CERGE-EI
Charles University Prague
Center for Economic Research and Graduate Education
Academy of Sciences of the Czech Republic
Economics Institute

Juraj Stančík

Essays on International Economics

Dissertation

Prague, November 2009

Juraj Stančík

Essays on International Economics

Dissertation

Prague, November 2009

Dissertation Committee:

Štěpán Jurajda (CERGE-EI, Prague; chair)
Evžen Kočenda (CERGE-EI, Prague)
Jan Hanousek (CERGE-EI, Prague)
Peter Katuščák (CERGE-EI, Prague)

Referees:

Klara Sabirianova Peter (Georgia State University, USA)
Lucjan Orlowski (Sacred Heart University, USA)

Acknowledgements

I would like to thank all the people who helped me with this thesis. Especially, I am indebted to Štěpán Jurajda, my main advisor, for his guidance and excellent supervision, as well as patience and understanding. I have learned a lot from him. He helped me in the most difficult times and I would be long gone without his support. My big thanks goes also to Evžen Kočenda for supervising my first paper and introducing me to research. I am indebted also to Jan Hanousek for his advice and for providing me data for two papers. As members of my dissertation committee, Evžen and Jan have always been there for me, anytime I needed them. I am thankful also to the last member of the committee, Peter Katuščák, for giving me valuable comments on my research. I would like to express my gratitude also to Byeongju Jeong for his constructive criticism on the first paper. Throughout my studies I benefited from useful consultations with Jan Švejnar, Jan Kmenta, Renáta Kosová, Beata Smarzynska Javorcik, Petr Zemčík, and Lubomír Lízal. I am thankful also to Klara Sabirianova Peter and Lucjan Orlowski for referring my thesis, as well as Martin Čihák and two anonymous referees for referring the first paper. Furthermore, my thanks goes to members of the CERGE-EI English Department (Lawrence Smith, Robin-Eliece Mercury, and Richard Stock) for editing various stages of this thesis. While working on it, I also benefited from staying at the School of Arts and Sciences of the University of Pennsylvania. Financial support from the World Bank and the GACR is gratefully acknowledged as well.

I am very grateful also to my friends at CERGE-EI for supporting and believing in me. Lastly, I would like to thank my wife, Marianna, for her patience and support throughout my studies.

Contents

Introduction

This dissertation focuses on various economic problems of central European countries in transition. Membership in the Economic and Monetary Union (EMU) and an inflow of foreign capital belong to the biggest challenges these countries have to face.

The first essay therefore focuses on exchange-rate stability in five new members of the European Union (EU). This stability is not only a criterion for joining the EMU but also a fundamental property of stable economic development. However, there are several factors that could slow or interrupt these countries' EMU-integration process. For this reason, this essay analyzes key factors contributing to euro exchange-rate volatility in the new EU members during the period 1999-2004: economic openness, the "news" factor, and the exchange-rate regime. A TARCH (threshold autoregressive conditional heteroskedasticity) model is employed to model the volatility of exchange rates. Although this essay focuses on each country separately, in general the results suggest that economic openness has a calming effect on exchange-rate volatility, news significantly affects volatility, and flexible regimes experience higher degrees of volatility. The extent of all these effects varies substantially across countries, however.

The remaining of this dissertation is then devoted to various impacts of foreign direct investment (FDI) on domestic companies in the Czech Republic. Particularly, the second essay analyzes their sales growth rates. Using firm-level panel data from 1995 to 2003, it studies both horizontal and vertical spillovers. I pay attention to the potential endogeneity of FDI with respect to future industry growth. The results suggest that domestic companies are mostly suffering from the presence of foreign companies, especially in upstream sectors.

The third essay is coauthored with Štěpán Jurajda and we ask there the

following questions. Does foreign ownership improve corporate performance or do foreign firms merely select more productive targets for takeover? Do workers benefit from foreign acquisitions? We answer these questions based on comparing the before/after change in several performance indicators of Czech firms subject to foreign takeover after 1997, i.e., after the initial waves of privatization were completed, with the corresponding performance change of matched companies that remain domestically owned until 2005. We find that the impact of foreign investors on domestic acquisitions is significantly positive only in non-exporting manufacturing industries, while it is small in both services and manufacturing industries competing on international markets.

Chapter 1

Determinants of Exchange Rate Volatility: The Case of the New EU Members

Finance a úvěr - Czech Journal of Economics and Finance

(2007, vol. 57, no. 9-10)

1.1 Introduction

One of the reasons for establishing the Economic and Monetary Union (EMU) was to promote exchange rate stability among member countries and to encourage trade inside the European Union (EU). Otherwise, exchange rate instability could have a negative impact on investment and trade. In the case of sudden movements of an exchange rate, domestic risk-averse companies could turn their focus on the domestic market rather than on the foreign one because the amount of their revenue would become unclear (Dell'Ariccia, 1999). In fact, this exactly opposes the aim of the EU.

As a result of EU enlargement, ten new countries joined the EU in May 2004. The process of their accession further continues as they prepare to join the EMU probably around 2009-2012. By that time, these countries will have to fulfill the Maastricht criteria. This research focuses on factors that can jeopardize the process of fulfilling the second of these criteria - the Exchange Rate Mechanism (ERM) criterion which defines the exchange rate

of the participating currency against the euro. The currency can fluctuate around the central rate by ±15%.

Thus, the goal of this paper is to analyze the sources of euro exchange rate volatility for five central and eastern European countries (CEEC-5) that acceded to the EU in May 2004[1]. As possible sources, I am interested in the openness of an economy, the "news" factor, and the exchange rate regime due to their undisputed contribution to exchange rate movements. Since these countries are trying to fulfill exacting criteria imposed by the EU, including stable exchange rates, it is necessary and beneficial to know the source of their possible failure.[2]

Although there are already several studies dealing with the volatility of exchange rates in transition countries (Kočenda, 1998; Orlowski, 2003; Kóbor and Székely, 2004; Bulíř, 2005; Kočenda and Valachy, 2006), the contribution of this study over the previous projects lies in investigating not only the volatility itself but also its determinants and their casual effects. Moreover, I employ the TARCH model for modeling the volatility of exchange rates because it allows for an asymmetric, i.e., more realistic, impact of news on exchange rate volatility.

In general, the results are consistent with natural expectations. They suggest that the openness has a lowering effect on exchange rate volatility in the case of Poland, Slovakia, and Slovenia. Furthermore, a less tight regime corresponds to higher volatility in the case of Hungary, Poland, and Slovenia. A significant effect of news on exchange rate volatility is found in all cases. However, the extent of all these effects varies substantially across countries.

The paper is structured as follows: Section 1.2 deals with previous studies relevant for this research. The methodology is explained in Section 1.3. Section 1.4 comprises data description and Section 1.5 presents the empirical results. The last section concludes.

[1]These are the Czech Republic, Hungary, Poland, Slovakia, and Slovenia. I do not include Malta and Cyprus here since these two countries are not in the process of transition and they are considered to be functioning market economies. Moreover, Estonian kroon, Latvian lats, and Lithuanian litas are firmly linked to the euro, and therefore, Estonia, Latvia, and Lithuania are not included in this research either.

[2]Although Slovenia has been a member of the EMU since January 1, 2007, it is included in this research for the sake of consistency.

1.2 Literature Review

There is a variety of factors contributing to the fluctuation of an exchange rate, e.g., the openness of an economy, the domestic and foreign money supplies, the exchange rate regime, interest rates, central bank independence, levels of output, income, inflation, and unpredictable circumstances. The degree of the impact of each of these factors varies and depends on a particular country's economic condition. However, the countries that are in the process of transition (CEEC-5 group) are more vulnerable to being affected by these factors. Although this paper analyzes just a few of these factors, according to the empirical literature mentioned below they should be the ones with the biggest impact. In the following section, I explain my incentives for choosing particular factors as well as their validity.

1.2.1 Openness of an Economy

As was discussed above, one of the reasons for establishing the EMU was to promote the greater openness of economies and higher exchange rate stability among EU countries. However, you cannot achieve one without achieving the other. Thus, it is likely that there is a close link between these two factors.

One of the studies dealing with these factors was elaborated by Hau (2002). In particular, the author analyzes the openness of an economy and its impact on real exchange rate movements. He claims that trade integration and real exchange rate volatility are structurally linked and that there is a negative correlation between them. As support, he uses a small open economy model with a tradable and a non-tradable sector. The solution of this model indicates that economies which are more open have a more flexible aggregate price level. This flexibility reduces the effect of unanticipated money supply shocks. It further results in lower real exchange rate volatility for countries with greater openness of the economy. Hau further supports his claim with empirical research with a sample of 48 countries over a 19-year time period. As a proxy for openness he uses an import vs. GDP ratio. Real exchange rate volatility is measured as the standard deviation for the percentage changes of the effective real exchange rate over intervals of 36 months. The results confirm the impact of an economy's openness on exchange rate volatility when openness explains almost half of exchange rate variations. However, Hau's

results do not say anything about particular countries because each country is represented only by arithmetic mean values over the whole period.

1.2.2 Unpredictable Circumstances

The next factor analyzed in this paper concerns unpredictable circumstances or news. This affects all real variables as well as asset yields. In stock markets simple information, often not even valid, might cause huge movements of stock prices. The behavior of exchange rates is very similar, and the consequences of events like government crises, market crises, industrial shocks and terrorist attacks are undisputed. The role of news as the predominant cause of exchange rate movements has already been emphasized in studies by Dornbusch (1978) and Frenkel (1981).

The latter one, by Frenkel, studies the volatility of the US exchange rates between GBP, FFR and DEM.[3] The first part of his paper concerns exchange rate movements and their predictability where he claims that the predicted changes in exchange rates capture only a small fraction of actual changes. Therefore, since most changes in exchange rates are unanticipated, most of them happen due to some new information. Frenkel supports this with an eight-year period of monthly data of the US/GBP, US/FFR, and US/DEM exchange rate movements. In the second part of his study, Frenkel, seeking a suitable instrumental variable for modeling news, discusses the relationship between exchange and interest rates. Although macroeconomic theory explains the negative impact of interest rates on exchange rates via capital/current accounts, he claims – based on empirical results from US data – that it does not hold in an inflationary environment, and the impact is actually positive.[4] Furthermore, in line with the rational expectations hypothesis indicating the predominant role of news in affecting real variables and Dornbusch (1978), who decomposes the news effects into "those which alter the expected future spot rate between the last period and the present, and those which lead to a reassessment of the one-period interest rate differential,"[5] Frenkel proposes a model for estimating the effect of news on exchange rate

[3]GBP = Great Britain Pound, FFR = French Franc, DEM = Deutsche Mark

[4]However, based on the empirical results from Frenkel's study, the macroeconomic theory holds in this case because the effect is negative for all three exchange rates, although it does not differ significantly from zero.

[5]Frenkel (1981), pp. 686.

variability:

$$\ln S_t = a + b \ln F_{t-1} + \alpha \left[(i - i^*)_t - E_{t-1}(i - i^*)_t \right] + \omega_t,$$

where S_t is the spot rate, F_{t-1} is the lagged forward exchange rate, i is the interest rate in the domestic currency, i^* is the interest rate in the foreign currency, and $E_{t-1}(.)$ represents the interest differential expected at time t based on information available at time $t-1$. The first two components on the right-hand side represent the expected exchange rate and the term in brackets represents news. According to Frenkel, applying this regression on all three pairs of currencies (separately) indicates a positive correlation between news and exchange rates. However, there is a weakness in these results. Frenkel uses $\ln S_t$ as a dependent variable but he does not consider that this time series is most likely non-stationary. He also does not take into account asymmetric effects of positive and negative news. Moreover, monthly data, used by Frenkel, cannot capture the moment of surprise caused by some new information. Therefore, I expect to obtain better and more significant results using higher frequency data.

The effect of news is discussed also in a study by Galati and Ho (2003) who investigate to what extent daily movements in the euro/dollar exchange rate are driven by news. Finding again a statistically significant correlation between them, good news results in the appreciation of currency, and vice versa. For modeling news they use a similar approach to Frenkel – the difference between the actual and forecasted values – although they measure it on various macroeconomic indicators.[6] The exchange rate movements are captured by the differences in values of the logarithm of the spot prices. Additionally, although Galati and Ho focus also on studying asymmetric behavior of an exchange rate with respect to good or bad news, they do not find any significant asymmetry. On the other hand, Engle and Ng (1993) claim that there is an asymmetric effect of news on volatility and suggest various modifications of the ARCH model[7] for emulating exchange rate volatility. For example, the EGARCH model allows different impacts of good and bad news, as well as major and minor news. In the spirit of this asymmetry,

[6] Change in non-farm payrolls, the unemployment rate, the employment cost index, durable goods orders, NAPM manufacturing, NAPM non-manufacturing, advance retail sales, industrial production, the consumer price index, and the producer price index.

[7] The autoregressive conditional heteroskedasticity model (ARCH) was introduced by Engle (1982). Later, this model was generalized (GARCH) by Bollerslev (1986).

Sanchez-Fung (2003) studies daily returns, volatility, and news in the foreign exchange market of the Dominican Republic, concluding that impact on the volatility of exchange rate returns is higher for positive shocks (depreciations) than for negative ones (appreciations).

1.2.3 Exchange Rate Regime

The last but equally important factor is the exchange rate regime. It is a well-known fact that nominal exchange rate variability is lower in the case of fixed exchange rates than for floating ones. For my research, examples of countries that adopted a floating exchange rate are Slovakia, Poland, and the Czech Republic, while Slovenia and Hungary prefer variations of a pegged exchange rate.

1.2.4 Volatility of Exchange Rate

There are further studies concerning exchange rate volatility, although mostly they investigate the impact of exchange rate volatility rather than sources of this volatility. However, among other things (such as the subject of study), they differ in the way of modeling exchange rate volatility. According to this modeling, they can be divided into two groups – the ones that use various modifications of standard deviations and the ones that use modifications of the ARCH approach.

Belke and Setzer (2003) belong to the first group. They study the impact of exchange rate volatility on the labor market. In their case, the exchange rate volatility is measured as the standard deviation of the 12 month-to-month changes in the logarithm of the spot rate. Dell'Ariccia (1999) studies the effect of exchange rate volatility on bilateral trade flows. He uses the standard deviation of the first difference of the logarithmic exchange rate as well, but he also employs two other measures – the sum of the squares of the forward errors and the percentage difference between the maximum and minimum nominal spot rate. Moreover, there are studies, such as Kenen and Rodrik (1986), Koray and Lastrapes (1989), Chowdhury (1993), Kóbor and Székely (2004), and Bulíř (2005) that model the exchange rate volatility as the moving sample standard deviation of the growth rate of the real exchange rate.

On the other hand, Baum et al. (2004), analyzing the impact of exchange rate volatility on the volume of bilateral exports, and Choudhry (2005), investigating the influence of exchange rate volatility on real exports, apply the GARCH model for measuring volatility. Further modification of the ARCH approach can be found in Orlowski (2003, 2004). Here, for modeling exchange rate volatility the TARCH model is employed. Kočenda and Valachy (2006), analyzing recent developments in exchange rate volatility in the Visegrad Group countries,[8] suggest usage of the leverage GARCH model.[9] Moreover, exchange rate volatility and the TARCH model are analyzed also in studies by Kočenda (1998) and McKenzie (2002). Although the TARCH approach is mostly employed in papers analyzing stock price movements, Kočenda (1998) claims that with regard to risk there is almost no difference between holding foreign exchange and equity. For this reason, he stresses the justification of using the TARCH approach also for modeling exchange rate volatility.

Thus, this latter approach – ARCH – is plausible also for this research because its modification allows for an asymmetric, i.e., more realistic, impact of news on exchange rate volatility.

1.2.5 Previous Literature about Exchange Rate Volatility

The issue of the stability of the exchange rate in new EU member countries preparing for EMU accession is well researched. The following paragraphs describe some of the most important papers focusing on this topic.

Kočenda (1998) studies the exchange rate of the Czech Koruna against six major currencies. He finds the somewhat surprising result that the Czech exchange rate is less volatile with a wider fluctuation band. Orlowski (2003) examines the impact of monetary policies on exchange rate risk premiums and inflation in the Czech Republic, Poland, and Hungary. He concludes that the governments of these countries succeeded mainly in lowering inflation rather than exchange rate volatility. Orlowski (2004) then continues in his research by analyzing the effect of interest rates and inflation on exchange rate movement, which is defined as the differential of the log of the spot exchange rate. He claims that the Czech exchange rate is more affected by

[8] the Czech Republic, Hungary, Poland, and Slovakia.
[9] The leverage GARCH model is in fact the TARCH model.

inflation expectations, while the opposite is true for Poland, where the impact of the interest rate differential is more pronounced. Regarding Hungary, its currency is affected by both of those factors. A further analysis of exchange rate volatility reveals that in the Czech Republic and Poland it is driven mainly by the persistency effect. In Hungary it is dominated by asymmetric shocks. All three of these papers allow for asymmetric effects of shocks on volatility but only within the TARCH model through a leverage term.

The following three papers are similar in focusing on the same objects – the Visegrad Group countries. Kóbor and Székely (2004) study volatility using a Markov regime-switching model which allows them to identify periods of highly and lowly volatile exchange rates. Not surprisingly, their results say that volatility between these periods changes and is lower in lowly volatile periods. They also claim that there are substantial differences in volatility among the four countries. Bulíř (2005) looks at the relationship between exchange rate volatility and financial market liberalization and concludes that liberalization significantly contributes to the stability of the exchange rates in all four countries. Finally, Kočenda and Valachy (2006) compare exchange rate volatility between fixed and floating regimes. Their findings confirm natural expectations that volatility increases under a less tight, i.e., floating, regime. Moreover, they augment the TARCH model by inclusion of an interest rate differential and its intertemporal change in order to account for their impact on volatility. They claim asymmetric decreasing effects of news on exchange rate volatility, as well as contemporaneous impact of the interest differential.

The previous literature dealing with exchange rate volatility is quite comprehensive. Nevertheless, the previous studies concentrate mainly on volatility itself leaving the question of its determinants unresolved. Although there are some attempts to solve this problem, they are mostly implicit. Literature focusing primarily and explicitly on determinants of exchange rate volatility is still missing.

