (recall example of companies investing funds into non-productive fixed assets) up to discrepancies in the raw data collection.

In the authors' opinion, once the relationship between FDI and TFP is established, it is important to proceed with deeper analysis of the transmission processes.

As for practical implications to policy makers, recent study done by Beinarovica and Jefimova (2009) for Turkish market reveals that important classic determinants of inward FDI flows are stable economic growth, bilateral trade agreements, lower wage and depreciation of national currency. As for institutional determinants, important factors are level of corruption, level of law enforcement, effectiveness of democracy, and favourable business environment. Another recent and in authors' opinion important remark with respect to institutional determinants of inward FDI flows has been made by Narula (2007), who noted that "if economic policy does not look to build the institutions and conditions for learning, FDI policy will not matter". Therefore policy makers should not purely focus on how to attract more foreign capital, but rather should decide how to create conditions that would attract foreign capital.

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Appendices

Appendix A – Explicit Derivation of Solow Residual

Step 1: Aggregate production as function can be written

$$Q = A(t)\,f(K,L)$$

Step 2: Differentiate each side with respect to time

$$\frac{\partial Q}{\partial t} = \frac{\partial A}{\partial t} f(K,L) + A\frac{\partial f}{\partial K}\frac{\partial K}{\partial t} + A\frac{\partial f}{\partial L}\frac{\partial L}{\partial t}$$

Step 3: Divide both sides by Q

$$\frac{\frac{\partial Q}{\partial t}}{Q} = \frac{\frac{\partial A}{\partial t} f(K,L)}{Q} + \frac{A}{Q}\frac{\partial f}{\partial K}\frac{\partial K}{\partial t} + \frac{A}{Q}\frac{\partial f}{\partial L}\frac{\partial L}{\partial t}$$

Step 4: Expressing $A(t)^{-1}$ using (1) and inserting into (3) the authors get

$$\frac{\frac{\partial Q}{\partial t}}{Q} = \frac{\frac{\partial A}{\partial t}}{A} + \frac{A}{Q}\frac{\partial f}{\partial K}\frac{\partial K}{\partial t} + \frac{A}{Q}\frac{\partial f}{\partial L}\frac{\partial L}{\partial t}$$

Step 5: Assuming factors are paid their marginal revenue, the authors denote wages per labour output and rents per capital as

$$w = A\frac{\partial f}{\partial L} \qquad r = A\frac{\partial f}{\partial K}$$

Step 6: Inserting equations from step 5 into the equation in step 4 provides the following

$$\frac{\frac{\partial Q}{\partial t}}{Q} = \frac{\frac{\partial A}{\partial t}}{A} + \frac{r}{Q}\frac{\partial K}{\partial t} + \frac{w}{Q}\frac{\partial L}{\partial t} \quad or \quad similarly \quad \frac{\frac{\partial Q}{\partial t}}{Q} = \frac{\frac{\partial A}{\partial t}}{A} + \frac{rK}{Q}\frac{\frac{\partial K}{\partial t}}{K} + \frac{wL}{Q}\frac{\frac{\partial L}{\partial t}}{L}$$

Here rK and wL are aggregate rents paid to capital and aggregate wages of labour respectively

Step 7: Denote share of GDP of capital and labour as $\alpha = \frac{rK}{Q}$ and $\beta = \frac{wL}{Q}$ respectively. Then

$$\frac{\frac{\partial A}{\partial t}}{A} = \frac{\frac{\partial Q}{\partial t}}{Q} - \alpha\frac{\frac{\partial K}{\partial t}}{K} + \beta\frac{\frac{\partial L}{\partial t}}{L}$$

Step 8: Finally, recall constant returns to scale and concept's implication of $\alpha + \beta = 1$. Then

$$\frac{\frac{\partial A}{\partial t}}{A} = \frac{\frac{\partial Q}{\partial t}}{Q} - \alpha\frac{\frac{\partial K}{\partial t}}{K} + \beta\frac{\frac{\partial L}{\partial t}}{L} = \left(\frac{\frac{\partial Q}{\partial t}}{Q} - \frac{\frac{\partial L}{\partial t}}{L}\right) - \alpha\left(\frac{\frac{\partial K}{\partial t}}{K} - \frac{\frac{\partial L}{\partial t}}{L}\right)$$

Final point to bear in mind is that in the main body of thesis the authors denote time differentials following Newton's notations, instead of Leibniz notations used in appendix, i.e. the authors use $\dot{A}$ instead of $\frac{\partial A}{A}$ - this is done in order to simplify view of formulas.