1.3 Methodology

The paper analyzes the volatility of the exchange rate between the euro and the domestic currency for five different countries. The crux of this project

lies in properly choosing the way to model the analyzed factors, especially the openness of an economy and news and, more importantly, to approximate an otherwise unobservable volatility.

1.3.1 Factors

Starting with independent variables, for modeling the openness of an economy, I follow Hau (2002) and use a proxy defined as the ratio of quarterly imports and quarterly gross domestic product. However, in order to observe the effects of openness on exchange rate volatility caused only by structural changes in openness and not by business cycles noise, the Hodrick-Prescott filter[10] is applied to quarterly openness time series. Then, since I need a daily frequency time series, the resulting time series is extended so that it comprises only four different values for every year, and the same smooth ratio of quarterly imports and quarterly GDP is assigned to each day in a particular quarter.

Since it is difficult to observe and quantify unpredictable circumstances or news, I build on the specification proposed by Frenkel (1981), who, knowing the fact that asset markets clear fast and react immediately to news, creates a new variable

$$NEWS_t = (i - i^*)_t - E_{t-1}(i - i^*)_t, \tag{1.1}$$

where i is the interest rate in the home currency and i^* is the interest rate in the foreign currency; the first term in this difference denotes the innovation in the interest differential and the second one denotes the interest differential which was expected to prevail in period t based on the information available at $t-1$. Partially following Frenkel, the latter term is estimated from a regression of the interest differential on the constant, two-lagged values of the differential and the logarithm of the lagged spot exchange rate. Frenkel is followed only *partially* because originally he suggests using the forward exchange rate instead of the spot exchange rate. However, since forward exchange rate markets are either not developed sufficiently or do not have a long history in the CEEC-5 group, the spot rate is used instead. I justify this modification using Frenkel's own argumentation when he claims the cor-

[10]This is a smoothing method used by macroeconomists to obtain a smooth estimate of the long-term trend component of a series, first used by Hodrick and Prescott (1997). The penalty parameter is set to 1600 since the filter is applied to quarterly data.

relation between the forward and spot exchange rate to be more than 0.99 in the case of his data. This is also the case for CEEC-5 where the correlation for available periods is more than 0.98 for every country.

For modeling different exchange rate regimes, I create a set of dummy variables for different regimes.

1.3.2 Measure of Volatility

Regarding the dependent variable, i.e., the volatility of exchange rates, I employ the threshold autoregressive conditional heteroskedasticity (TARCH) model. This model comprises a leverage term that allows for the asymmetric effects of good and bad news. The general $TARCH(p,q)$ model is specified as:

$$r_t = a_0 + \sum_{i=1}^{P} a_i r_{t-i} + \sum_{i=0}^{Q} b_i \varepsilon_{t-i};\ \varepsilon_t \sim N\left(0, \sigma_t^2\right)$$

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{q} \beta_i \sigma_{t-i}^2 + \xi d_{t-1} \varepsilon_{t-1}^2,$$

where variable r_t is the exchange rate change over two consecutive trading days, and σ_t^2 is the conditional variance that is a function of not only the previous realizations of ε_t, but also the previous conditional variances and the leverage term. The core of this leverage term is the dummy variable d_{t-1} that equals 1 in the case of a negative shock ($\varepsilon_{t-1} \leq 0$) and 0 in the case of a positive shock ($\varepsilon_{t-1} > 0$). Thus, the positive value of the coefficient ξ indicates an increased conditional variance by ε_{t-1}^2 in the case of negative shocks or news that occur at time t-1, while the negative value of coefficient ξ indicates a decreased conditional variance. The additional restriction $\sum_{i=1}^{p} \alpha_i + \sum_{i=1}^{q} \beta_i < 1$ is a sufficient and necessary condition for stability of the conditional variance.

In order to get a properly specified model and correctly conditioned volatility, the most appropriate $ARMA(P,Q)$ model of the exchange rate return is estimated using the Box-Jenkins methodology[11]. Then the Ljung-Box Q-test[12] is applied to test squared residuals of the $ARMA(P,Q)$ model for the presence of conditional heteroskedasticity. The next step is to identify the orders of the $TARCH(p,q)$ process by experimenting with different

[11] Box and Jenkins (1976)
[12] Ljung and Box (1978)

orders p and q; estimating the whole $ARMA(P,Q) - TARCH(p,q)$ model; checking the significance of the estimated coefficients; and then diagnosing the standardized residuals. Once the presence of conditional heteroskedasticity is detected and the orders p and q of the TARCH process are chosen, the whole $ARMA(P,Q) - TARCH(p,q)$ model is estimated using the maximum likelihood estimation where the log-likelihood function has the form

$$L = -\frac{1}{2T}\sum_{t=1}^{T} \log \sigma_t^2 + \varepsilon_t^2/\sigma_t^2.$$

Finally, the standardized residuals are diagnosed by applying the *Ljung-Box Q-test* and the *LM test for the presence of an ARCH process*.[13] If the estimated model is a correct one, then these residuals should be white noise[14] and no further GARCH process should be present.

1.3.3 Model for Estimation of the Effects

Having estimated all the necessary variables, I perform the actual analysis of the impact of various factors by estimating the following model using OLS:

$$ERV_t = \alpha + \beta\left(\frac{Im_t}{GDP_t}\right) + \gamma_G G_t * NEWS_t + \gamma_B B_t * NEWS_t + \delta REGIME_t + \varepsilon_t, \tag{1.2}$$

where ERV_t denotes exchange rate volatility estimated in the previous TARCH model, G_t is a dummy variable that equals 1 in case of good news ($NEWS_t < 0$), B_t is a dummy variable that equals 1 in case of bad news ($NEWS_t > 0$) and $REGIME_t$ denotes a set of dummy variables for exchange rate regimes. This process is repeated for each of the five countries in order to determine the different impacts on each particular currency. The interpretation of coefficient β is straightforward, a positive value of β results in increased volatility in the case of increased openness. Similarly, a positive value of coefficient δ results in increased volatility in the presence of a particular regime with respect to a base regime. However, the manner of constructing the $NEWS_t$ variable

[13] Engle (1982)

[14] The latest literature suggests an even stronger condition. The standardized residuals should be tested for being *iid* because there might be hidden nonlinear patterns that are not detected if a white noise test is applied. For this purpose, one can apply the BDS test developed by Brock et al. (1987) or, as an alternative, Kočenda's test, which was devised by Kočenda (2001). However, these two tests cannot be applied here, since they require the standardized residuals to have a normal distribution and the residuals estimated in this study do not have such a property.

requires an opposite interpretation – if it is assumed that the interest rate in the foreign currency does not change due to news in the home country and good news in the home country leads to a decrease in the home currency interest rate, then good news results in a negative value of the $NEWS_t$ variable. Thus, a negative value of coefficient γ results in increased volatility in the case of good news.

1.4 Data

All the data used in this project were collected with daily frequency during the period of January 1, 1999 – December 31, 2004 from several sources – IMF-IFS, Eurostat, national banks, and central statistical offices. Although there is another strand of literature that studies intraday volatility[15] using high frequency data with a several-minute-long time interval (Černý and Koblas, 2005), for the purpose of this project it is sufficient to use daily data. Using lower frequency data, e.g., monthly or quarterly, might result in the failure of this study because it would often not be able to capture any effects of news on exchange rate movements.

The extent of openness differs substantially in the CEEC-5 group. While the value of Polish imports corresponds on average to 31% of GDP, in the case of Slovenia it is about 50%. The economies of the Czech Republic and Hungary are on average even more open (61%), but the biggest share of imports over GDP can be found in Slovakia (almost 70%). Figure 1.1 displays the openness path in each country before (dotted line) and after (solid line) smoothing. All patterns exhibit an increasing trend, except Hungary with its decreasing trend since the fourth quarter of 2001. Basic characteristics are summarized in Table 1.1.

The factor of news is modeled from a particular country's interest rates (IBORs) with maturity of three months,[16] the Central European Bank's interest rates (EURIBOR) with the same maturity, and the spot exchange rates against the euro.

An overview of adopted official exchange rate regimes in each country can

[15] Typically concerning stock market indices.

[16] PRIBOR for the Czech Republic, BUBOR for Hungary, WIBOR for Poland, and BRIBOR for Slovakia. In the case of Slovenia, interbank money market rates for deposits up to 30 days are used instead due to the lack of SITIBOR data.

be found in Table 1.2. Since Slovakia and the Czech Republic did not change their exchange rate regime during the whole time span, the regime factor is not analyzed as a source of exchange rate volatility in their case.[17]

Finally, the basic characteristics of the nominal exchange rates of each CEEC-5 country's currency vis-à-vis the euro are summarized in Table 1.4. Corresponding exchange rate changes are displayed in Figure 1.2. Looking at this figure, there is a general trend of decreasing volatility at the end of the time span. Regarding the connection between volatility and real-life events, there is a tendency for increased volatility prior to presidential or parliamentary elections, although this is not always the case. In the case of Hungary, there is a visible change in the regime in May 2001 with much higher volatility afterwards. On the other hand, Slovenia has extremely low volatility, which is the result of a tight exchange rate regime during the whole time span.

1.5 Empirical Results

The first stage of analyzing the effects of determinants of exchange rate volatility consists of estimating the corresponding TARCH model for each currency. The results of these estimations are summarized in Table 1.3. With the exception of Slovenia, the results suggest that in the CEEC-5 group the exchange rate volatility is statistically significantly asymmetrically affected by unpredictable circumstances. The sign of leverage term implies lower conditional variance in the case of a negative shock for Hungary, Poland, and Slovakia, while for the Czech Republic it implies higher conditional variance. In the case of Slovenia, a simple ARCH model with variance as an ARCH-M term is estimated instead. For each country the sum of α's and β's in the variance equation satisfies the stability condition, which implies that exchange

[17] According to Reinhart and Rogoff (2004), it is necessary to be careful while modeling different exchange rate regimes and not to blindly follow official classification of these regimes. For this reason, they study dual and parallel exchange rate markets on a sample of 153 countries over a 55-year time period. Based on this, they claim that a majority of official pegs are actually floats, and vice versa. As a result, they provide a new system for classifying exchange rate regimes with the accent on real and proclaimed regimes. Fortunately, this is not the case in the CEEC-5 group. These countries either comply with their proclaimed regimes or the changes are only superficial. Only in the case of Poland is there a pre-announced crawling band of $\pm 12.5\%$, later changed to $\pm 15\%$, while according to Reinhart and Rogoff (2004) it is de facto $\pm 5\%$ in both cases. Therefore, I employ official exchange rate regimes for the purpose of this study.

rate changes converge to the steady-state level, although this convergence is slow in the Czech Republic with sums close to one. Additionally, the value of coefficient β in the GARCH term close to one suggests that there is a high persistence of conditional variance in these two countries. Regarding asymmetric effects and variance persistency, these results are in accordance with previous studies by Orlowski (2003) and Kočenda and Valachy (2006), although these studies do not deal with Slovenia.

Once the correct ARCH model is specified, conditional variance from this model is calculated. Moreover, the $NEWS$ variable is estimated from equation (1.1). Basic characteristics about variance and news are presented in Tables 1.5 and 1.6, respectively. Both of these variables are further depicted in Figures 1.3 and 1.4, respectively.

The final stage is to run a regression (1.2). This regression is run without the $REGIME$ variable for the Czech Republic and Slovakia, since these countries did not change their exchange rate regime during the whole time span. I also allow for lags of the $NEWS$ variable in this regression in order to capture delayed effects of news. The results of these estimations are summarized in Table 1.7.

The negative sign of coefficient β corresponds to the previously mentioned theory that countries with more open economies tend to have lower exchange rate volatility. The only exception here is Hungary with a positive, but statistically insignificant, value of β. The effect of openness is insignificant also in the Czech Republic. On the other hand, openness has statistically significant effects on exchange rate volatility in the other three countries. The smallest effect is in Slovakia, where a 1% increase in the ratio of import over GDP decreases variance by 3.1% of its mean value. Bigger effects are seen in Poland (8.8%) and in Slovenia with its huge 98% decrease.[18] Although the impact on Slovenia seems to be too dramatic, one has to keep in mind that openness in Slovenia is the most stable among these five countries and a 1% increase in the overall trend is quite unlikely. Moreover, these numbers are provided here only for comparison in order to see the differences between particular countries – Slovenia is much more affected by its foreign trade than are the other four countries.

[18]These results are obtained by comparing the estimated coefficient from Table 1.7 with the corresponding mean value of estimated conditional variance from Table 1.5.

The results for regimes reflect natural expectations – a less tight regime corresponds to higher volatility. In May 2001 Hungary changed its exchange rate regime from a ±2.25% crawling band to ±15% and the results suggest that the former regime significantly lowers conditional variance by its mean value compared to the latter regime. In the case of Poland, a change of the exchange rate regime from a ±12.5% crawling band to ±15% has no significant effects on conditional variance with respect to a base floating exchange rate regime. Similarly, in Slovenia a change from a ±2% crawling band to Exchange Rate Mechanism II (ERM II) has no significant effects on volatility either. This implies that Slovenia does not use the whole ±15% band that is allowed by ERM II.

With regard to the news effects,[19] the results are mostly consistent with the results concerning the leverage effect from the TARCH model. The exceptions are Poland and Hungary with lagged effects of news. In both cases, the effects of good news are opposite those estimated by the leverage term from the TARCH model. The reason for this discrepancy may be that the TARCH model uses the residuals only from exchange rate changes, while the approach in equation (1.1) accounts for changes in expectations about exchange rates as well as interest rates. However, the complexity of this latter approach guarantees more accurate measures of the news effects. In all five countries, the results suggest that news statistically significantly impacts exchange rate volatility; there is no statistically significant difference between good and bad news at the level of the effect, and there are huge differences in vulnerability across the CEEC-5 group when taking into account the extreme values of estimated news.[20] Good (bad) news increases (decreases) exchange rate volatility in the Czech Republic (about 30% of its mean) and Poland (about half the mean). The situation is the opposite in Slovakia, where good news decreases and bad news increases exchange rate volatility by more than the mean of its exchange rate volatility. Hungary and Slovenia are the only countries where any news, good or bad, increases exchange rates volatility, again by more than the mean of their exchange rate volatility.

[19]Recall that a negative sign of coefficient γ in the case of good news is interpreted so that it increases exchange rate volatility.

[20]The following results are obtained by multiplying the estimated coefficients from Table 1.7 with the corresponding extreme values from Table 1.6 (min. for good news and max. for bad news) and then comparing them with the mean value of estimated conditional variance from Table 1.5.

The previous results reveal an interesting fact. While good news contributes to increased volatility in every country except Slovakia, the impact of bad news is negative or close to zero when positive values are either not significant or significant only at the 15% level in the case of Hungary, Slovakia, and Slovenia. Nevertheless, although this fact seemingly contradicts natural expectations, it has a reasonable explanation. Regarding good news – the exchange rate changes also in this case and even if it declines – this appreciation contributes to increased volatility. On the other hand, the impact of bad news is suppressed because bad news is usually accompanied by expectations of active policy responses that hamper any potential movements in the exchange rate (Orlowski, 2003).

Several further tests are performed to ensure that the previous results are robust for changes in the methodology of either the dependent or independent variable. At first, openness in regression (1.2) is replaced with its original form, i.e., without the Hodrick-Prescott filter. The results for news and regimes remain unchanged – the sign as well as significance. Regarding openness, the results are in general lower in magnitudes (2-10 times), with the sign and significance unchanged. This is probably caused by higher variation in unfiltered openness when the overall impact is diminished. This only supports the application of the Hodrick-Prescott filter. The second variation in regression (1.2) is the change in the dependent variable. Now exchange rate volatility is modeled using a simpler GARCH model so the asymmetric effects are allowed only by the $NEWS$ variable.[21] The results of all variables are consistent with the baseline specification also in this case. There are only minor differences in magnitudes of news.

1.6 Conclusion

In this paper I have analyzed the sources of euro exchange rate volatility separately for every country in the CEEC-5 group. As possible sources, I am interested in the openness of an economy, the news factor, and the exchange rate regime. Exchange rate volatility is estimated from a TARCH model with emphasis on the asymmetric effects of news. However, these asymmetric

[21] This robustness test is not performed for Slovenia since the TARCH model was not employed in this case.

effects are confirmed only in the sense of their sign, not their value. This study further confirms the assumption that more open economies tend to have lower exchange rate volatility when this result holds in most countries.

Looking at the results for particular countries, news has a large effect on exchange rate volatility in Hungary, Slovakia, and Slovenia. But Slovenia has huge potential in its openness, which has a substantial decreasing impact on its exchange rate volatility. On the other hand, Hungary and Slovakia cannot rely on such a tool because openness has almost no effect on their exchange rate volatility. The other two countries, Poland and the Czech Republic, cannot rely on openness in decreasing their exchange rate volatility either. However, these countries' exchange rate volatility is affected by news only slightly. Regarding regimes, only key changes in exchange rate regimes have significant effects on exchange rate volatility, while minor and superficial changes are not reflected in volatility at all.

Looking at the results for particular countries, there is a large effect of news on exchange rate volatility in Hungary, Slovakia, and Slovenia. But Slovenia has a huge potential in its openness which has a substantial decreasing impact on its exchange rate volatility. On the other hand, Hungary and Slovakia cannot rely on such a tool because the openness has almost no effect on their exchange rate volatility. The other two countries, Poland and the Czech Republic, cannot rely on the openness in decreasing their exchange rate volatility as well. However, these countries' exchange rate volatility is affected by news only slightly. Regarding regimes, only key changes in exchange rate regimes have significant effects on exchange rate volatility, while minor and superficial changes are not reflected in volatility at all.

The main contribution of this study is that it sheds some light on a few potential pitfalls that may occur during the CEEC-5 group's EMU integration process. The fact that the vulnerability of these countries varies may be explained by the different strength of each country's currency or by different policies adopted by each country's central bank. Either way, further research is needed in order to distinguish between these two cases and to see their impact on other Maastricht criteria.

1.7 References

Baum, C. F., Caglayan, M., & Ozkan, N. (2004). Nonlinear Effects of Exchange Rate Volatility on the Volume of Bilateral Exports. *Journal of Applied Econometrics, 19(1)*, 1-23.

Belke, A., & Setzer, R. (2003). Exchange Rate Variability and Labor Market Performance in the Visegrad Countries. *Economics of Planning, 36(2)*, 153-175.

Bollerslev, T. (1986). Generalized Autoregressive Conditional Heteroskedasticity. *Journal of Econometrics, 31*, 307-327.

Box, G., & Jenkins, G. (1976). Time Series Analysis, Forecasting, and Control. *San Francisco, California: Holden day.*

Brock, W. A., Dechert, W. D., & Scheinkman, J. A. (1987). A Test for Independence Based on the Correlation Dimension. *University of Wisconsin at Madison, Department of Economics Working Paper.*

Bulíř, A. (2005). Liberalized Markets Have More Stable Exchange Rates: Short-Run Evidence from Four Transition Countries. *Finance a úvěr/Czech Journal of Economics and Finance, 55(5-6)*, 206-231.

Černý, A., & Koblas, M. (2005). Stock Market Integration and the Speed of Information Transmission: the Role of Data Frequency in Cointegration and Granger Causality Tests. *Journal of International Business and Economics, 1*, 110-120.

Choudhry, T. (2005). Exchange Rate Volatility and the United States Exports: Evidence from Canada and Japan. *Journal of the Japanese and International Economies, 19(1)*, 51-71.

Chowdhury, A. R. (1993). Does Exchange Rate Volatility Depress Trade Flows? Evidence from Error-Correction Models. *The Review of Economics and Statistics, 75(4)*, 700-706.

Dell'Ariccia, G. (1999). Exchange Rate Fluctuations and Trade Flows: Evidence from the European Union. *IMF Stuff Paper, 46(3)*, 315-334.

Dornbusch, R. (1978). Monetary Policy under Exchange Rate Flexibility, In Managed Exchange-rate Flexibility: The Recent Experience. *Federal Reserve Bank of Boston Conference Series, 20.*

Engle, R. F., & Ng, V. K. (1993). Measuring and Testing the Impact of News on Volatility. *The Journal of Finance, 48(5)*, 1749-1778.

Engle, R. F. (1982). Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of U.K. Inflation. *Econometrica, 50*, 987-1008.

Frenkel, J. A. (1981). Flexible Exchange Rates, Prices, and the Role of "News": Lessons from the 1970s. *Journal of Political Economy, 89(4)*, 665-705.

Galati, G., & Ho, C. (2003). Macroeconomic News and the Euro/Dollar Exchange Rate. *Economic Notes, 32(3)*, 371-398.

Hau, H. (2002). Real Exchange Rate Volatility and Economic Openness: Theory and Evidence. *Journal of Money, Credit and Banking, 34(3)*, 611-630.

Hodrick, R. J., & Prescott, E. C. (1997). Postwar U.S. Business Cycles: An Empirical Investigation. *Journal of Money, Credit and Banking, 29(1)*, 1-16.

Kenen, P. B., & Rodrik, D. (1986). Measuring and Analyzing the Effects of Short-Term Volatility in Real Exchange Rates. *The Review of Economics and Statistics, 68(2)*, 311-315.

Kočenda, E. (1998). Altered Band and Exchange Volatility. *Economics of Transition, 6(1)*, 173-181.

Kočenda, E. (2001). An Alternative to the *BDS* Test: Integration across the Correlation Integral. *Econometric Reviews, 20(3)*, 337-351.

Kočenda, E. & Valachy, J. (2006). Exchange Rate Volatility and Regimes Change: A Visegrad Comparison. *Journal of Comparative Economics, 34*, 727-753.

Kóbor, Á. & Székely, I. P. (2004). Foreign Exchange Market Volatility in EU Accession Countries in the Run-Up to Euro Adoption: Weathering Uncharted Waters. *IMF Working Paper, 16.*

Koray, F., & Lastrapes, W. D. (1989). Real Exchange Rate Volatility and U.S. Bilateral Trade: A Var Approach. *The Review of Economics and Statistics, 71(4)*, 708-712.

Ljung, G., & Box, G. (1978). On a Measure of Lack of Fit in Time Series Models. *Biometrica, 65*, 297-303.

Orlowski, L. T. (2003). Monetary Convergence and Risk Premiums in the EU Accession Countries. *Open Economies Review, 14*, 251-267.

Orlowski, L. T. (2004). Exchange Rate Risk and Convergence to the Euro. *ZEI Working Paper, B25.*

Reinhart, C. M., & Rogoff, K. S. (2004). Modern History of Exchange Rate Arrangements: A Reinterpretation. *Quarterly Journal of Economics, 119(1)*, 1-48.

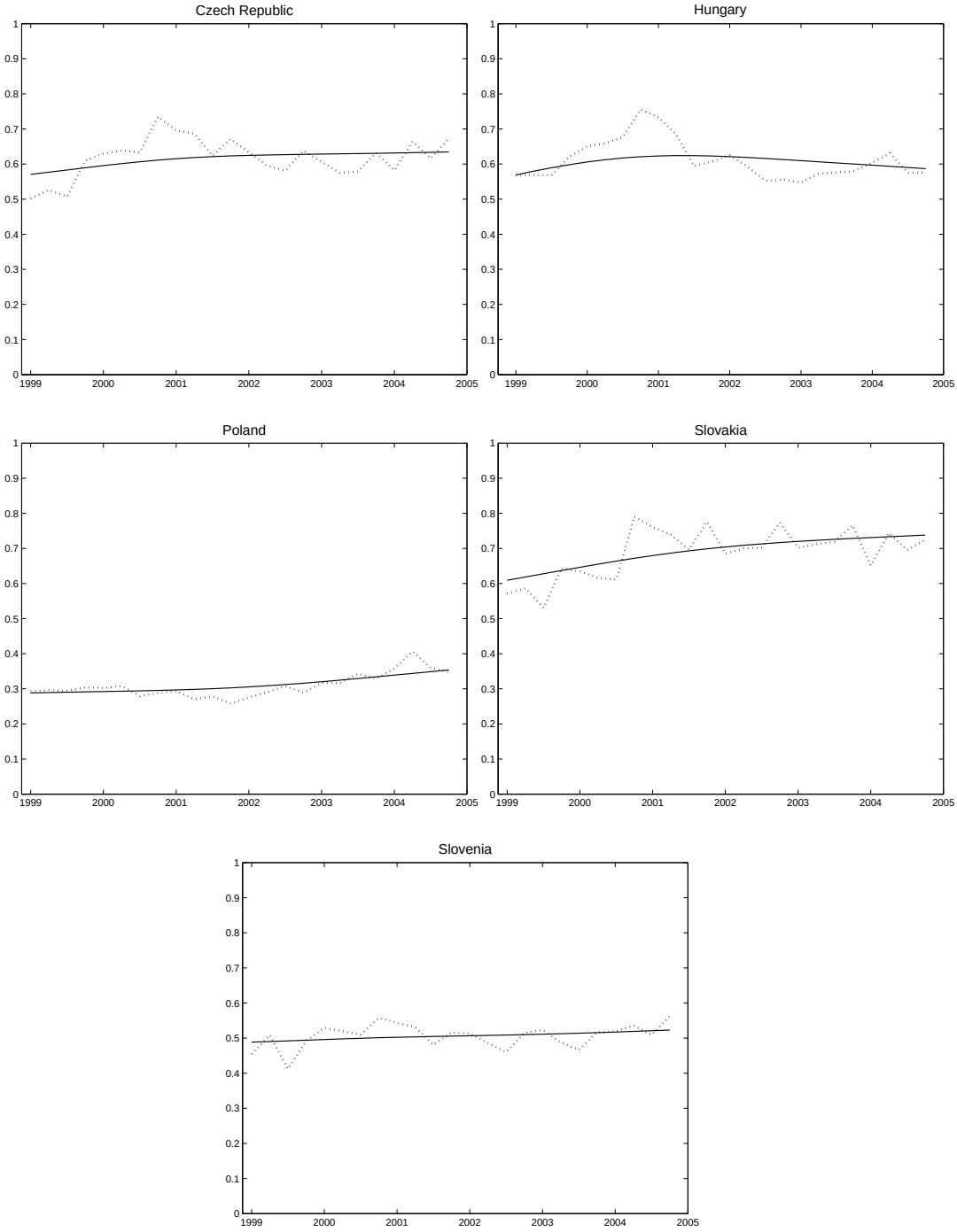
Sanchez-Fung, J. R. (2003). Non-linear Modeling of Daily Exchange Rate Returns, Volatility, and News in a Small Developing Economy. *Applied Economics Letters, 10(4)*, 247-250.

1.8 Appendix

Table 1.1: Openness after smoothing – Data summary.

country	min	max	mean	st.dev.
Czech Republic	0.5706	0.6345	0.6153	0.0193
Hungary	0.5687	0.6241	0.6059	0.0155
Poland	0.2882	0.3538	0.3112	0.0207
Slovakia	0.6093	0.7380	0.6903	0.0402
Slovenia	0.4886	0.5229	0.5060	0.0098

Figure 1.1: Openness in the CEEC-5 group during 1999-2004.



Source: IMF-IFS; Eurostat; and author's calculations.

Figure 1.2: Exchange rate changes in the CEEC-5 group.

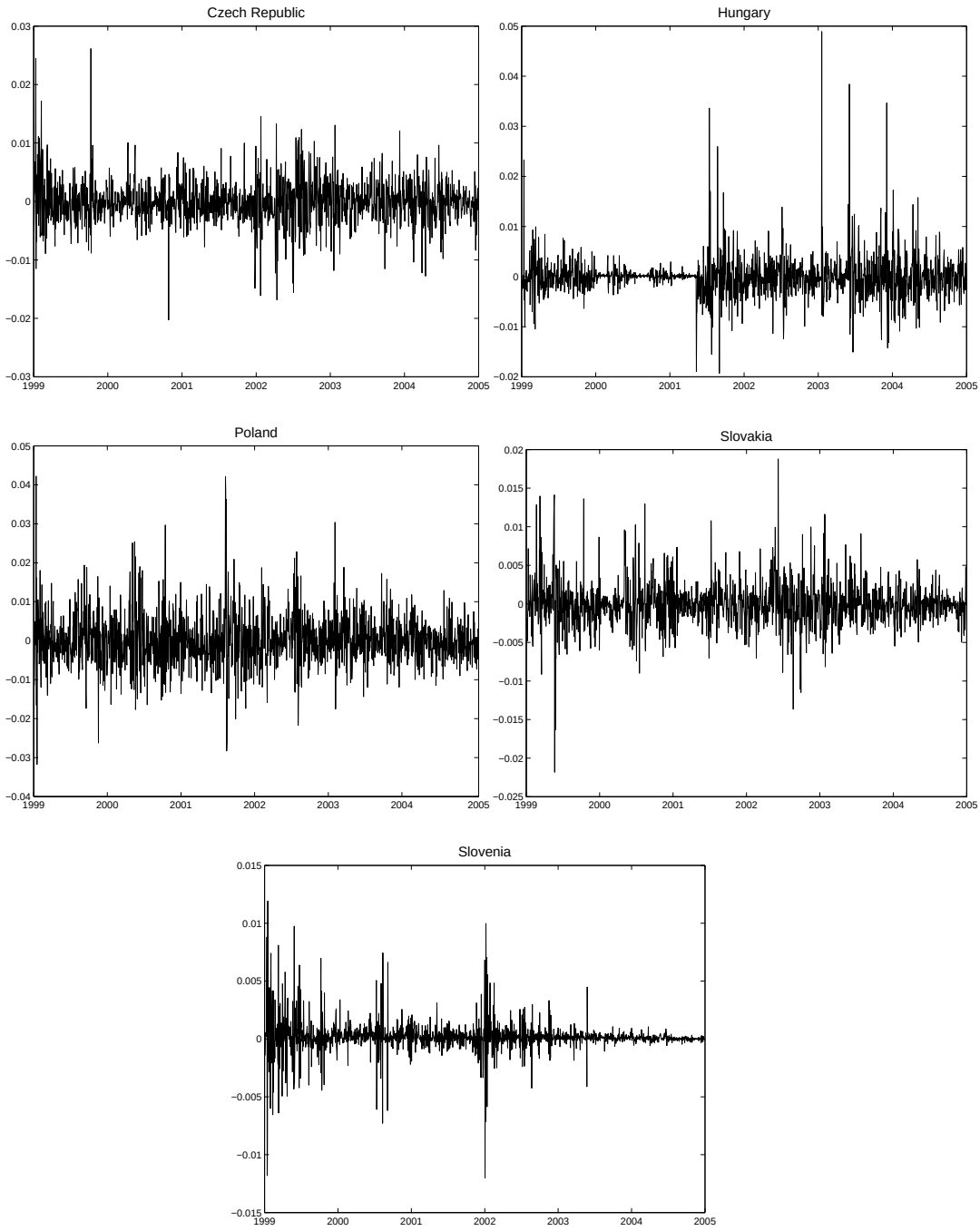


Figure 1.3: Estimated conditional variance in the CEEC-5 group.

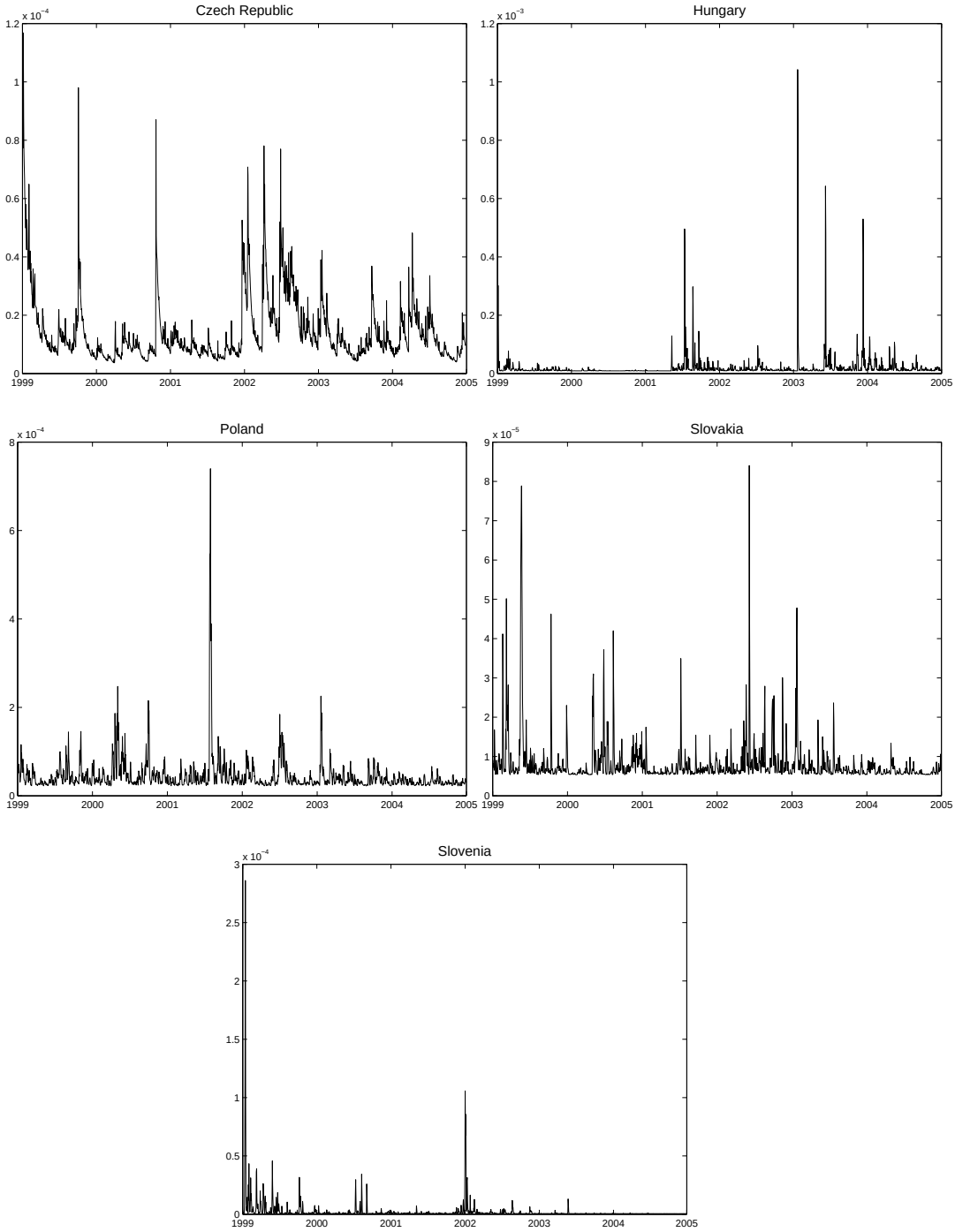


Figure 1.4: Estimated NEWS variable in the CEEC-5 group.