Appendix B – NACE Classification Comparison

Table B1

Classification of Economic Activities in the European Community and System of Recalling NACE 2.1 Classification Sectors into NACE 1.1 Sectors

NACE 1.1		NACE 2.1		NACE 2.1	Corresponding NACE 1.1.
A	Agriculture, hunting and forestry	A	Agriculture, forestry and fishing	A →	A
B	Fishing	B	Mining and quarrying	B →	C
C	Mining and quarrying	C	Manufacturing	C →	D
D	Manufacturing	D	Electricity, gas, steam and air conditioning supply	D →	E
E	Electricity, gas and water supply	E	Water supply; sewerage, waste management and remediation activities	E →	E
F	Construction	F	Construction	F →	F
G	Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods	G	Wholesale and retail trade; repair of motor vehicles and motorcycles	G →	G
H	Hotels & restaurants	H	Transportation and storage	I →	H
I	Transport, storage and communication	I	Accommodation and food service activities	H →	I
J	Financial intermediation	J	Information and communication	J →	I
K	Real estate, renting and business activities	K	Financial and insurance activities	K →	J
L	Public administration and defence; compulsory social security	L	Real estate activities	L →	K
M	Education	M	Professional, scientific and technical activities	M →	K
N	Health & social work	N	Administrative and support service activities	N →	K
O	Other community, social and personal service activities	O	Public administration and defence; compulsory social security	O →	L
P	Activities of households	P	Education	P →	M
Q	Extra-territorial organizations and bodies	Q	Human health& social work activities	Q →	N
		R	Arts, entertainment and recreation	R →	O
		S	Other service activities	S →	O
		T	Activities of households as employers; undifferentiated goods and services-producing activities of households for own use	T →	P
		U	Activities of extraterritorial organisations and bodies	U →	Q

Note. Compiled by the authors according to *Correspondence table NACE Rev. 1.1 - NACE Rev. 2* (2007), *List of NACE Codes* (2009), and *Regulation (EC) (*2006).

Appendix C – FDI Originating Countries

Table C1
Grouping the FDI Originating Countries

Developed (Dev)	Central Eastern Europe and Post Soviet (CEE)	Asia (Asia)	Latin America (Latin)	Africa and Middle East (Africa)
Andorra	Albania	Afghanistan	Anguilla	Benin
Australia	Armenia	Bangladesh	Antilles	Congo
Austria	Azerbaijan	China	Argentina	Cote d'Ivoire
Belgium	Belarus	Hong Kong	Bahamas	Egypt
Canada	Bosnia - Herzegovina	India	Barbados	Israel
Cyprus	Bulgaria	Iran	Belize	Jordan
Denmark	Czech Republic	Korea	Bermudas	Kuwait
Farer Is.	Croatia	Malaysia	Brazil	Lebanon
Finland	Estonia	Marshal Is.	British Virgin Is.	Liberia
France	Georgia	Mongolia	Columbia	Mali
Germany	Hungary	Nepal	Costa Rica	Morocco
Gibraltar	Kazakhstan	Niue	Cuba	Mauritius
Greece	Kirgizstan	Pakistan	Dominica	Nigeria
Iceland	Lithuania	Sri Lanka	Caimans	Saudi Arabia
Ireland	Moldova	Singapore	Mexico	Seychelles
Isle of Men	Montenegro	Thailand	Panama	Sierra Leone
Italy	Poland	Taiwan	Peru	South Africa
Japan	Rumania	Vanuatu	Puerto Rico	Syria
Jersey	Russia	Vietnam	St. Kitts and Nevis	The UAE
Liechtenstein	Serbia		Turks and Caicos	Togo
Luxembourg	Slovakia		Venezuela	Tunis
Malta	Slovenia			Turkey
New Zealand	Tajikistan			Yemen
Norway	Turkmenistan			
The Netherlands	Ukraine			
Portugal	The USSR			
San Marino	Uzbekistan			
Spain				
Sweden				
Switzerland				
The UK				
The USA				

Note. Compiled by the authors according to Fortanier (2007).