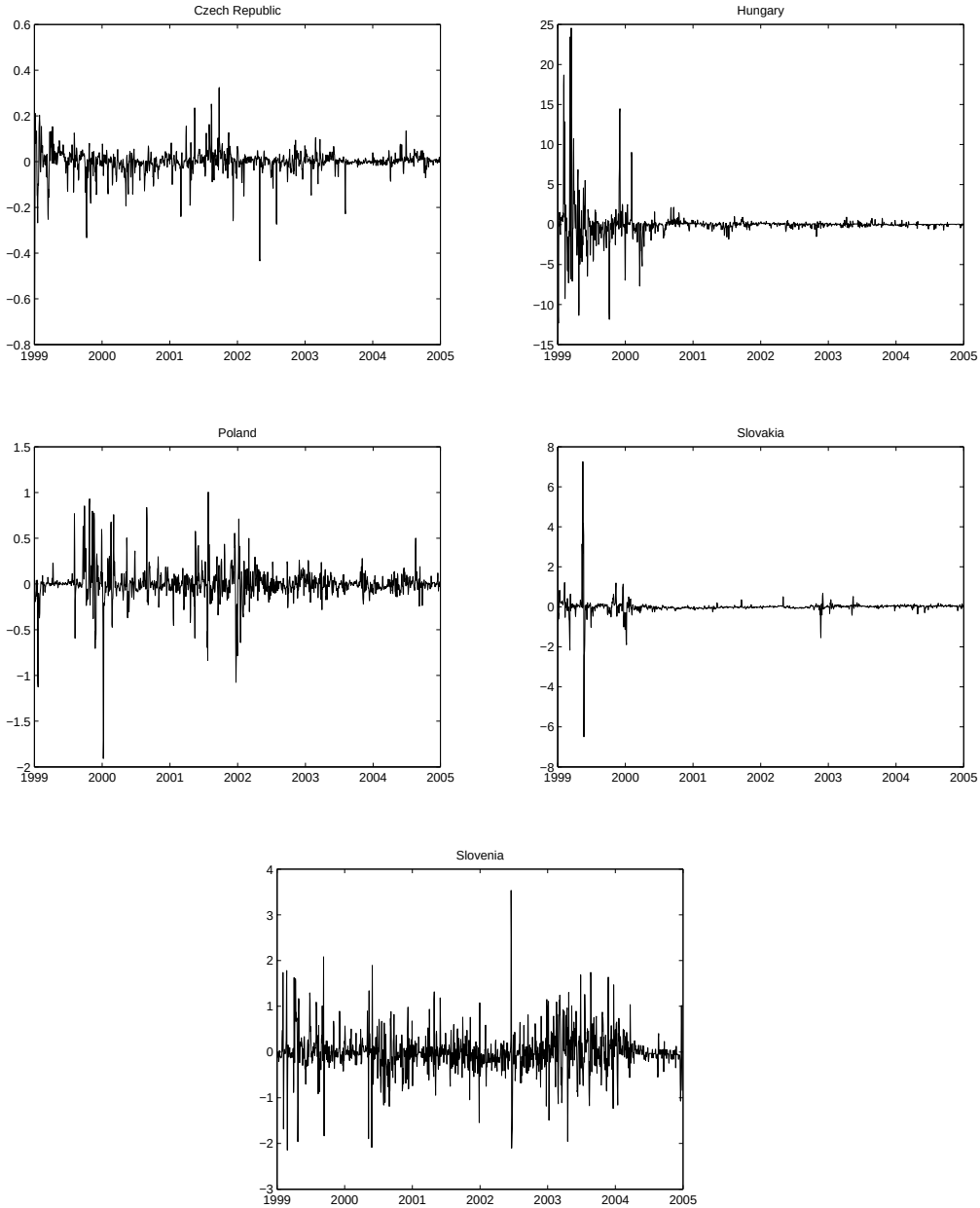


Table 1.2: Exchange rate regimes – An overview.

country	variable	period	official regime
Czech Rep.	–	27.5.1997– ...	managed floating
Hungary	REG1	1.1.1999–31.12.1999	crawling band around basket (±2.25%) (basket=USD 30%, EUR 70%)
	REG2	1.1.2000–3.5.2001	crawling band around EUR (±2.25%)
	REG3	4.5.2001–3.6.2003	crawling band around EUR (±15%) (central rate 276.10 HUF/EUR)
	base	4.6.2003– ...	crawling band around EUR (±15%) (central rate 282.36 HUF/EUR)
Poland	REG1	1.1.1999–24.3.1999	crawling band around basket (±12.5%) (basket=USD 45%, EUR 55%)
	REG2	25.3.1999–11.4.2000	crawling band around EUR (±15%)
	base	12.4.2000– ...	managed floating
Slovakia	–	1.10.1998– ...	managed floating
Slovenia	REG1	1.1.1999–27.6.2004	crawling band around EUR (±2%)
	base	28.6.2004– ...	ERM II

Source: Reinhart and Rogoff (2002); Kočenda and Valachy (2006); national banks.

Table 1.3: TARCH model estimations.

	Czech Rep.	Hungary	Poland	Slovakia	Slovenia
σ^2	–	–	–	–	55.8525^a
	–	–	–	–	(9.4673)
a_1	–	0.0857^b	–	0.0855^a	-0.2439^a
	–	(0.0424)	–	(0.0316)	(0.0604)
a_2	–	–	-0.0781^a	–	–
	–	–	(0.0291)	–	–
a_5	-0.4526^a	-0.0766	–	–	–
	(0.1446)	(0.0472)	–	–	–
a_6	–	-0.0779^a	–	–	–
	–	(0.0287)	–	–	–
a_{10}	–	–	0.0846^a	–	–
	–	–	(0.0262)	–	–
b_5	0.4768^a	–	–	–	–
	(0.1424)	–	–	–	–
ω	$2 \cdot 10^{-7}$	$9 \cdot 10^{-6a}$	$2 \cdot 10^{-5a}$	$5 \cdot 10^{-6a}$	$5 \cdot 10^{-7}$
	$(1 \cdot 10^{-7})$	$(3 \cdot 10^{-6})$	$(2 \cdot 10^{-6})$	$(7 \cdot 10^{-7})$	$(8 \cdot 10^{-6})$
α_1	0.1203^b	0.4318^a	0.2000^a	0.2201^a	0.6542^a
	(0.0570)	(0.1667)	(0.0502)	(0.0648)	(0.1544)
α_2	-0.0849	0.3263^b	0.1276^a	0.1208^b	0.2167^b
	(0.0520)	(0.1505)	(0.0467)	(0.0580)	(0.1053)
α_3	–	–	0.1753^a	0.0495	–
	–	–	(0.0491)	(0.0338)	–
α_4	–	–	0.0809^b	–	–
	–	–	(0.0373)	–	–
β_1	0.9114^a	–	–	–	–
	(0.0216)	–	–	–	–
ξ	0.0779^b	-0.3332^b	-0.1995^a	-0.1347^c	–
	(0.0352)	(0.1550)	(0.0628)	(0.0822)	–
# of obs.	1497	1507	1438	1469	1497
adj. R^2	0.0125	0.0084	0.0070	0.0069	-0.0379
AIC	-8.5043	-8.3460	-7.3190	-8.9829	-11.0550
SIC	-8.4795	-8.3213	-7.2896	-8.9613	-11.0372

Note: standard errors are in parentheses; significance at 1%, 5%, and 10% level is denoted by a, b, and c superscript, respectively.

Table 1.4: Nominal exchange rates vis-à-vis the EUR – Data summary.

country	min	max	mean	st.dev.
Czech Republic	28.9590	38.5830	33.5196	2.2916
Hungary	234.7200	273.9200	252.9331	7.7495
Poland	3.3433	4.9346	4.1169	0.3439
Slovakia	38.5450	47.4840	42.3693	1.5187
Slovenia	187.1333	240.0300	219.6494	15.6962

Source: author's calculations.

Table 1.5: Estimated conditional variance – Data summary.

country	min	max	mean	st.dev.
Czech Republic	$3.68 \cdot 10^{-6}$	0.000117	$1.42 \cdot 10^{-5}$	$1.15 \cdot 10^{-5}$
Hungary	$9.12 \cdot 10^{-6}$	0.001042	$2.01 \cdot 10^{-5}$	$4.92 \cdot 10^{-5}$
Poland	$2.24 \cdot 10^{-5}$	0.000740	$4.42 \cdot 10^{-5}$	$3.98 \cdot 10^{-5}$
Slovakia	$5.37 \cdot 10^{-6}$	0.000084	$8.10 \cdot 10^{-6}$	$6.15 \cdot 10^{-5}$
Slovenia	$4.96 \cdot 10^{-7}$	0.000286	$2.28 \cdot 10^{-6}$	$1.03 \cdot 10^{-5}$

Table 1.6: Variable $NEWS$ – Data summary.

country	min	max	mean	st.dev.	median
Czech Republic	−0.7872	0.3244	$-5.85 \cdot 10^{-16}$	0.0564	0.0033
Hungary	−12.3328	24.5462	$1.03 \cdot 10^{-14}$	1.9964	0.0222
Poland	−1.9082	1.0049	$1.15 \cdot 10^{-15}$	0.1789	−0.0024
Slovakia	−6.4948	7.2563	$-4.19 \cdot 10^{-15}$	0.3832	0.0021
Slovenia	−2.1471	3.5324	$6.41 \cdot 10^{-16}$	0.4378	−0.0303

Note: a negative value indicates good news, a positive values indicates bad news.

Table 1.7: Sources of exchange rate volatility – Results.

$$ERV_t = \alpha + \beta\left(\frac{Im_t}{GDP_t}\right) + \gamma_G G_t * NEWS_t + \gamma_B B_t * NEWS_t + \delta REGIME_t + \varepsilon_t$$

	Czech Rep.	Hungary	Poland	Slovakia	Slovenia
α	$2 \cdot 10^{-5}$	$-1 \cdot 10^{-4}$	$2 \cdot 10^{-4a}$	$3 \cdot 10^{-5a}$	$1 \cdot 10^{-4c}$
	$(3 \cdot 10^{-5})$	$(2 \cdot 10^{-4})$	$(5 \cdot 10^{-5})$	$(8 \cdot 10^{-6})$	$(6 \cdot 10^{-5})$
β	$-1 \cdot 10^{-5}$	$3 \cdot 10^{-4}$	$-4 \cdot 10^{-4a}$	$-3 \cdot 10^{-5b}$	$-2 \cdot 10^{-4c}$
	$(6 \cdot 10^{-5})$	$(4 \cdot 10^{-4})$	$(2 \cdot 10^{-4})$	$(1 \cdot 10^{-5})$	$(1 \cdot 10^{-4})$
γ_G	$-7 \cdot 10^{-6}$	–	–	–	–
	$(6 \cdot 10^{-6})$	–	–	–	–
$\gamma_{G\ lag\#1}$	–	–	$-7 \cdot 10^{-6b}$	–	–
	–	–	$(4 \cdot 10^{-6})$	–	–
$\gamma_{G\ lag\#3}$	–	–	–	$1 \cdot 10^{-6b}$	$-2 \cdot 10^{-6c}$
	–	–	–	$(4 \cdot 10^{-7})$	$(1 \cdot 10^{-6})$
$\gamma_{G\ lag\#5}$	–	$-4 \cdot 10^{-6c}$	–	–	–
	–	$(2 \cdot 10^{-6})$	–	–	–
$\gamma_{B\ lag\#3}$	–	–	–	–	$7 \cdot 10^{-7}$
	–	–	–	–	$(5 \cdot 10^{-7})$
$\gamma_{B\ lag\#4}$	–	–	–	$2 \cdot 10^{-6d}$	–
	–	–	–	$(1 \cdot 10^{-6})$	–
$\gamma_{B\ lag\#5}$	$-1 \cdot 10^{-5c}$	$4 \cdot 10^{-7d}$	–	–	–
	$(7 \cdot 10^{-6})$	$(3 \cdot 10^{-7})$	–	–	–
$\gamma_{B\ lag\#7}$	–	–	$-3 \cdot 10^{-5c}$	–	–
	–	–	$(1 \cdot 10^{-5})$	–	–
δ_{REG1}	–	$-1 \cdot 10^{-5a}$	$-2 \cdot 10^{-5}$	–	$-2 \cdot 10^{-6}$
	–	$(4 \cdot 10^{-6})$	$(2 \cdot 10^{-5})$	–	$(1 \cdot 10^{-6})$
δ_{REG2}	–	$-2 \cdot 10^{-5b}$	$-7 \cdot 10^{-6}$	–	–
	–	$(1 \cdot 10^{-5})$	$(8 \cdot 10^{-6})$	–	–
δ_{REG3}	–	$-8 \cdot 10^{-6}$	–	–	–
	–	$(1 \cdot 10^{-5})$	–	–	–
ρ	0.8511^a	0.5228^a	0.8170^a	0.6993^a	0.6630^a
	(0.0310)	(0.1158)	(0.1075)	(0.0550)	(0.2272)
# of obs.	1495	1506	1437	1464	1493
adj. R^2	0.7405	0.2901	0.6753	0.5303	0.4594

Note: standard errors are in parentheses; significance at 1%, 5%, 10%, and 15% level is denoted by a, b, c, and d superscript, respectively. Parameter ρ is included to account for serial correlation in residuals.

Chapter 2

Horizontal and Vertical FDI Spillovers: Recent Evidence from the Czech Republic

(CERGE-EI Working Paper #340)

2.1 Introduction

Foreign direct investment (FDI) is a driving force of growth in developing economies. It brings new capital, technology and know-how (Dunning, 1994; Gorodnichenko et al., 2008). Foreign-owned companies are typically characterized by higher productivity and competitiveness compared to domestic ones (e.g., Arnold and Javorcik, 2005). This is often referred to as the *direct effect* of FDI.

FDI can also have a variety of indirect effects on domestic companies. The entry of any high-productivity company should naturally encourage other companies within the same sector to improve their performance. Such increase in the efficiency of the production process can occur through copying new technologies or by hiring trained workers and managers from foreign-owned companies (Javorcik, 2004). On the other hand, those domestic companies that are not able to catch up with the high performance of competitors within the sector may be crowded out of the market. These productivity effects are referred to as *horizontal spillovers*.

Companies from sectors other than that of the foreign enterprise might also be affected by its presence, if they are in direct business contact with its sector. This includes companies that supply or provide services for foreign firms, as well as companies whose inputs are supplied by foreign enterprises or their sectors. It is likely that foreign companies require higher standards from their suppliers. On the other hand, it is also likely that higher standards are provided by foreign companies to domestic companies as well, which might improve the domestic companies' efficiency and performance. These effects are referred to as *vertical spillovers*.

Expectations of strong positive direct as well as indirect benefits from FDI lead most transition (i.e., post-communist) and developing countries to present themselves as attractive places for investment and to attract foreign investors by offering them various advantages. The Czech Republic is no exception. In 1998, its government approved a system of subsidies for foreign investors that aimed at increasing the competitiveness of Czech industry.[1] However, to-date the issue of the actual effect of FDI is not settled.

Although the literature studying the effects of FDI on domestic companies is extensive and the empirical studies focusing on both transition and developed countries are numerous (e.g., Aitken and Harrison, 1999; Kinoshita, 2000; Haskel et al., 2002; Damijan et al., 2003b; Javorcik, 2004; Sabirianova et al., 2005; Kosová, 2009), their findings are ambiguous and in many cases contradictory, even for the same country. Clearly, the findings are sensitive to each country's unique experience, quality of data, time period or applied methodology.

In particular, most of the studies of the Czech Republic suffer from relying on small samples and focusing on the early transition period. Early transition, i.e., 1991-1996, is characterized by mass privatization and unclear ownership structures, whereas the main boom of foreign investment came after 1998 (see Figure 2.1 in the Appendix), which is the last sample year in almost every previous study about the Czech Republic.[2] Therefore, it may not be significant that previous studies often do not succeed in finding any spillover effects.

The goal of this paper is to analyze the effects of FDI on the performance

[1] http://www.mfcr.cz/cps/rde/xchg/mfcr/hs.xsl/inv_pob_vyvoj.html

[2] Kosová (2009) is the only exception; her data end in 2001.

of domestic companies in the Czech Republic during 1995-2003. I study the productivity effects of FDI within the same sector as well as the potential gains through vertical linkages. The value added of the present paper vis-à-vis the existing literature on the Czech Republic is in considering both the horizontal impact and the backward and forward vertical spillovers, and in employing up-to-date data. I also shed light on the sources of identification of FDI spillover effects and pay attention to the potential endogeneity of FDI with respect to future industry growth.

Contrary to expectations and the arguments supporting FDI subsidies, this paper finds that foreign investors contribute negatively to the (sales) performance of domestic companies, especially to those in upstream sectors. In other words, domestic companies in sectors supplying foreign-owned firms are negatively affected by the presence of foreign investors through a negative backward spillover. One underlying explanation supported by indirect evidence is that foreign investors prefer to import their supplies from abroad, such that Czech companies oriented mainly on domestic markets suffer. This effect becomes even more evident after accounting for the endogeneity of FDI.

The paper is structured as follows. The next section describes the relevant existing studies. My research strategy is explained in the Section 2.3. The Section 2.4 contains the data description. The empirical results are presented in the Section 2.5. The last section concludes.

2.2 Literature Review

This section reviews several key papers on FDI spillover effects. I discuss three studies with significant value added to the literature. The second half of this section then looks more closely at the papers concerning the Czech Republic.

One of the first studies investigating the benefits for domestic companies from FDI using company-level panel data is Aitken and Harrison (1999). They use a sample of about $5,000$ companies in Venezuela during the years 1976-1989. They find a positive effect of FDI on domestic companies with less than 50 employees and a small negative effect of FDI on all domestic companies. They further claim that the positive effect of the presence of foreign enterprises is solely due to joint ventures with foreign capital. In a more

recent study, Haskel et al. (2002) use a sample of more than 90% of all manufacturing firms in the UK from 1973-1992. According to their results, there is a positive horizontal spillover effect on total factor productivity (TFP) within sectors, which takes some time to *permeate* the domestic companies.

Javorcik (2004) is the first study to focus not only on horizontal spillovers, but also on vertical spillover effects; she also sheds some light on the mechanism of such vertical linkages. Her research is based on a sample of 85% of all Lithuanian companies in the period 1996-2000. She does not find any significant horizontal spillover effects; however, she finds a positive backward spillover effect of FDI on domestic companies. As regards the determinants of spillovers, she finds that the effect is more prevalent when foreign-owned companies are domestic-market rather than export-oriented, and that there is no difference in magnitude between the effects from partially or fully foreign-owned companies.

There are several firm-level studies of FDI in the Czech Republic. Djankov and Hoekman (2000) study the impact of FDI on the TFP growth of recipient firms between 1992-1996 and find this impact to be positive and significant.[3] On the other hand, the effect of joint ventures is less positive and not statistically significant. As regards the spillover effects, they find a negative horizontal spillover effect of FDI and joint ventures, taken together, on domestic companies. However, they use a sample of only 513 firms.

Kinoshita (2000) uses a larger data set covering $1,217$ manufacturing firms during the period 1995-1998. She finds no significant technology spillover effect of joint ventures or FDI on productivity growth neither within the firm nor within the industry. On the other hand, she contends that this effect varies hugely across sectors and is positive and significant for oligopolistic sectors, such as radio and TV or electrical machinery. Kinoshita further examines the two roles of the firm's R&D – innovation and absorptive capacity. According to her results, the effects of FDI are significant for firms that perform their own R&D – the horizontal spillover is positive and the direct effect is negative, whereas the direct effect of R&D on productivity growth

[3] In a related analysis, Jurajda and Stančík (2009) study the impact of foreign ownership on corporate performance. Based on a sample of $4,049$ companies from the period 1995-2005 and using the matched difference-in-differences approach, they conclude that foreign takeovers significantly boost several corporate performance indicators in non-exporting manufacturing industries, but have little effect in other industries.

remains insignificant.

Jarolím (2001) concentrates mainly on the performance of foreign-owned companies, but he examines also the horizontal spillover effects of FDI on domestic companies within the same sector. For this purpose, he uses a sample of 3,152 enterprises from the manufacturing sector over the period 1993-1998. In line with the previous literature, he shows that foreign-owned companies are characterized by higher TFP. However, he does not find any significant horizontal spillover effects. Moreover, he compares the performance of greenfield ventures with foreign acquisitions and concludes that the former perform significantly better.

Damijan et al. (2003a) examine the direct effect of FDI, intra-industry knowledge spillovers from FDI and the impact of firms' own R&D accumulation on productivity growth using a sample of eight transition countries[4] in the period 1994-1998. Regarding the Czech Republic, they use a sample of 1,115 manufacturing companies and find a positive direct effect of FDI on domestic recipient companies. Intra-industry spillovers are found to be insignificant, but, similarly to findings in Kinoshita (2000), their significance increases when controlling for a firm's own R&D. Surprisingly, the productivity growth of Czech companies that perform their own R&D decreases with foreign presence in the industry. Moreover, according to their results, most domestic firms' knowledge and technology improvements are gained from their trade partners abroad.

In a closely related study, Damijan et al. (2003b) use the sample of Damijan et al. (2003a), add Lithuania and Latvia, and study the period 1995-1999. Their analysis incorporates not only horizontal but also vertical spillovers. They conclude that vertical spillover effects are more important than horizontal effects. Particularly, both of these effects are positive in the Czech Republic. In terms of direct effects of foreign ownership, these new findings contradict their previous study, especially when they imply that companies with foreign presence have lower productivity growth than companies without foreign capital. The contribution of a firm's own R&D is not confirmed to be significant, which is also in contrast to their previous study.

Kosová (2009) studies the effect of FDI on the productivity of domestic

[4]Bulgaria, Czech Republic, Estonia, Hungary, Poland, Romania, Slovakia, and Slovenia.

firms and the crowding-out effect from the presence of foreign companies. She uses a sample of 9,986 Czech companies from all sectors covering the period 1994-2001. She finds a positive effect of foreign capital presence on domestic firms' growth and survival. She concludes that exit rates are lower for companies in industries with foreign presence. Moreover, she finds that a positive intra-industry technological spillover effect is present in more technologically advanced industries.[5]

These mixed results are summarized in Table 2.1. The employed samples are rather small, except for the last two papers, and most of these studies examine the period before 1999 when there was relatively little FDI inflow into the Czech Republic. Further, most of the previous literature is limited to manufacturing sectors only. However, it is likely that domestic companies from service sectors would be especially affected by the presence of foreign investors. Unlike manufacturing companies, these companies are not able to export their services abroad and they are limited to the domestic market only. Overall, there is every kind of horizontal spillover found in the previous literature – negative, insignificant, and positive – while the only two papers that study vertical spillovers find them to be positive.[6]

2.3 Research Approach

2.3.1 Theoretical Model

The goal of this paper is to examine whether sales growth is affected by the share of foreign capital within and across sectors. For this purpose, I follow the methodology of Haddad and Harrison (1993). They assume a production function with value added Y that is a function of two inputs, capital K and labor L:

$$Y_{ijt} = A_{jt} f(K_{ijt}, L_{ijt}).$$

[5]In a related line of work, Kosová and Ayyagari (2006) ask about the impact of FDI on domestic entrepreneurship. Based on a sample of 9,979 Czech companies covering the period 1994-2000, they find that foreign presence contributes positively to the entry rates of domestic companies through both horizontal and vertical spillovers.

[6]In international comparison, the estimated effects for the Czech Republic are similar to those from the region of Central Europe (Damijan et al., 2003b). On the other hand, these effects have either different sign or bigger magnitude in Balkan countries (Damijan et al., 2003b; Javorcik, 2004). These studies focus on particular countries separately, while Gorodnichenko et al. (2007) perform their firm-level analysis using a joint sample from 27 countries. They find positive backward spillovers.

The level of productivity is given by A_{jt}. It is assumed to vary across sectors j and time t. By using total differential, taking logs, and using the fact that the value of the marginal product for each factor equals its cost, I have

$$\Delta \ln Y_{ijt} = \frac{\Delta A_{jt}}{A_{jt}} + \alpha_1 \Delta \ln K_{ijt} + \alpha_2 \Delta \ln L_{ijt}, \tag{2.1}$$

where $\frac{\Delta A}{A}$ is productivity growth. The coefficients on the growth of labor and capital are simply their share in value added. I test the hypothesis that productivity growth is affected by the share of foreign capital both within and across sectors by assuming that productivity growth can be decomposed into the following components:

$$\frac{\Delta A_{jt}}{A_{jt}} = \alpha_0 + \alpha_3 HORIZ_{jt} + \alpha_4 BACK_{jt} + \alpha_5 FORW_{jt} + \alpha_t + \varepsilon_{ijt}, \tag{2.2}$$

where $HORIZ$, $BACK$, and $FORW$ are FDI variables and the set of dummy variables, α_t, is introduced to control for year-specific effects. A disturbance term ε_{ijt} is added to account for possible changes in productivity growth due to stochastic shocks at the firm or sector level over time. Combining (2.1) and (2.2) yields the equation I estimate:

$$\begin{aligned} \Delta \ln Y_{ijt} =& \alpha_0 + \alpha_1 \Delta \ln K_{ijt} + \alpha_2 \Delta \ln L_{ijt} + \alpha_3 HORIZ_{jt} + \alpha_4 BACK_{jt} + \\ &+ \alpha_5 FORW_{jt} + \alpha_t + \varepsilon_{ijt}. \end{aligned} \tag{2.3}$$

2.3.2 Spillover Variables

For the sake of continuity and comparability with previous studies, I follow the approach of Javorcik (2004) and create three spillover variables representing the stock of foreign capital at sectoral level. The variable $HORIZ_{jt}$ measures the foreign presence within a sector; it represents the share of foreign capital invested in foreign companies[7] in sector j at time t and is defined as

$$HORIZ_{jt} = \frac{\sum_{i:i\in j, FS_{ijt}\geq 0.1} FS_{ijt} FA_{ijt}}{\sum_{i:i\in j} FA_{ijt}}, \tag{2.4}$$

where FS_{ijt} denotes the share of foreign capital in firm i at time t in sector j and FA_{ijt} denotes the fixed assets of firm i at time t in sector j.

[7] I interpret a company as foreign if it has at least 10% of its equity owned by a foreign investor. The same threshold is also used in the Czech National Bank official definition of FDI and in Damijan et al. (2003b) and Javorcik (2004).

The variable $BACK_{jt}$ represents the weighted share of foreign capital in all sectors that are supplied by sector j at time t and, conversely, the variable $FORW_{jt}$ represents the weighted share of foreign capital in all sectors that supply sector j at time t. They are defined as

$$BACK_{jt} = \sum_{k:k\neq j} \beta_{jkt} HORIZ_{kt} \tag{2.5}$$

$$FORW_{jt} = \sum_{k:k\neq j} \beta_{kjt} HORIZ_{kt}, \tag{2.6}$$

where β_{xyt} stands for the fraction of output from sector x supplied to sector y at time t. $BACK_{jt}$ measures the presence of foreign companies downstream of a domestically owned firm's sector and $FORW_{jt}$ measures the presence of foreign companies upstream.

2.4 Data

The company-level annual data used here come from the *ASPEKT* database, which is a Czech source for the *Amadeus* pan-European database and is widely used in empirical research (Hanousek et al., 2007; Bena and Hanousek, 2006). Financial data cover the period 1993-2004, include 24,648 Czech firms in total and form an unbalanced panel, where the number of usable companies varies from almost 2,000 in 1993 to more than 17,000 in 2002. The *ASPEKT* database also provides information about companies' ownership structure. However, due to the limited availability of this information, the total number of companies is significantly reduced to 1/6.[8] Ownership information allows me to distinguish foreign companies from domestic ones. In contrast to most previous studies, I do not limit the analysis only to the manufacturing sectors. With few exceptions, I employ data from all sectors; only sectors with a strong regulatory role of the government are excluded.[9]

For studying vertical spillover effects, I employ inter-industry data (input-output matrices) that come from the Czech Statistical Office (CSO).[10] A

[8]This reduced sample comprises mostly larger companies and the correlation between the full and reduced sample across 2-digit NACE industries is 0.95. With respect to fixed assets, the coverage of this reduced sample vs. total economy is about 12%.

[9]Agriculture, forestry, fishing, utilities, public administration, health and education; NACE codes 1, 2, 5, 40, 41, 75, 80, and 85.

[10]In a recent study, Barrios et al. (2009) claim that input sourcing behavior of foreign companies differs from that of domestic firms and, moreover, it is distinct for each country of origin. Therefore, they suggest alternative measures of backward linkages that employ foreign countries' input-output tables.

significant improvement over the existing literature[11] is that I have these matrices available for every year during 1995-2003. Previous studies use the assumption that these matrices do not change much over time. However, the opposite is true. Descriptive analysis reveals that for almost 30% of relations,[12] the standard deviation over time is bigger than the mean value. In order to remove possible measurement errors, I use fitted values of time trends based on these matrices instead of the original values. In other words, I still have a different input-output matrix for each year, but these matrices now capture trends rather than the dramatically oscillating annual values.

After merging all variables and performing several data cleaning procedures, the resulting sample covers the period 1995-2003 and contains information about $4,002$ companies from 43 industries,[13] $20,908$ firm-year observations in total. An overview of the time and ownership structure of the final sample is provided in Table 2.2. The number of companies varies from $1,323$ in 1995 to $2,733$ in 2000. Foreign companies represent 25% of all observations. Table 2.3 shows the summary statistics of all variables used in this research. Inputs to production such as fixed assets or staff costs as well as sales of Czech companies are increasing on average. As regards the ownership structure, the average share of a foreign investor in a Czech company is almost 19%.

Although the model described in the Section 2.3.1 assumes value added as a dependent variable, I employ sales instead. The main reason for this discrepancy is the limited availability of value added which is less than half with respect to sales. A natural solution in this case would be to control for material costs. Unfortunately, this approach is not feasible as well due to the lack of material costs data. The accent in this study is put rather on size of the usable sample. To verify this choice, Table 2.11 provides a comparison of the results when value added is used instead of sales. There are two different subsamples compared for illustration. Since, the character of those results for both cases is very similar, statistically as well as economically, I can

[11] Damijan et al. (2003b), Javorcik (2004), or Kosová and Ayyagari (2006).

[12] A relation is a time series of the flow of goods and services from sector X to sector Y for the whole period 1995-2003. There are almost $7,000$ such relations – for every combination of sectors X and Y, as well as for the supply and demand relationship. These relations are used to generate a mean value and standard deviation for every time series.

[13] At 2-digit NACE classification (Classification of Economic Activities in the European Community).

expect that the results would not differ much, if I employed value added as a dependent variable.

2.5 Estimation Results

2.5.1 Baseline Specification

In order to study the horizontal and vertical spillover effects from FDI, the following modification of model (2.3) is estimated:

$$\Delta \ln SALES_{ijt} = \gamma_i + \alpha_1 \Delta \ln FA_{ijt} + \alpha_2 \Delta \ln SC_{ijt} + \alpha_3 HORIZ_{jt} + \alpha_4 BACK_{jt} + \\ + \alpha_5 FORW_{jt} + \alpha_t + \varepsilon_{ijt}, \quad (2.7)$$

where $SALES_{ijt}$, FA_{ijt}, and SC_{ijt} stand for sales, fixed assets, and staff costs, respectively, for firm i at time t in sector j. The set of year dummy variables, α_t, is also introduced. To capture company differences in time-constant firm-level unobserved characteristics, e.g., management or technology, the specification conditions on the firm's fixed effect γ_i.

A positive value of the variable $HORIZ_{jt}$ would imply that the presence of foreign companies in the sector has a positive impact on the productivity of domestic companies in the same sector. A positive value of the variable $BACK_{jt}$ would imply that the presence of foreign companies has a positive impact on the productivity of those domestic companies that supply the foreign companies' sector. Similarly, a positive value of the variable $FORW_{jt}$ would imply that the presence of foreign companies has a positive impact on the productivity of those domestic companies that are supplied by the foreign companies' sector. Since the goal of this paper is to study the effects on domestic companies, model (2.7), as well as all further models, are estimated on a sample of "always-domestic" companies only. This sample excludes companies that are foreign at any time during the sample frame. It allows one to study the pure spillover effects of FDI that are not affected by the better performance of either foreign greenfield companies, local companies that have been taken over by a foreign entity or local companies that are about to become foreign in the near future. However, for comparison, I also estimate model (2.7) using the whole company population as well, including foreign companies.

Another reason for using the always-domestic firms is the potential endogeneity of ownership at the firm level. Foreign investors can acquire "better" domestic companies, i.e., those with superior current or future performance. The inclusion of domestic firms that will be bought up by foreign owners later could bias the estimated coefficients towards negative values. In order to check whether this is the case, I also run regression (2.7) on a sample of companies that are always domestic plus the companies that will be acquired by foreign investors in the future during the period 1995-2003 but are still domestic as of the current period.

The estimates from these regressions are summarized in Table 2.4. The first column includes the estimated coefficients using a sample of always-domestic companies. The coefficients of capital and labor inputs are positive and significant, which is in line with expectations. However, the coefficient of the horizontal spillover variable is insignificant. This result partially corresponds to previous studies that mostly do not find any significant horizontal spillover effects. The coefficient of the forward spillover variable is insignificant as well. Only in the case of backward spillovers is the estimated coefficient significant and negative.[14] The estimates suggest that domestic companies supplying foreign companies are negatively affected by the presence of FDI: a 1% increase in foreign capital's share in a downstream sector causes a decrease in the growth rate of the sales of supplying domestic companies by almost 1.4 percentage points.

Table 2.4 also presents the results from the estimation using a population of "up-to-now-domestic" companies. The results are consistent with little *cherry picking* by foreign investors as the estimated coefficients have basically the same magnitudes compared to those based on the sample of "always-domestic" companies.

2.5.2 Does FDI Encourage Sales Growth or Vice Versa?

The idea behind equation (2.7) is that when a foreign investor comes to the Czech Republic and brings new technologies or expertise, domestic companies consequently become more efficient. However, the causality direction does not have to be so straightforward. Foreign investors usually come to sectors

[14] The only previous study of vertical spillover effects on productivity growth rate, which implies a positive backward spillover effect, is Damijan et al. (2003b).

where they expect high profitability. Such sectors are characterized either by low productivity of most of the domestic companies within that sector or by an ongoing or nascent boom. Under the latter reasoning, an increase in sales growth may not be caused by foreign investors, but the future growth of a sector may attract foreign investors.

In order to capture the possibility that foreign investors coming to the Czech Republic choose sectors with increasing sales growth in the future, the following modification of model (2.7) is estimated using the domestic-only subsample:

$$\begin{aligned}\Delta \ln SALES_{ijt} =& \gamma_i + \alpha_1 \Delta \ln FA_{ijt} + \alpha_2 \Delta \ln SC_{ijt} + \alpha_3 HORIZ_{jt+1}^{inflow} + \\ &+ \alpha_4 BACK_{jt+1}^{inflow} + \alpha_5 FORW_{jt+1}^{inflow} + \alpha_t + \varepsilon_{ijt}, \end{aligned} \quad (2.8)$$

where the variable $HORIZ_{jt+1}^{inflow}$ represents the share of the inflow of foreign capital into sector j at time $t+1$ over the total amount of fixed assets within that sector in that year. The variable $BACK_{jt+1}^{inflow}$ represents the weighted share of the inflow of foreign capital into all sectors that are supplied by sector j at time $t+1$ and, similarly, the variable $FORW_{jt+1}^{inflow}$ represents the weighted share of the inflow of foreign capital into all sectors that supply sector j at time $t+1$. The definition of foreign-presence variables is similar to that from Section 2.3.2 except that I use flows, not stocks, and I look one period ahead. The results of the estimation of this model are summarized in Table 2.5. The time span is now only 1995-2002 because lead values are used. Looking at the results, the coefficients of horizontal, backward, and forward spillover variables in both cases are significant and positive. These positive "spillover" coefficients do not correspond to any effects of FDI on domestic growth as the foreign capital inflow has not yet occurred. Instead, they indicate that investors are influenced by the overall increase of the sectoral sales growth rate and they tend to go either to sectors with an expected higher sales growth rate and to sectors that are upstream/downstream from these growing sectors.[15]

[15]This claim is further supported by regressing the lead horizontal spillover variable on the sales growth rate when the corresponding coefficient is positive and significant. Similarly, I find the same result when using the lead backward or forward spillover instead.