Appendix D – Regression Matrices

Table D1

Time Series Regression Matrix for the Whole Economy

Variable	Model 1 NW	Model 2 NW	Model 3 NW	Model 4 NW
Solow residual % change	L4 .4919***	L4 .5252***	L4 .5273***	L4 .4499***
Accumulated FDI Inflow change	L0 .0889 L2 .6153**	-	L0 .1108	-
Accumulated FDI Inflow change from Dev°	-	L0 .0987 L2 .6808*	-	L0 .0853 L1 .9194***
Accumulated FDI Inflow change from CEE°	-	L0 -.0302	-	L0 .2715
Accumulated FDI Inflow change from Asia°	-	L0 .0102**	-	L0 -.0019 L1 -.0077*** L2 .0064** -.0013
Accumulated FDI Inflow change from Latin°	-	L0 -.1457* L2 .1969* .0512*	-	L0 -.1855 L2 .2052**
Import / Output change	-	-	L0 -.0978*	L0 .3658** L1 -.5350*** -.1692
Constant	-.0122	-.0140	.0192	.0162
n	45	43	43	43

Variable	Model 5 NW	Model 6 NW	Model 7 NW	Model 8 NW
Solow residual % change	L4 .5660***	L4 .5581***	L4 .6725***	L4 .5916***
Accumulated net FDI change	L0 .2952**	-	L0 .3116	-
Accumulated net FDI change from Dev°	-	L0 .0197 L2 .3264**	-	L0 .0422
Accumulated net FDI change from CEE°	-	L0 .1812	-	L0 -.0270
Accumulated net FDI change from Asia°	-	L0 .0051* L4 -.0030** .0021	-	L0 .0532** L1 -.1019*** L3 .0268*** -.0022
Accumulated net FDI change from Latin°	-	L0 -.1121*** L2 .1325** L4 .0787* .0991	-	L0 -.0120
Import / Output change	-	-	L0 .4762 L3 .6254* L4 -.3576*** L5 -.1374*** .1304	L0 1.5399*** L3 -.2982*** L4 -.2768*** .9649
Constant	-.0077	-.0013	.0188	.0553***
n	43	43	39	40

Note. *$p < .1$. **$p < .05$. ***$p < .01$. No asterisk means p > .1. Superscript W next to the number of model – final results obtained from linear regression with heteroskedastic standard errors, NW – with Newey-West standard errors. “L” with a digit before coefficient shows the number of a lag. °- see Appendix C. Source: STATA output.

Table D2

Time Series Regression Matrix for Economic Sector A - Agriculture, Hunting and Forestry

Variable	Model 1 ^{W}	Model 2 ^{W}	Model 3 ^{W}	Model 4 ^{W}
Solow residual % change	L4 .7995***	L4 .8001***	L4 .7698***	L4 .7668***
Accumulated FDI Inflow change	L0 .0228 L1 -.4398*	-	L0 .1773 L5 .4883**	-
Accumulated FDI Inflow change from Dev°	-	L0 .1253	-	L0 .1690
Accumulated FDI Inflow change from CEE°	-	L0 -.2554*** L4 .1647*** -.0900	-	L0 -.2549*** L4 .1717*** -.0832
Accumulated FDI Inflow change from Asia°	-	-	-	-
Accumulated FDI Inflow change from Latin°	-	-	-	-
Import / Output change	-	-	L0 .1086***	L0 .1096***
Constant	.0308	-.0037	-.0393	-.0113
n	44	43	43	43