2.5.3 Allowing for the Endogeneity of FDI

The results presented in Table 2.5 provide sufficient reason to expect that foreign investment is not completely exogenous and that it is necessary to minimize this endogeneity, which stems from ex ante industry growth opportunity affecting both observed growth rates and FDI inflow. Some headway can be achieved by finding a variable that is correlated with the sales growth rate but is not affected by foreign investment, i.e., to approximate the counterfactual growth opportunity at the industry level. A natural choice is to look abroad and find such proxy in the remaining Visegrad Four countries, i.e., Hungary, Poland, and Slovakia. The economies of these countries are similar to and linked with the Czech economy[16] such that when there is a boom in one of these country's industries, it is likely that this boom occurs also in the same industry across the border. Table 2.6 summarizes the results from a regression of Czech industry-level production on production in the remaining Visegrad countries, both in level and log form.[17] These results suggest that the Czech economy is closely linked to the economies of Hungary and Slovakia, while the linkage with Poland is much weaker. However, both Hungary and Poland are not suitable as counterfactual industry growth proxies because they became attractive to foreign investors much earlier than the Czech Republic and their industry growth is already impacted by FDI.[18] The only suitable country remains Slovakia. Foreign investment in Slovakia lags behind the Czech Republic's by $4-5$ years with the main *investment boom* starting in 2002. Thus, the production growth rate in Slovakia is not affected by massive foreign investment almost during the whole time span used in this paper and it can be used to proxy a "natural" level of production[19] in the Czech Republic. Specifically, I regress the Czech industry-level production on Slovak production in the years 1990-1997 and use this regression to predict the Czech "natural" industry production during 1995-2003. This predicted

[16]Boone and Maurel (1998), Horváth (2002), Firdmuc (2008).

[17]The data for this regression comes from the OECD STAN database.

[18]Hungary was attracting FDI even before 1989, reaching its peak in 1995 (4.5 bil. USD, 9.8% of GDP). FDI inflow was then declining till 2001 when it started to rise again. The FDI inflows into Poland were rather modest until 1994, but started to grow in 1995. Poland attracted a record amount of foreign investment in 2000 (10.6 bil. USD, 6.2% of GDP).

[19]This is a level of production that is assumed to be realized by an industry in the Czech Republic, had it not received any FDI.

industry growth rate is then used to lower the extent of endogeneity of FDI in the following modification of model (2.7):

$$\begin{aligned}\Delta \ln SALES_{ijt} =& \gamma_i + \alpha_1 \Delta \ln FA_{ijt} + \alpha_2 \Delta \ln SC_{ijt} + \alpha_3 HORIZ_{jt} + \\ &+ \alpha_4 BACK_{jt} + \alpha_5 FORW_{jt} + \Delta \ln PROD_{jt}^{CZ} + \alpha_t + \varepsilon_{ijt},\end{aligned} \tag{2.9}$$

where the variable $\Delta \ln PROD_{jt}^{CZ}$ stands for the predicted "natural" production growth rate in sector j at time t in the Czech Republic. The results are summarized in Table 2.7, again with separate columns for each sample.[20] Similarly to the results presented in Table 2.4 and corresponding to model (2.7), the new results indicate neither significant horizontal nor forward spillover effects. Regarding backward spillovers, the coefficients are still negative and significant. Their magnitude is higher in comparison to those from the baseline specification by about 20%. This evidence is consistent with the notion of lowering industry FDI endogeneity with previous results being biased towards positive spillovers because of an underlying growth rate differential that may be mistakenly causally linked with FDI. Even though the Czech-Slovak comparison hardly presents a perfect natural experiment, it has been used in existing research (Ham et al., 1998) and may be as close as we can get to causal evidence on FDI in transition.

According to these results, domestic companies are negatively affected by the presence of foreign investors in downstream sectors. The next question is: what makes the sales growth rates of these companies lower? A suggestive answer can be found in Tables 2.9 and 2.10. The first column of Table 2.9 shows the results from a regression of industry imports, the amount of goods and services imported to sector j at time t from abroad, on the share of foreign capital. The positive coefficient of $HORIZ_{jt}$ suggests that foreign investors tend to import their supplies from abroad rather than use domestic suppliers. In addition, according to Table 2.10, domestic companies oriented at foreign markets are able to deal with this fact. The regression in Table 2.10 is run on the firm level, although companies are divided into export- and non-export-oriented groups based on data on the sector level. A sector is considered to be export-oriented if it exports on average over the period

[20] Again, the comparison between "always-domestic" and "up-to-now-domestic" samples is consistent with little cherry picking by foreign investors.

1995-2003 at least 50% of its production abroad. Although the corresponding coefficient of the backward spillover variable is negative, it is statistically insignificant. However, domestic companies oriented mostly on the domestic market have nobody else to supply. In this case, there is a significant and negative backward spillover effect. Since the number of these domestically-oriented companies is higher than that of the export-oriented, this negative effect dominates when the combined sample of all "always-domestic" companies is employed.

2.5.4 FDI Spillovers on Various Subsamples

The previous results indicate that there are strong backward spillover effects from FDI on domestic companies. However, these effects may be prevalent or stronger only in some period of time or in some specific group of companies. Fortunately, the sample used in this paper is sufficiently big which allows for the creation of several smaller subsamples. Thus, the regression (2.9) is run stepwise on samples from the periods 1995-1997, 1998-2000, and 2001-2003. Moreover, it is run on a sample from the period 1998-2003 to see the impact of FDI on domestic companies after the boom in 1998. Then, it is run also on a sample of "smaller" companies. In this case, a company is defined as "smaller at time t" if its amount of fixed assets in year t is lower than the average amount of fixed assets of all companies within the same sector in the same year t. This case is interesting because there are potentially two opposite effects. Due to their smaller size, these companies are more flexible and able to adjust more quickly to a new situation in a market. On the other hand, precisely because of their smaller size, they have only limited sources for improving their technologies or hiring new managers. Finally, the regression (2.9) is run on samples of only-manufacturing companies as well as only-service companies to see the impact of FDI on these specific industries.

The results of estimated coefficients from those seven regressions on subsamples of always-domestic companies are summarized in Table 2.8. The coefficients of inputs are almost the same as with the original sample. The only difference is that the coefficient of *fixed assets* is significant only for service sectors, "smaller" companies and the period after 1997. The results further suggest that there are neither horizontal nor forward spillover effects of FDI in the period 1998-2003 as corresponding coefficients are non-significant. Al-

though these effects are present with negative values in the earlier as well as the later period, they are dominated by years 1998-2000 with corresponding positive values. Negative horizontal spillovers can be probably explained by increased competition within sectors. Regarding forward spillover effects, their negative values in years 1995-1997 and 2001-2003 can be explained by similar arguments as in the case of backward spillovers on the whole sample of always-domestic companies. According to Tables 2.9 and 2.10, foreign companies tend to export their products abroad which makes domestically oriented consuming domestic companies suffer. Although the last columns in Table 2.10 are related to the period 2001-2003, the results are qualitatively the same also for the period 1995-1997. On the other hand, positive backward spillovers in years 2001-2003 can be assigned to increased effort of domestic companies to satisfy their foreign customers.

The situation for "smaller" companies just copies the overall results with only negative backward spillovers. Thus, as regards to the potential opposite effects mentioned above, the effect of "smaller" companies' limited sources dominates their flexibility. While the results for manufacturing companies do not reveal any significant spillovers, the last column shows that especially the service sector is the one who suffers in the presence of foreign investors upstream. This is a natural result because service companies are almost completely domestically oriented and usually they are not forced by domestic market to improve their products. Therefore, it is even harder for them to adjust to the presence of foreign companies. However, surprisingly, forward spillovers are found positive which might suggest an ability of domestic companies to improve themselves once they are offered products and services from foreign companies from upstream sectors.

2.6 Conclusion

In this paper I analyze the spillover effects of FDI on the sales growth of domestic Czech companies over the period 1995-2003. I estimate both horizontal spillovers within an industry and vertical spillovers, i.e., the FDI indirect effects on supplying or purchasing domestic companies from other sectors. Moreover, this study attempts to minimize the likely endogeneity of FDI with respect to future industry growth.

Contrary to the arguments supporting the subsidization of FDI, this paper finds that foreign investors contribute negatively to the performance of domestic companies. The results suggest the presence of negative backward spillover effects from FDI. A 1 percentage point increase in foreign capital in a downstream sector causes a decrease in the growth rate of sales of supplying domestic companies by almost two percentage points. This result is consistent with domestic suppliers suffering in the presence of foreign companies, which tend to import their inputs from abroad instead of using domestic suppliers. The estimates are significantly affected by controlling for an industry growth counterfactual proxy, suggesting that existing positive spillover effects should be interpreted with caution.

Even though I conclude that foreign investors contribute negatively to the performance of domestic companies, such evidence is not sufficient to argue that one should not encourage FDI. Besides the evidence that companies receiving foreign investment are typically characterized by higher productivity (Arnold and Javorcik, 2005), there are numerous other potential positive effects, that are difficult to evaluate.

2.7 References

Aitken, B. J., & Harrison, A. E. (1999). Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela. *American Economic Review, 89(3)*, 605-618.

Arnold, J., & Javorcik, B. S. (2005). Gifted Kids or Pushy Parents? Foreign Acquisitions and Plant Performance in Indonesia. *Policy Research Working Paper, 3597*, The World Bank.

Barrios, S., Görg, H., & Strobl, E. (2009). Spillovers Through Backward Linkages from Multinationals: Measurement Matters! *IZA Discussion Paper, 4477.*

Bena, J., & Hanousek, J. (2006). Rent Extraction by Large Shareholders: Evidence Using Dividend Policy in the Czech Republic. *CERGE-EI Working Paper, 291.*

Boone, L., & Maurel, M. (1998). Economic Convergence of the CEECs with the EU. *CEPR Discussion Paper, 2018.*

Damijan, J. P., Knell, M., Majcen, B., & Rojec, M. (2003a). The Role of FDI, R&D Accumulation and Trade in Transferring Technology to Transition Countries: Evidence from Firm Panel Data for Eight Transition Countries. *Economic Systems, 27(2)*, 189-204.

Damijan, J. P., Knell, M., Majcen, B., & Rojec, M. (2003b). Technology Transfer through FDI in Top-10 Transition Countries: How Important are Direct Effects, Horizontal and Vertical Spillovers? *WDI Working Paper, 549.*

Djankov, S., & Hoekman, B. (2000). Foreign Investment and Productivity Growth in Czech Enterprises. *The World Bank Economic Review, 14(1)*, 49-64.

Dunning, J. H. (1994). Re-evaluating the Benefits of Foreign Direct Investment. *Transnational Corporations, 3*, 23-51.

Firdmuc, J. (2008). The Endogeneity of the Optimum Currency Area Criteria, Intra-industry Trade, and EMU Enlargement. *Contemporary Economic Policy, 22(1)*, 1-12.

Gorodnichenko, Y., Švejnar, J., & Terrell, K. (2007). When Does FDI Have Positive Spillovers? Evidence from 17 Emerging Market Economies. *IZA Discussion Paper, 3079.*

Gorodnichenko, Y., Švejnar, J., & Terrell, K. (2008). Globalization and Innovation in Emerging Markets. *IZA Discussion Paper, 3299.*

Haddad, M., & Harrison, A. (1993). Are there Positive Spillovers from Direct Foreign Investment? Evidence from Panel Data for Morocco. *Journal of Development Economics, 42*, 51-74.

Ham, J., Švejnar, J., & Terrell, K. (1998). Unemployment and the Social Safety Net during Transitions to a Market Economy: Evidence from the Czech and Slovak Republics. *American Economic Review, 88(5)*, 1117-1142.

Hanousek, J., Kočenda, E., & Švejnar, J. (2007). Origin and Concentration: Corporate Ownership, Control and Performance. *Economics of Transition, 15(1)*, 1-31.

Haskel, J. E., Pereira, S. C., & Slaughter, M. J. (2002). Does Inward FDI Boost the Productivity of Domestic Firms? *NBER Working Paper, 8724.*

Horváth, J. (2002). Supply and Demand Shocks in Europe: Large 4-EU Members, Visegrad-5 and Baltic-3 Countries. *Central European University, mimeo.*

Jarolím, M. (2001). Foreign Direct Investment and Productivity of Czech Manufacturing Firms. *CERGE-EI Dissertation.*

Javorcik, B. S. (2004). Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers through Backward Linkages. *American Economic Review, 94(3)*, 605-627.

Jurajda, Š., & Stančík, J. (2009). Foreign Ownership and Corporate Performance: The Czech Republic at EU Entry. *CERGE-EI Working Paper, 389.*

Kinoshita, Y. (2000). R&D and Technology Spillovers via FDI: Innovation and Absorptive Capacity. *WDI Working Paper, 349.*

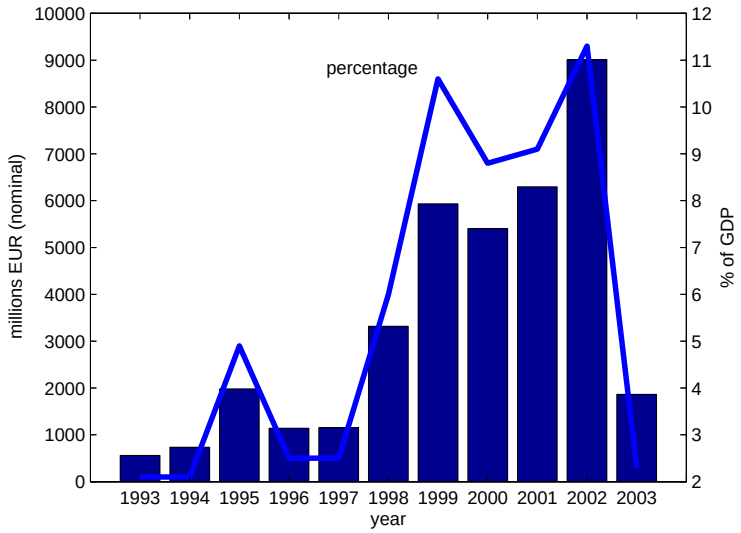
Kosová, R. (2009). Do Foreign Firms Crowd Out Domestic Firms? Evidence from the Czech Republic. *Review of Economics and Statistics*, forthcoming.

Kosová, R., & Ayyagari, M. (2006). Does FDI Facilitate Domestic Entrepreneurship? Evidence from the Czech Republic. *School of Business, GWU Working Paper, 8.*

Sabirianova, K., Švejnar, J., & Terrell, K. (2005). Distance to the Efficiency Frontier and Foreign Direct Investment Spillovers. *Journal of the European Economic Association, 3(2-3)*, 576-586.

2.8 Appendix

Figure 2.1: FDI inflow into the Czech Republic.



Source: Czech National Bank

Table 2.1: Previous studies on the Czech Republic

authors	sample	source	period	direct effect	horizontal effect	vertical effect
Djankov and Hoekman (2000)	513 manufacturing & services	PSE	1992-1996	+	–	n/a
Kinoshita (2000)	1217 manufacturing	CSO	1995-1998	– (if R&D)	+ (if R&D)	n/a
Jarolím (2001)	3152 manufacturing	CSO	1993-1998	+	?	n/a
Damijan et al. (2003a)	1115 manufacturing	Amadeus	1994-1998	+	– (if R&D)	n/a
Damijan et al. (2003b)	1168 manufacturing	Amadeus	1995-1999	–	+	+
Kosová (2009)	9986 all sectors	Amadeus	1994-2001	+	+	n/a

Note: : " – " stands for a negative significant effect; " + " stands for a positive statistically significant effect; " ? " stands for a zero or statistically insignificant effect; " n/a " indicates that an effect was not the subject of the study.
PSE = Prague Stock Exchange, CSO = Czech Statistical Office

Table 2.2: Number of companies by year.

The column "frequency" includes information about the number of companies from each year, the column "foreign" includes the number of foreign companies within each year. Percentage column includes the shares from the total number of companies from each year ("frequency" column).

year	frequency	foreign	foreign (%)
1995	1 323	127	10%
1996	1 974	267	14%
1997	2 325	396	17%
1998	2 518	502	20%
1999	2 623	631	24%
2000	2 733	766	28%
2001	2 600	835	32%
2002	2 529	894	35%
2003	2 283	814	36%
Total	20 908	5 232	25%

Table 2.3: Summary statistics.

The variable *foreign (%)* denotes the share of foreign capital in a company. The variable *horizontal foreign presence* represents the share of foreign capital invested within a sector, the variable *backward foreign presence* represents the weighted share of foreign capital in all sectors that are supplied by a sector, and the variable *forward foreign presence* represents the weighted share of foreign capital in all sectors that supply a sector.

variable	observations	mean	std. deviation	min	max
sales (ths. CZK)	20 908	622 108	3 019 073	100	154 000 000
fixed assets (ths. CZK)	20 908	418 567	2 893 904	100	130 500 000
staff costs (ths. CZK)	20 908	70 691	282 379	10	8 153 205
Δ ln sales	20 908	0.015	0.896	-8.719	14.458
Δ ln fixed assets	20 908	0.057	0.683	-7.052	11.785
Δ ln staff costs	20 908	0.079	0.571	-6.136	9.968
Δ ln value added	10 190	0.089	0.712	-6.711	10.285
Δ ln CZ production	18 026	0.020	0.040	-0.128	0.300
foreign (%)	20 908	18.980	36.584	0	100.275
horizontal foreign presence	20 908	0.218	0.185	0	1
backward foreign presence	20 908	0.146	0.096	0.002	0.667
forward foreign presence	20 908	0.136	0.083	0.011	0.429

Table 2.4: Baseline specification.

This table presents the estimated horizontal and vertical spillover effects of FDI. The dependent variable is $\Delta \ln SALES$. The first column represents the model with spillovers examined on the sample of always-domestic companies, the second represents spillovers estimated on the sample of up-to-now-domestic companies, and the last one shows the results using the sample of all companies, including the foreign owned.

	always-domestic	up-to-now-domestic	whole population
const	0.283***	0.285***	0.323***
	(0.090)	(0.084)	(0.094)
$\Delta \ln FA$	0.067***	0.065***	0.046***
	(0.018)	(0.017)	(0.016)
$\Delta \ln SC$	0.662***	0.671***	0.691***
	(0.035)	(0.035)	(0.030)
Horizontal	-0.120	-0.106	-0.099
	(0.136)	(0.135)	(0.135)
Backward	-1.389***	-1.373***	-1.677***
	(0.448)	(0.445)	(0.452)
Forward	-0.393	-0.367	-0.528
	(0.380)	(0.398)	(0.415)
Year dummies	yes	yes	yes
N	14 833	15 676	20 908
F statistic	43.344	43.595	60.177

Note: Regressions with firms' fixed effects. Robust standard errors are in parentheses; they have been corrected for clustering for each sector-year; significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Table 2.5: The specification with lead flow of FDI.