Variable	Model 5 ^{W}	Model 6 ^{NW}	Model 7 ^{NW}	Model 8 ^{NW}
Solow residual % change	L4 .8000***	L4 .8026***	L4 .7629***	L4 .8559***
Accumulated net FDI change	L0 -.0622 L1 -.2946*	-	L0 .0426	-
Accumulated net FDI change from Dev°	-	L0 .0532	-	L0 .0532
Accumulated net FDI change from CEE°	-	L0 -.2126*** L4 .1386*** -.0740	-	L0 -.1886*** L4 .2073*** .0187
Accumulated net FDI change from Asia°	-	-	-	-
Accumulated net FDI change from Latin°	-	-	-	-
Import / Output change	-	-	L0 .1063***	L0 -.1254 L1 2.146** L3 -.7584** L5 -.1607 1.2269
Constant	.0257	.0077	-.0058	-.0491
n	44	43	43	38

Note. *p < .1. **p < .05. ***p < .01. No asterisk means p > .1. Superscript ^{W} next to the number of model – final results obtained from linear regression with heteroskedastic standard errors, ^{NW} – with Newey-West standard errors. "L" with a digit before coefficient shows the number of a lag. °- see Appendix C. Source: STATA output.

Table D3

Time Series Regression Matrix for Economic Sector D - Manufacturing

Variable	Model 1^{W}	Model 2^{NW}	Model 3^{NW}	Model 4^{NW}	Variable	Model 5^{W}	Model 6^{NW}	Model 7^{W}	Model 8^{NW}
Solow residual % change	L4 .5325***	L4 .5453***	L4 .5195***	L4 .5546***	Solow residual % change	L4 .5645***	L4 .4500***	L4 .5627***	L4 .5550***
Accumulated FDI Inflow change	L0 .09 L2 2.2009*	-	L0 .3856 L1 2.4625	-	Accumulated net FDI change	L0 .2408	-	L0 .8591	-
Accumulated FDI Inflow change from Dev°	-	L0 1.1949	-	L0 .7361	Accumulated net FDI change from Dev°	-	L0 .2686 L2 -.8965**	-	L0 .7653** L2 -1.1367** L4 1.1948*** .8234
Accumulated FDI Inflow change from CEE°	-	L0 .2276	-	L0 .2399	Accumulated net FDI change from CEE°	-	L0 .0738	-	L0 -.0899
Accumulated FDI Inflow change from Asia°	-	L0 -.0015	-	L0 -.0028	Accumulated net FDI change from Asia°	-	L0 .0015* L3 .0022*** 0.0037	-	L0 .1902** L2 .1508*** L3 -.0430*** L4 -.0106*** .2874
Accumulated FDI Inflow change from Latin°	-	L0 .0619	-	L0 .0634	Accumulated net FDI change from Latin°	-	L0 -.05474 L3 .0740**	-	L0 -.0272 L1 -.0843*** L3 .1076*** L4 .0976*** .1209
Import / Output change	-	-	L0 -.0151	L0 .0155	Import / Output change	-	-	L0 -.0041	L0 .3024 L3 -1.7820*** L4 1.245*** -.5370
Constant	-.0118	-.0123	-.0124	-.0129	Constant	-.0043	-.0019	-.0041	.0081
n	43	43	43	3	n	43	43	40	43

Note. **p* < .1. ***p* < .05. ****p* < .01. No asterisk means p > .1. Superscript ^{W} next to the number of model – final results obtained from linear regression with heteroskedastic standard errors, ^{NW} – with Newey-West standard errors. "L" with a digit before coefficient shows the number of a lag. °- see Appendix C. Source: STATA output.