This table presents the estimated horizontal and vertical spillover effects of foreign investment that will flow into the Czech Republic in the next year. The dependent variable is $\Delta \ln SALES$.

	always-domestic	whole population
const	0.140*	0.162*
	(0.080)	(0.084)
$\Delta \ln FA$	0.068***	0.050***
	(0.018)	(0.016)
$\Delta \ln SC$	0.698***	0.716***
	(0.036)	(0.031)
Inflow Horizontal$_{t+1}$	0.378**	0.307*
	(0.151)	(0.163)
Inflow Backward$_{t+1}$	0.710	0.762
	(0.529)	(0.499)
Inflow Forward$_{t+1}$	1.565**	1.614**
	(0.707)	(0.761)
Year dummies	yes	yes
N	13 364	18 625
F statistic	43.764	60.697

Note: Regressions with firms' fixed effects. Robust standard errors are in parentheses; they have been corrected for clustering for each sector-year; significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Table 2.6: The relationship between production of the CR and other V4 countries.

This table presents the relationship between the level of production in the Czech Republic and the remaining Visegrad countries at NACE2 level. The first column represents the level specification, while the second one represents the *log* specification. The dependent variable is production in the CR at NACE2 level. Time span is 1990-2003.

specification	level	*log*
const	5 990 077	3.132***
	(10 300 000)	(1.143)
Slovakia	2.116***	0.296**
	(0.586)	(0.117)
Poland	-0.188	0.198
	(0.612)	(0.130)
Hungary	0.091**	0.349***
	(0.037)	(0.119)
N	400	400
R^2	0.694	0.787

Note: Robust standard errors are in parentheses; they have been corrected for clustering for each sector; significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Table 2.7: Regression with forecasted Czech production growth rate.

This table presents the estimated horizontal and vertical spillover effects of FDI when accounting for natural growth in an economy using forecasted data about Czech production. The dependent variable is $\Delta \ln SALES$. The first column represents the model with spillovers examined on a sample of always-domestic companies, the second represents spillovers estimated on a sample of up-to-now-domestic companies, and the last shows the results using a sample of all companies.

	always-domestic	up-to-now-domestic	whole population
const	0.252***	0.249***	0.289***
	(0.093)	(0.088)	(0.097)
$\Delta \ln FA$	0.069***	0.063***	0.039**
	(0.021)	(0.021)	(0.018)
$\Delta \ln SC$	0.662***	0.678***	0.699***
	(0.037)	(0.038)	(0.032)
Horizontal	-0.135	-0.113	-0.125
	(0.137)	(0.138)	(0.138)
Backward	-1.658***	-1.644***	-2.034***
	(0.524)	(0.521)	(0.501)
Forward	-0.254	-0.210	-0.333
	(0.388)	(0.414)	(0.430)
$\Delta \ln PROD^{Czech}$	1.106***	1.060***	1.058***
	(0.334)	(0.328)	(0.361)
Year dummies	yes	yes	yes
N	12 693	13 429	18 026
F statistic	35.459	35.285	48.900

Note: Regressions with firms' fixed effects. Robust standard errors are in parentheses; they have been corrected for clustering for each sector-year; significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Table 2.8: Different subsamples.

This table presents the estimated horizontal and vertical spillover effects of FDI on several different subsamples of always-domestic companies. First four columns represents different time spans, the last three represents a sample of smaller domestic companies, a sample of companies from manufacturing sectors, and a sample of companies from service sectors, respectively. The dependent variable is $\Delta \ln SALES$.

specification	1995-1997	1998-2000	2001-2003	1998-2003	FA<mean	manufacture	service
const	0.650***	0.009	0.375	0.154**	0.254***	0.046*	0.540***
	(0.214)	(0.100)	(0.394)	(0.072)	(0.096)	(0.025)	(0.124)
$\Delta \ln FA$	0.046	0.029	0.008	0.044**	0.045**	0.032	0.072**
	(0.033)	(0.028)	(0.046)	(0.022)	(0.019)	(0.028)	(0.029)
$\Delta \ln SC$	0.601***	0.604***	0.664***	0.648***	0.659***	0.686***	0.636***
	(0.066)	(0.043)	(0.073)	(0.037)	(0.041)	(0.051)	(0.059)
Horizontal	-2.025*	0.239*	-0.667***	-0.107	-0.060	-0.093	-0.328
	(1.193)	(0.134)	(0.210)	(0.139)	(0.156)	(0.089)	(0.290)
Backward	-3.257	-2.008**	3.226***	-1.764***	-1.734***	-0.133	-4.564***
	(2.334)	(0.968)	(1.204)	(0.597)	(0.521)	(0.279)	(0.969)
Forward	-5.075**	1.635*	-4.188***	0.207	-0.029	-0.042	3.523***
	(2.462)	(0.838)	(1.426)	(0.546)	(0.457)	(0.397)	(1.024)
$\Delta \ln PROD^{CZ}$	0.790**	1.091***	0.061	0.867*	0.933***	0.729**	0.478
	(0.333)	(0.319)	(0.397)	(0.489)	(0.331)	(0.328)	(0.615)
Year dummies	yes	yes	yes	yes	yes	yes	yes
N	3 643	4 770	4 280	9 050	9 836	6 331	5 160
F statistic	25.764	49.116	20.929	42.035	28.797	47.288	20.170

Note: Regressions with firms' fixed effects. Robust standard errors are in parentheses, they have been corrected for clustering for each sector-year; significance at 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

Table 2.9: The relationship between FDI and import (export).

This table presents the results from the regression of sector import (export) on the share of foreign capital within the sector.

dependent variable	$\ln IMPORT_{jt}$	$\ln EXPORT_{jt}$
const	8.458***	8.993***
	(0.191)	(0.129)
$HORIZ_{jt}$	1.652***	1.409***
	(0.468)	(0.332)
N	361	367
R^2	0.022	0.040

Note: Robust standard errors are in parentheses; significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Table 2.10: Division by (non)exporting and (non)importing sectors.

This table presents the estimated horizontal and vertical spillover effects of FDI on several different subsamples of always-domestic companies. The division is done according to exporting and importing strategies on sector level. First two columns represents the division of the whole time span into non-exporting and exporting sectors; the last two represents the division of the shorter time span into non-importing and importing sectors on the other hand. The former one explains negative backward spillover effects found in regression (2.9), while the latter one explains negative forward spillover effects found in Table 2.8. The dependent variable is $\Delta \ln SALES$.

sample	always-domestic		only years 2001-2003	
sectors	non-export	export	non-import	import
const	0.328***	0.101***	0.288	1.146**
	(0.106)	(0.035)	(0.362)	(0.469)
$\Delta \ln FA$	0.078***	0.012	-0.002	0.119
	(0.023)	(0.044)	(0.049)	(0.091)
$\Delta \ln SC$	0.629***	0.813***	0.671***	0.645***
	(0.041)	(0.058)	(0.085)	(0.114)
Horizontal	-0.118	-0.256**	-0.630***	-0.790
	(0.187)	(0.100)	(0.220)	(0.509)
Backward	-2.760***	-0.392	3.184**	-1.809
	(0.731)	(0.331)	(1.272)	(3.027)
Forward	0.517	-1.731***	-4.481***	-1.816
	(0.490)	(0.458)	(1.599)	(3.309)
$\Delta \ln PROD^{CZ}$	1.078***	0.175	-0.084	0.500
	(0.357)	(0.320)	(0.447)	(0.789)
Year dummies	yes	yes	yes	yes
N	9 790	2 903	3 763	517
F statistic	26.328	32.786	16.765	80.986

Note: Regressions with firms' fixed effects. Robust standard errors are in parentheses, they have been corrected for clustering for each sector-year; significance at 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

Table 2.11: Comparison of the results – sales vs. value added.

This table presents the estimated horizontal and vertical spillover effects of FDI using a sample of always-domestic companies. Two different performance measures are compared here – $\Delta \ln SALES$ and $\Delta \ln VA$. First two columns compare the results for the whole sample, the last two represents the results for a subsample of companies from manufacturing sectors only. In order to have comparable samples, when $\Delta \ln SALES$ is used, the sample is reduced only to those companies for which $\Delta \ln VA$ is available.

sample	all sectors		manufacture	
dependent variable	$\Delta \ln VA$	$\Delta \ln SALES$	$\Delta \ln VA$	$\Delta \ln SALES$
const	0.086***	0.200***	0.043	0.062**
	(0.031)	(0.052)	(0.039)	(0.029)
$\Delta \ln FA$	0.078***	0.047**	0.033	0.010
	(0.019)	(0.023)	(0.025)	(0.022)
$\Delta \ln SC$	0.387***	0.613***	0.446***	0.598***
	(0.036)	(0.042)	(0.049)	(0.046)
Horizontal	0.180*	0.107	0.115	0.146
	(0.105)	(0.128)	(0.124)	(0.104)
Backward	0.151	-0.374	0.210	0.032
	(0.333)	(0.356)	(0.441)	(0.421)
Forward	-0.306	-0.503	-0.141	0.313
	(0.525)	(0.526)	(0.718)	(0.623)
Year dummies	yes	yes	yes	yes
N	7 559	7 549	3 221	3 219
F statistic	33.340	37.102	30.378	51.748

Note: Regressions with firms' fixed effects. Robust standard errors are in parentheses, they have been corrected for clustering for each sector-year; significance at 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

Chapter 3

Foreign Ownership and Corporate Performance: The Czech Republic at EU Entry

(Joint work with Štěpán Jurajda)

(CERGE-EI Working Paper #389)

3.1 Introduction

Foreign Direct Investment (FDI) is likely to be one of the key channels of economic development for middle-income countries, particularly so for the post-communist economies of Central Europe (e.g., Alfaro et al., 2004; Neuhaus, 2006). Foreign-owned companies, a group that includes both greenfields and foreign acquisitions, are consistently more productive than domestically owned firms, as Sabirianova et al. (2005) demonstrate for the Czech Republic and Russia.[1] Taking the productivity advantage of FDI as a given, a large literature therefore studies its *indirect* impacts on domestic companies – productivity spillovers within and across industries (e.g., Javorcik, 2004). However, there is less work available measuring the *direct* causal productivity effects of foreign takeovers of domestic companies, even though such measurements are important for evaluating the benefits of greenfield vs. brownfield

[1]For theory of and empirical tests supporting the productivity dominance of foreign-owned firms, see Helpman et al. (2004) and, e.g., Girma et al. (2004).

FDI support and for understanding the nature of FDI flows.

There is, of course, a large literature studying the effects of early-transition privatization of state-owned companies in post-communist economies. In one of the most complete analysis, Brown et al. (2006) suggest that privatizing state-owned companies to foreign entities during the 1990s generated larger productivity gains than privatization to domestic owners. In several transition economies, however, large FDI inflows started only after the mass privatization programs were completed. The Czech Republic is a case in point as it received a massive inflow of foreign capital only after 1997.[2]

In this paper, we therefore provide evidence on FDI's recent *direct* effects: We assess the effects of over three hundred cases of foreign takeovers observed in a sample of Czech firms between 1997 and 2005. Unlike most of the work on privatization or, indeed, on foreign takeovers, we analyze not only manufacturing companies, but also the service sector, where the share of foreign capital as of 2005 was about 40% of that in manufacturing industries.[3] We contrast the takeover effects across not only the services/manufacturing divide, but also across the groups of exporting and non-exporting manufacturing industries as these are likely to differ in terms of the strategies that multinationals use when entering a given sector. While acquiring a domestic company in a non-exporting sector eliminates a potential domestic competitor, acquiring a local company in an internationally competitive industry is more likely to be motivated mainly by high domestic-company performance and may therefore lead to smaller takeover productivity improvements.[4]

Further, we follow Brown et al. (2009) in studying not only the productivity effects of ownership changes, but also the effects on workers. Specifically, we ask whether foreign takeovers affect the wage bill of the company, i.e., the total earnings of employees. The question of interest to workers as well as

[2]Benefiting from investment subsidies and tax breaks introduced in 1997, Czech FDI inflows rose from below 3% of GDP in 1996 to 1997 to over 10% during 1999 to 2002. As a result, Czech FDI stock per capita reached 5,256 EUR in 2005, the end of our sample frame, which compares favorably with the 2005 FDI stock in Slovakia (2,721) or Poland (2,070).

[3]Out of over ten studies of foreign ownership effects in the Czech Republic during the 1990s, the only one to cover the service sector is Kosová (2009), who focuses on the indirect effects of FDI. Outside of Central Europe, only Aitken and Harrison (1999) work with non-manufacturing data. The related literature is discussed in more detail in Section 3.2.

[4]There is a growing theoretical literature on how firms choose modes of foreign market access, but little empirical work on the topic; see, e.g., Nocke and Yeaple (2007) for a general equilibrium model with heterogenous firms.

policy makers is whether scale effects of takeovers outweigh the cost-cutting potentially associated with the higher productivity foreign owners impose on their acquisitions and, therefore, whether foreign acquisitions ultimately benefit the employees of domestic companies.

A fundamental problem with the identification of these causal effects is that multinational companies are likely to select the best domestic firms as acquisition targets. In the absence of credible instrumental variables, most studies attempt to achieve progress on causality by conditioning on pre-takeover performance. An increasingly popular technique, see, e.g., Arnold and Javorcik (2005) or Girma et al. (2007), is to match foreign acquisitions to domestic firms with similar probability of being acquired by multinationals and to compare the before/after performance changes between the two groups. As argued by Blundell and Costa Dias (2000), this approach combines careful conditioning on observables through matching on pre-takeover performance (trends) with before/after differencing that eliminates time-constant unobservables. We follow their suggestion and apply the matched difference-in-differences approach to our sample of Czech manufacturing and service firms, effectively comparing the change in performance of companies taken over by foreign investors between the moment of acquisition and one to three years later with the corresponding change in performance of matched domestic companies.

Using several performance indicators, we find the impact of foreign investors on domestic acquisitions to vary across types of target industries. Based on data covering the experience of Czech firms around the moment of the Czech Republic's entry into the EU, we uncover significant effects of foreign takeovers only in the non-exporting manufacturing sector, consistent with the argument that firms in exporting manufacturing industries successfully face direct international competition and do not need to be 'disciplined' by foreign owners.

The paper is structured as follows. The next section covers the existing work on takeover effects and ownership change, with a focus on results available for the Czech Republic. Our empirical strategy and data are described in Sections 3.3 and 3.4, respectively, while Section 3.5 presents the findings. The last section concludes.

3.2 Literature Review

There are numerous studies estimating the direct effects foreign investors have on the performance of domestic companies during the early-transition mass-privatization period (see, e.g., Djankov and Murrell, 2002, for a survey; or Estrin et al., 2009). In this section, we first highlight those that focus on the Czech Republic and then briefly discuss groups of studies of ownership effects that differ in their preferred estimation technique.

A small literature estimates positive effects of foreign ownership on total factor productivity (TFP), or its growth, in the Czech Republic using data from 1992 to 1998 covering the mass privatization (e.g., Djankov and Hoekman, 2000; Jarolím, 2000; Damijan et al., 2003; Evenett and Voicu, 2003). These studies typically use small samples of manufacturing or publicly traded firms to estimate linear regressions with exogeneity in foreign status (or sample selection corrections)[5] based on various arguments, including the exclusion of the firm's initial efficiency or the relative size of the given firm within its industry from the company performance regression. In the most detailed and careful study of the Czech mass-privatization experience to-date, Hanousek et al. (2007) instrument for ownership changes using pre-market initial conditions and detect positive effects of foreign ownership on various performance measures driven mainly by foreign industrial firms.[6]

The research on Czech firms undergoing mass privatization is typical of most of the existing work on ownership effects from other countries in that it relies on panel-data techniques and postulates exclusion restrictions that allow for instrumental variable (IV) strategies.[7] Some of this work combines the IV approach with fixed-effects estimation conditioning on lagged dependent variable and requires the (weak) exogeneity of lagged outcome and control

[5]Variables affecting ownership status but unrelated to company performance (including potential future performance in absence of a takeover) can be used to either instrument for a foreign-ownership dummy in a pooled regression or to identify sample selection corrections in a switching-regression framework.

[6]Several recent papers also ask about the indirect effects of FDI on domestic Czech companies through productivity spillovers within and across industries (see, e.g., Kosová, 2009, or Stančík, 2007). The key identification problem of this literature, similar to the need for exogenous determinants of foreign ownership in the work on FDI's direct effects, is to identify variation in industry FDI inflow that is not driven by (estimates of) future growth of that industry.

[7]Only the early studies in this area did not attempt to account for the endogeneity ("cherry picking") of foreign ownership, e.g., Aitken and Harrison (1999) for Venezuela.

variables (e.g., Benratello and Sembenelli, 2006). The identification of such dynamic GMM models, however, is fragile when the variables of interest are sufficiently persistent.

Convincing quasi-experiments affecting ownership but not performance are seldom found, especially once the focus shifts beyond pre-market initial conditions to late-transition data. Another strand of research thus attempts to control for the correlation between ownership type and company unobservables in a simple static regression framework using company fixed effects and/or time trends. A prime example of this body of work is provided by the analysis of long panel data from four transition countries by Brown et al. (2006), who suggest that privatizing state-owned companies to foreign entities generates larger productivity gains than privatization to domestic owners. The basic goal of these regressions is to compare the performance of domestic and foreign-owned firms after conditioning on both time-constant unobservables (captured by the firm fixed effects) and pre-takeover performance change (captured by the firm-specific time trends). However, to the extent that much of the data used in the estimation of these firm fixed effects and time trends comes from after the ownership change, these methods may 'over-control' and lead to an under-estimation of the effect of interest. Furthermore, regression-based techniques may suffer from the so-called lack of 'common support' (Barsky et al., 2002) when the characteristics of firms acquired by foreign investors differ from those of a significant share of firms in the data that remain domestic.