Table D4

Time Series Regression Matrix for Economic Sector E - Electricity, Gas and Water Supply

Variable	Model 1 ^{W}	Model 2 ^{W}	Model 3 ^{W}	Model 4 ^{W}
Solow residual % change	L4 .9490***	L4 .9709***	L4 .9482***	L4 .9813***
Accumulated FDI Inflow change	L0 .0580** L1 .0456* .514	-	L0 -.0594** L1 .0471* L4 .0744* .0621	-
Accumulated FDI Inflow change from Dev°	-	L0 -.3430* L1 .0805* L4 .1807* -.0818	-	L0 -.3241*
Accumulated FDI Inflow change from CEE°	-	L0 .0046	-	L0 .0037
Accumulated FDI Inflow change from Asia°	-	-	-	-
Accumulated FDI Inflow change from Latin°	-	-	-	-
Import / Output change	-	-	L0 .0221	L0 .0609
Constant	.0026	-.0022	-.0059	-.0088
n	43	43	43	43

Variable	Model 5 ^{W}	Model 6 ^{W}	Model 7 ^{W}	Model 8 ^{W}
Solow residual % change	L4 .9463***	L4 .9784***	L4 .9516***	L4 .9744***
Accumulated net FDI change	L0 -.0424*** L1 .0367* -.0057	-	L0 -.0566***	-
Accumulated net FDI change from Dev°	-	L0 -.4430** L4 .1084* -.3346	-	L0 -.3893**
Accumulated net FDI change from CEE°	-	L0 .0075*	-	L0 .0058
Accumulated net FDI change from Asia°	-	-	-	-
Accumulated net FDI change from Latin°	-	-	-	-
Import / Output change	-	-	L0 .0932	L0 .0899
Constant	.0024	.0063	-.0023	.0042
n	43	43	43	43

Note. *p < .1. **p < .05. ***p < .01. No asterisk means p > .1. Superscript ^{W} next to the number of model – final results obtained from linear regression with heteroskedastic standard errors, ^{NW} – with Newey-West standard errors. “L” with a digit before coefficient shows the number of a lag. °- see Appendix C. Source: STATA output.

Table D5

Time Series Regression Matrix for Economic Sector F – Construction

Variable	Model 1 W	Model 2 W		Model 4 W
Solow residual % change	L4 .9184***	L4 .8865***	L4 .9187***	L4 .8416***
Accumulated FDI Inflow change	L0 .1439	-	L0 .1434	-
Accumulated FDI Inflow change from Dev°	-	L0 -.0537	-	L0 -.1023
Accumulated FDI Inflow change from CEE°	-	L0 .2146**	-	L0 .1865***
Accumulated FDI Inflow change from Asia°	-	-	-	-
Accumulated FDI Inflow change from Latin°	-	-	-	-
Import / Output change	-	-	L0 -.0006	L0 .5079*** L2 -.5317*** L3 .1726** .1488
Constant	-.0147	-.0200	-.0146	-.0189
n	43	43	43	40

Variable	Model 5 W	Model 6 W	Model 7 W	Model 8 W
Solow residual % change	L4 .9149***	L4 .8334***	L4 .9191***	L4 .8271***
Accumulated net FDI change	L0 -.0445	-	L0 -.0713	-
Accumulated net FDI change from Dev°	-	L0 -.0752* L1 .0774** L2 .0731* L3 -.0714** .0039**	-	L0 -.0683* L1 .0819** L2 .07549** L3 -.0707** 0.0184
Accumulated net FDI change from CEE°	-	L0 .1518***	-	L0 .1575***
Accumulated net FDI change from Asia°	-	-	-	-
Accumulated net FDI change from Latin°	-	-	-	-
Import / Output change	-	-	L0 -.0139	L0 .0175
Constant	-.0041	-.0170	-.0008	-.0211
n	43	43	43	43

Note. **p* < .1. ***p* < .05. ****p* < .01. No asterisk means p > .1. Superscript W next to the number of model – final results obtained from linear regression with heteroskedastic standard errors, NW – with Newey-West standard errors. "L" with a digit before coefficient shows the number of a lag. °- see Appendix C. Source: STATA output.

Table D6

Time Series Regression Matrix for Economic Sector G - Wholesale, Retail Trade; Repair of Motor Vehicles, Motorcycles, Personal, Household Goods

Variable	Model 1 W	Model 2 W	Model 3 W	Model 4 W
Solow residual % change	L4 .9275***	L4 .9242***	L4 .9020***	L4 .8417***
Accumulated FDI Inflow change	L0 .0614	-	L2 -.2366	-
Accumulated FDI Inflow change from Dev°	-	L0 .1915	-	L0 .1204 L4 .5678**
Accumulated FDI Inflow change from CEE°	-	L0 .3060* L2 -.2453*** 0.0607	-	L0 .2267
Accumulated FDI Inflow change from Asia°	-	-	-	-
Accumulated FDI Inflow change from Latin°	-	-	-	-
Import / Output change	-	-	L0 -.0443**	L0 -.7115* L3 .1837** -.5278
Constant	-.0049	.0102	.0120	-.0039
n	43	43	43	40

Variable	Model 5 W	Model 6 W	Model 7 W	Model 8 W
Solow residual % change	L4 .9200***	L4 .9452***	L4 .9039***	L4 .8889***
Accumulated net FDI change	L0 -.0532 L4 .5671***	-	L0 .2897	-
Accumulated net FDI change from Dev°	-	L0 1308	-	L0 .2059 L1 .3970* L2 -.4414* -.0444
Accumulated net FDI change from CEE°	-	L0 .1141 L3 .2804**	-	L0 .0632 L3 .3418***
Accumulated net FDI change from Asia°	-	-	-	-
Accumulated net FDI change from Latin°	-	-	-	-
Import / Output change	-	-	L0 -.0693**	-.0703***
Constant	-.0181*	-.0235	.0010	-.0144
n	43	43	43	43

Note. *$p < .1$. **$p < .05$. ***$p < .01$. No asterisk means p > .1. Superscript W next to the number of model – final results obtained from linear regression with heteroskedastic standard errors, NW – with Newey-West standard errors. "L" with a digit before coefficient shows the number of a lag. °- see Appendix C. Source: STATA output.

Table D7

Time Series Regression Matrix for Economic Sector H – Hotels & Restaurants

Variable	Model 1[W]	Model 2[W]	Model 3[W]	Model 4[W]
Solow residual % change	L4 .3965*	L4 .3354	L4 .4003*	-
Accumulated FDI Inflow change	L0 -.0070	-	L0 .0405	-
Accumulated FDI Inflow change from Dev°	-	L0 -.1888	-	L0 -.3247*
Accumulated FDI Inflow change from CEE°	-	L0 .2363*	-	L0 .4103*** L2 -.4955*** -.0852
Accumulated FDI Inflow change from Asia°	-	L0 1.0165	-	L0 .4068
Accumulated FDI Inflow change from Latin°	-	L0 -.0618	-	L0 -.1364** L1 -.3033*** -.4397
Import / Output change	-	-	L0 -.0185	L0 .0081
Constant	.0028	-.0133	.0036	.0410
n	43	43	43	43

Variable	Model 5[W]	Model 6[W]	Model 7[W]	Model 8[W]
Solow residual % change	L4 .3785*	-	L4 .3800***	
Accumulated net FDI change	L0 .2121	-	L0 .2155	-
Accumulated net FDI change from Dev°	-	L0 -.0706	-	L0 .0008
Accumulated net FDI change from CEE°	-	L0 .2080***	-	L0 .2742***
Accumulated net FDI change from Asia°	-	L0 -.1578	-	L0 .1578
Accumulated net FDI change from Latin°	-	L0 2038	-	L0 .2129
Import / Output change	-	-	L0 -.0172	L0 .0100
Constant	-.001	.0001	.0009	-.0130
n	43	47	43	43

Note. *$p < .1$. **$p < .05$. ***$p < .01$. No asterisk means p > .1. Superscript [W] next to the number of model – final results obtained from linear regression with heteroskedastic standard errors, [NW] – with Newey-West standard errors. "L" with a digit before coefficient shows the number of a lag. °- see Appendix C. Source: STATA output.

Table D8

Time Series Regression Matrix for Economic Sector I - Transport, Storage and Telecommunication.

Variable	Model 1 NW	Model 2 W	Model 3 NW	Model 4 NW	Variable	Model 5 W	Model 6 NW	Model 7 W	Model 8 NW
Solow residual % change	L4 .9367***	L4 .9092***	L4 .9383 ***	L4 .9401***	Solow residual % change	L4 .9112***	L4 .9800***	L4 9120***	L4 .9799***
Accumulated FDI Inflow change	L0 -.2247	-	L0 -.1821	-	Accumulated net FDI change	L0 -.0886 L1 .4686***	-	L0 -.0713 L1 .4806**	-
Accumulated FDI Inflow change from Dev°	-	L0 -.0923 L4 -.7988*	-	L0 -.1839	Accumulated net FDI change from Dev°	-	L0 -.1543 L4 -. 4985***	-	L0 -.1527 L4 -.4966***
Accumulated FDI Inflow change from CEE°	-	L0 .4107 L4 2.0731*	-	L0 .7044	Accumulated net FDI change from CEE°	-	L0 .6870**	-	L0 .6825**
Accumulated FDI Inflow change from Asia°	-	-	-	-	Accumulated net FDI change from Asia°	-	-	-	-
Accumulated FDI Inflow change from Latin°	-	-	-	-	Accumulated net FDI change from Latin°	-	-	-	-
Import / Output change	-	-	L0 -.0204	L0 -.4557*** L1 .1858*** -.2699	Import / Output change	-	-	L0 -.0245	L0 -.0020
Constant	.0051	.0117*	.0069	.0202	Constant	-.0014	.0036	.0013	.0038
n	43	43	43	42	n	43	43	43	43

Note. *$p < .1$. **$p < .05$. ***$p < .01$. No asterisk means p > .1. Superscript W next to the number of model – final results obtained from linear regression with heteroskedastic standard errors, NW – with Newey-West standard errors. "L" with a digit before coefficient shows the number of a lag. °- see Appendix C. Source: STATA output.

Table D9

Time Series Regression Matrix for Economic Sector K - Real Estate, Renting and Business Activities.

Variable	Model 1 ^{W}	Model 2 ^{W}	Model 3 ^{W}	Model 4 ^{W}
Solow residual % change	L4 .4617***	L4 .4669***	L4 .5621***	L4 .5599***
Accumulated FDI Inflow change	L0 .3365** L1 .4786* .8151	-	L0 .2340*	-
Accumulated FDI Inflow change from Dev°	-	L0 .2200** L1 .3431* .5631	-	L0 .1451**
Accumulated FDI Inflow change from CEE°	-	L0 .0681	-	L0 .1378
Accumulated FDI Inflow change from Asia°	-	-	-	-
Accumulated FDI Inflow change from Latin°	-	-	-	-
Import / Output change	-	-	L0 -.2053*	L0 -.2160***
Constant	-.0726	-.0605*	-.0044	-.0482
n	43	43	43	43

Variable	Model 5 ^{W}	Model 6 ^{W}	Model 7 ^{NW}	Model 8 ^{W}
Solow residual % change	L4 .5074***	L4 .5568***	L4 .5257***	L4 .5609***
Accumulated net FDI change	L0 .2709* L1 .4392* .7101	-	L0 .2679* L1 .4141* .6820	-
Accumulated net FDI change from Dev°	-	L0 .1988**	-	L0 .0573 L4 .1841*
Accumulated net FDI change from CEE°	-	L0 -.0570 L1 .4188**	-	L0 .0212
Accumulated net FDI change from Asia°	-	-	-	-
Accumulated net FDI change from Latin°	-	-	-	-
Import / Output change	-	-	L0 -.1904***	L0 -.2264***
Constant	-.0518**	-.0463**	.0294	.0021
n	43	43	43	43

Note. **p* < .1. ***p* < .05. ****p* < .01. No asterisk means p > .1. Superscript ^{W} next to the number of model – final results obtained from linear regression with heteroskedastic standard errors, ^{NW} – with Newey-West standard errors. "L" with a digit before coefficient shows the number of a lag. °- see Appendix C. Source: STATA output.

Table D10

Time Series Regression Matrix for Economic Sector M - Education

Variable	Model 1 W	Model 2 W	Model 3 W	Model 4 NW	Variable	Model 5 NW	Model 6 NW	Model 7 NW	Model 8 NW
Solow residual % change	L4 .5725***	L4 .5648***	L4 .4880***	L4 .5254***	Solow residual % change	L4 .5690***	L4 .5577***	L4 .6197***	L4 .5957***
Accumulated FDI Inflow change	L0 .5159*** L1 -.4751*** .0408*	-	L0 .7240*** L4 .9618*** 1.6858	-	Accumulated net FDI change	L0 .1423*	-	L0 .1369	-
Accumulated FDI Inflow change from Dev°	-	L0 .0874** L1 .0882*** .1756**	-	L0 .0841*** L4 .1480** .2121	Accumulated net FDI change from Dev°	-	L0 .0722*** L1 -.1191*** -.1238	-	L0 .0753*** L1 -.1120** -.0367
Accumulated FDI Inflow change from CEE°	-	L0 .8526	-	L0 -1.5059 L2 3.3483*	Accumulated net FDI change from CEE°	-	L0 -.0873** L2 -.3354*** L3 .1868 -.2359*	-	L0 -.1027** L3 .1495*** .0468
Accumulated FDI Inflow change from Asia°	-	-	-	-	Accumulated net FDI change from Asia°	-	-	-	-
Accumulated FDI Inflow change from Latin°	-	-	-	-	Accumulated net FDI change from Latin°	-	-	-	-
Import / Output change	-	-	L0 .4593 L2 .5861***	L0 .5716***	Import / Output change	-	-	L0 .4619***	L0 .4301***
Constant	.0008	-.0028	-.0769***	-.0514*	Constant	.0016	-.0027	-.0260*	-.0230
n	43	43	41	43	n	43	43	43	43

Note. *$p < .1$. **$p < .05$. ***$p < .01$. No asterisk means p > .1. Superscript W next to the number of model – final results obtained from linear regression with heteroskedastic standard errors, NW – with Newey-West standard errors. "L" with a digit before coefficient shows the number of a lag. °- see Appendix C. Source: STATA output.

Table D11

Time Series Regression Matrix for Economic Sector O - Other Community, Social and Personal Service

Variable	Model 1 NW	Model 2 W	Model 3 NW	Model 4 W
Solow residual % change	L4 .8819 ***	L4 .8878***	L4 .8483***	L4 .8370***
Accumulated FDI Inflow change	L0 .0466* L3 .0411* .0877	-	L0 .0257	-
Accumulated FDI Inflow change from Dev°	-	L0 .0146 L3 .0663**	-	L0 -.0019 L3 .0853***
Accumulated FDI Inflow change from CEE°	-	L0 .3260** L1 -.3032** L2 -.3460** L3 .3807* 0.0575	-	L0 .1789** L1 -.2633** L2 .3756*** .2912
Accumulated FDI Inflow change from Asia°	-	-	-	-
Accumulated FDI Inflow change from Latin°	-	-	-	-
Import / Output change	-	-	L0 -.1804***	L0 -.1870***
Constant	-.0070	.0101	.0213	.0449*
n	43	43	43	43

Variable	Model 5 W	Model 6 W	Model 7 W	Model 8 NW
Solow residual % change	L4 .8821***	L4 .8928***	L4 .8485***	L4 .8639***
Accumulated net FDI change	L0 .0271** L3 .0166	-	L0 .0178**	-
Accumulated net FDI change from Dev°	-	L0 .0157** L3 .0266** .0423	-	L0 .0110
Accumulated net FDI change from CEE°	-	L0 .1591** L1 -.1731** -.014	-	L0 .1079* L1 -.1594* -.0515
Accumulated net FDI change from Asia°	-	-	-	-
Accumulated net FDI change from Latin°	-	-	-	-
Import / Output change	-	-	L0 -.1801***	L0 -.1750***
Constant	-.0043	.0037	.0217	.0251
n	43	43	43	43

Note. *$p < .1$. **$p < .05$. ***$p < .01$. No asterisk means p > .1. Superscript W next to the number of model – final results obtained from linear regression with heteroskedastic standard errors, NW – with Newey-West standard errors. "L" with a digit before coefficient shows the number of a lag. °- see Appendix C. Source: STATA output.