An increasingly popular alternative conditioning technique is to match foreign acquisitions to domestic firms with similar probability of being acquired by multinationals based on pre-takeover performance and to compare the before/after performance changes between the two groups. Examples of this approach, which combines careful conditioning on observables through propensity score matching on pre-takeover performance (possibly including performance trends) with the before/after differencing that eliminates time-constant unobservables, are the studies of Arnold and Javorcik (2005) and Girma et al. (2007), who study Indonesian and UK manufacturing firms, respectively, and uncover significant foreign-takeover TFP effects.

Finally, while there are several results available on the effects of foreign takeovers on firm productivity, less attention has been paid to the effects on

firm wage bill and employment, even though these two variables are important from the perspective of political economy of FDI. Brown et al. (2009) are the first to combine evidence on productivity effects with estimates of wage and employment effects of ownership change of manufacturing firms of four transition economies (but not the Czech Republic); they suggest that foreign takeovers have scale-expansion effects that dominate the productivity-improvement effects, leading to a positive effect on workers' wages.

In this paper, we apply the matched difference-in-differences comparison to a sample of Czech manufacturing and service-sector firms from 1995-2005. Unlike the existing analysis of the Czech Republic, or indeed of other countries from Central Europe, we estimate the effects of foreign takeovers that took place after 1997, i.e., after the mass privatization programs were completed. Unlike almost all of the work on both transition and developing economies, we study the experience of not only manufacturing, but also service-sector firms, and we differentiate between exporting and non-exporting manufacturing industries. Finally, we also measure the consequences of foreign acquisitions not only for company performance indicators, but also for their wage bills – a variable more interesting for workers subject to such an ownership change.

3.3 Estimation Approach

To circumvent the selection into foreign-owned status ("cherry picking" by foreign investors), we draw on the microeconometric evaluation literature and employ propensity-score matching to compare changes in performance associated with foreign takeovers to changes in performance in highly similar companies that remain domestic. Specifically, one can estimate the causal effect of foreign ownership on a given outcome indicator by assuming that the assignment to foreign-owned status is as good as random conditional on observables summarized in the propensity score, i.e., within a group of firms that share a similar predicted probability of being acquired by foreign investors $P(X_{t-1}) \equiv P(FDI_t = 1|X_{t-1})$, where t corresponds to the timing of the foreign acquisition. The outcome measure of interest in our case consists of the difference between a company's performance at the time of being acquired and one to three years later, i.e., $Y_{t+k} - Y_t$, where $k = 1, 2, 3$.

The causal effect of interest, an average effect of treatment on the treated, is defined as the difference between the average outcome measure of firms that were acquired by foreign investors, denoted $E\left[Y_{1,t+k} - Y_{1,t} | FDI_t = 1\right]$, which is easy to obtain from data, and the hypothetical counterfactual outcome of these same firms had they not been acquired: $E\left[Y_{0,t+k} - Y_{0,t} | FDI_t = 1\right]$. The counterfactual is estimated based on the conditional independence assumption (Rosenbaum and Rubin, 1983) as the average outcome of firms that were not acquired by foreign investors, but that had the same probability of being acquired as of time t – the same value of the propensity score:

$$E\left[Y_{0,t+k} - Y_{0,t} | FDI_t = 1, P(X_{t-1})\right] = E\left[Y_{0,t+k} - Y_{0,t} \mid FDI_t = 0, P(X_{t-1})\right]. \tag{3.1}$$

The probability of being acquired (the propensity score) is assumed to depend on a set of time-changing observable characteristics, chiefly firm-level balance-sheet indicators, entered both contemporaneously and lagged to capture pre-takeover performance trends; the exercise is performed within groups defined by (matching is 'exact' on) year and industry.[8] Equation (3.1) implies that a basic requirement for the implementation of the matching approach is a sufficiently large overlap between the distribution of the propensity score of the acquired and the domestic companies (the *common support* condition).[9]

3.4 Data

The company-level balance-sheet annual data used in this study come from the *ASPEKT* commercial database, which is a Czech source for the *Amadeus* EU-wide data and is widely used in empirical research (e.g., Hanousek et al., 2007; Hanousek et al., 2009). Crucially, the *ASPEKT* data provide information on companies' ownership structure and, thus, allow one to identify foreign-owned companies. We interpret a company as foreign-owned if it has

[8] The procedure is implemented using Mahalanobis-metric matching with replacement in the latest version of the psmatch2 Stata routine provided by Leuven and Sianesi (2003).

[9] An assessment of the matching quality consists of checking whether the matching procedure is able to balance the distribution of the relevant variables across the control and treatment group. To this effect, we perform two-sample t-tests as suggested by Rosenbaum and Rubin (1985).

at least 10% of its equity owned by a foreign investor.[10]

The purpose of the study is to contrast the performance of domestic firms that were acquired by foreign investors to that of firms that remain domestic-owned. We therefore disregard information on foreign-owned greenfields in most of the analysis.[11] After dropping observations with inconsistent financial information, firms with fixed assets of less than 1 million CZK (approximately 30,000 EUR), as well as industrial branches involving a strong regulatory role of the government,[12] the resulting sample contains information on 4,049 companies from forty 2-digit NACE industrial sectors and covers the 1995-2005 period, generating 26,163 firm-year observations.[13]

An overview of the year-ownership and industry-ownership structure of the sample is provided in Tables 3.2 and 3.3, respectively. In a typical year, there are over two thousand companies in the data. We observe 324 cases of foreign takeovers and foreign-owned data represent almost 6% of all firm-year observations. The timing of foreign acquisitions mimics the time series of aggregate FDI inflow as recorded by the Czech National Bank (CNB), rising swiftly after 1997.[14] Table 3.3 shows that in some industries, as many as 20% of firms in our sample were acquired by foreign investors during the sample frame, while there are no foreign takeovers in several 2-digit industries. The share of foreign capital in each industry, which reflects both foreign takeovers and greenfields, also varies widely from low levels in, e.g., the leather or hotel

[10]This threshold is used also in the official definition of FDI by the Czech National Bank and in studies of firm-level data by Evenett and Voicu (2003), Damijan et al. (2003), or Javorcik (2004). The average share of a foreign investor in a Czech company in our data is 3.0%.

[11]Greenfields were preliminarily identified as firms newly appearing in the sample with (near) 100% foreign ownership; all such cases were then checked manually (information on these firms was found on the Internet) to confirm that the observed firm is in fact not an acquisition of a previously domestically owned company.

[12]Agriculture, forestry, fishing, utilities, public administration, health and education; NACE codes 1, 2, 5, 41, 75, 80, and 85.

[13]We also observe 1,018 unique greenfields with foreign ownership in our sample, 5,743 firm-year observations in total. Including the greenfields, our panel data thus have 31,906 observations.

[14]To check for potential attrition bias related to ownership, we compared the exit rates of 'always-domestic' and 'after-takeover' firms and found it nearly identical in all years.

and restaurant industries, to 0.8 in insurance and pension funding.[15]

We list 2-digit NACE industries in three groups: services, exporting, and non-exporting manufacturing.[16] An industry is considered to be 'exporting' if it exports at least 50% of its production on average over the period 1995-2005.[17] The average share of foreign-owned assets in our three groups of industries ranges from 13% in the service sector to 38% in the exporting manufacturing industries. Similarly, the share of foreign capital in a given industry in acquisitions (as opposed to greenfields) is the lowest in the service sector. Most foreign investors in services apparently build greenfields, which may reflect the relatively low Czech share of employment in the service sector in an EU comparison.

Table 3.4 provides summary statistics of all firm-level variables used in the estimation. Balance-sheet information is used to form four corporate performance indicators: ratios of profit over total assets; debt over total assets; a simple measure of total factor productivity (residuals from industry-specific regressions of firm value added on fixed assets and staff costs); and the company wage bill (unfortunately, employment is not available).

The Table provides descriptive statistics not only for the sample we work with, but also for the matched sub-sample of firms where the 'treatment' and 'control' firms used are only those that could be matched to their counterparts based on the estimated propensity score within industry and year cells.[18] Clearly, matching sheds almost half of the data, suggesting that the common support problem is a relevant concern in these data. In particular, several of the service-sector industries are lost from the matching comparison including

[15]To check the representativeness of the *ASPEKT* data with respect to foreign ownership, we compare the official FDI figures (from the CNB) listed in the third column of Table 3.3 to estimates of the share of foreign fixed assets based on our sample (calculated by summing up the capital of both foreign acquisitions and greenfields). The correlation between the two measures across 2-digit NACE industries, weighted by the share of fixed assets of each industry covered by the sample, is 0.96.

[16]A small group of 'other industries' is also included in the data when we analyze all industries.

[17]The output and export statistics were obtained from the OECD. We have alternatively defined exporting manufacturing industries using only the 1995-1997 time window, which led to the re-classification of four 2-digit NACE categories from the 'exporting' to the 'non-exporting' group; this change, however, had no material effect on the estimated effects of foreign acquisition reported in the next section.

[18]The propensity score controls for profits over total assets as well as for other firm-level variables, see Table 3.5 for details.

telecommunications and computer services.[19]

Before estimating the causal effects of foreign ownership, we provide one last descriptive comparison. Specifically, we ask whether foreign-owned firms out-perform domestic-owned ones on average within years and industries. We answer this descriptive question by running a simple OLS regression with our panel data (including greenfields), where we condition on year and 2-digit NACE industry dummies as well as three ownership indicators: a dummy that equals 1 during the two years before an entry of foreign equity into a domestic company; a dummy that equals 1 for all years after the foreign acquisition; and a separate dummy for foreign-owned greenfields; domestic-owned companies are the base group. Using such simple comparisons, and additionally controlling for the logarithm of firm staff costs, we find that greenfields have statistically significantly higher level of profits over total assets (by 0.06) compared to domestic-owned companies, while the differences between domestic-owned company-year observations and those for firms (about to be) acquired by foreign investors are not statistically discernible. Using the wage bill as the dependent variable, and replacing firm staff costs with firm fixed assets in the conditioning set, we find that all three foreign-ownership dummy coefficients are positive and statistically significant, ranging from 0.20 for foreign acquisitions to 0.35 for greenfields. Similarly, using TFP as the dependent variable, and conditioning only on year and industry dummies, we find that all three foreign-ownership dummy coefficients are positive and statistically significant, ranging from 0.07 for domestic firms about to be acquired by foreign investors to 0.24 for greenfields. In short, foreign ownership is associated with higher productivity, profits, or wages of Czech companies.

[19]Matching also effectively excludes observations with extreme values of profits over total assets. Dropping those observations manually (i.e., those that exceed 0.15 in absolute value) does not lead to sizeable changes in the estimated coefficients. Similarly for liabilities over total assets (with the exclusion threshold at 2).

3.5 Results

3.5.1 Propensity Score Estimation

Our first task is to estimate the propensity score – the probability that an individual firm with certain characteristics is acquired by a foreign entity in a given year. Such analysis is interesting in its own (descriptive) right, and it also provides the key continuous conditioning variable for the matching exercise. A set of logit specifications for the probability of foreign takeover is reported in Table 3.5. The propensity score is predicted based on company age and either fixed assets or staff costs (depending on the outcome performance measure: profit or liabilities over assets, TFP, and wages); each specification then additionally controls for the level of the outcome variable from one and two years prior to the current year, which is meant to control for trends in performance prior to takeover.

Older firms are more likely to be acquired as are larger firms and those with higher staff costs. A positive trend in profitability and a negative trend in liability (conditional on other controls) appear to predict the chances of a foreign takeover, while higher lagged TFP level is associated with a higher probability of foreign equity entering a given firm.[20] The results are thus consistent with foreign investors "cherry picking" domestic firms. There appears to be little relationship between company wage bills (conditional on firm size) and the takeover chances. These propensity scores are used in the difference-in-differences with matching estimation in the next section.[21]

Table 3.6 presents an auxiliary set of logit specifications controlling for profit over total assets, where we additionally condition on the share of for-

[20] The estimated propensity score coefficients are not materially affected when we add 2-digit industry and year dummies, i.e., the variables on which we match 'exactly'.

[21] To assess how well the propensity score performed in balancing observables across the matched treatment and controls, we performed two-sample t-tests suggested by Rosenbaum and Rubin (1985) and evaluated pseudo R2 statistics before and after matching. There were no systematic differences in the distribution of covariates after matching and the pseudo-R2 was close to zero (0.01, down from 0.06 before matching). Similar conclusions come from F-tests on the joint significance of all regressors. However, one may be concerned that since the share of domestic companies in our sample is shrinking over time (from 88% to 65%), the quality of the match could be deteriorating over time as well. For this reason, we performed a series of t-tests using subsamples based on 4-year moving windows of the data. The evolution of the pseudo-R2 values measured after matching does suggest some deterioration in match quality over time with a threefold rise over the sample frame, but the values generally stay under 0.1.

eign greenfields and takeovers in the given industry and year. These specifications are meant to shed some light on the industry-specific strategies that foreign investors follow when entering a given market. Estimation is performed on the full sample as well as on sub-samples of companies that operate in non-exporting manufacturing industries, exporting manufacturing industries, and in the service sector. The magnitude of the coefficients is broadly similar across the three industry groups, although we find the positive effect of *Takeover share* to be statistically significant only in the service sector. While there is no relationship between the presence of greenfields and the decision of a foreign investor to acquire a domestic firm, there appears to be strong industry-level consistency in the location of takeovers. For example in the service sector, 'moving' from the lowest to the highest observed industry *Takeover share* (from 0 to 0.06) increases the probability of another takeover by about two percentage points.

Table 3.6 also shows that the importance of the pre-acquisition trend in profits over assets is mainly coming from the service sector and, possibly quantitatively more importantly even if not statistically significantly, from the exporting manufacturing industries. On the other hand, there appears to be little "cherry picking" in the non-exporting sector, consistent with the notion that company performance may be less important for the acquisition decision in this sector.

3.5.2 Foreign-Ownership Effects

In this section, we report the results of the matched difference-in-differences analysis of the performance change gap between domestic and foreign companies one to three years after acquisition. Tables 3.7 to 3.10 report the results for the four performance indicators we study. In all four cases, we find that foreign ownership leads to substantial improvements in corporate performance indicators of firms in the non-exporting manufacturing industries, with typically the strongest impact two years after the foreign takeover,[22] while

[22]Girma et al. (2007) uncover a similar time pattern in their study of foreign ownership effects.

no significant effects are estimated for the remaining two industry groups.[23]

The magnitude of the estimated effects in the non-exporting industries is economically significant too. For example, the two-year change in profits over assets (liabilities per total assets) driven by a foreign acquisition corresponds to about one-tenth (twentieth) of the all-sample standard deviation of all observed two-year changes in this variable. Focusing on the TFP performance measure and using the estimate from three years after the foreign acquisition, the effect corresponds to about one-quarter of the all-sample standard deviation in these three-year changes. Finally, the impact of a foreign acquisition on the change in the (log) wage bill, and therefore on the workers subject to foreign takeover, is certainly economically significant at the 25 percentage points of the wage bill growth rate above the domestically owned firms two years after the acquisition. The timing of the onset of these effects in the non-exporting manufacturing industries, with profits rising early on, wage bills throughout and TFP only in year $t + 3$, is consistent with the presence of some short-term ("low-hanging") profit opportunities implemented after takeover such as the sale of non-core assets. Our results for total factor productivity and wage bills are in line with those from Arnold and Javorcik (2005), although their estimated effects of foreign acquisitions in Indonesia are substantially larger in magnitude.

We have performed a number of robustness checks that signalled little sensitivity of these conclusions to sample choices or to details of the estimation technique. Among other checks, we have tried dropping the last year of the sample (2005), where there is somewhat less data, and we also experimented with using only industries where the sample coverage of the firm population was above the 30th percentile of the industry distribution of coverage. Instead of following the performance indicators for each year after the acquisition separately, we additionally re-estimated the matching exercises whilst focusing on 2-year and 3-year moving average windows of performance, and we also assessed the sensitivity to defining exporting industries using 1995-1997 data instead of the whole sample period.

[23]The one exception to this statement is the large negative wage-bill effects estimated for both exporting manufacturing and service industries three years after foreign takeover. However, these estimates are based on the lowest number of matched 'treatment' companies of all of the estimated specifications, and we thus hesitate to draw strong conclusions. Perhaps the scope for scale effects is limited in these industries.

Most importantly, we have estimated the foreign-acquisition effects based on an alternative grouping of manufacturing industries. Instead of dividing the industries based on strong exporting performance, we have divided manufacturing industries based on their openness to international competition defined as share of import plus export on the aggregate import and export from a given year. We then divided industries into low/medium/high openness using the 33rd and 66th percentiles of the industry distribution of openness. Similar to our main set of findings, we uncovered significant foreign-acquisition effects only in the low-openness group of industries, while the size of the estimated treatment effects was broadly consistent with those reported in the main set of findings.

3.6 Conclusion

There is a large literature studying the effects of ownership changes during early-transition privatization, but much less work on the effects of recent FDI, which is, arguably, the more important 'engine of growth' in post-communist countries. Furthermore, most of the FDI-related research focuses on its indirect effect, such that we know comparatively little about the direct effect of foreign takeovers on domestic companies and the choices of mode of foreign-market access (greenfield vs. brownfield) that foreign investors make.

Based on data covering the experience of Czech companies around the time of the Czech Republic's entry into the EU and using the matched difference-in-differences approach, we find that foreign takeovers significantly boost several corporate performance indicators in non-exporting manufacturing industries, but have little effect in other industries. Workers of these firms benefit from the acquisitions as well, at least in terms of their wages. These findings are consistent with the argument that firms in exporting manufacturing industries face direct international competition and do not need to be 'disciplined' by foreign owners.[24] Our study complements the results of Alfaro (2003), who in a cross-country study of FDI effects, finds that manufacturing FDI generates a positive growth effect, while the impact is ambiguous in the

[24]In a related analysis, Konings et al. (2003) suggest that exposure to international trade and competition is one of the key driving forces of the restructuring of Ukrainian firms during 1998-2000.

service sector.[25] The absence of a statistically or economically significant effect of takeovers on service-sector firms may be driven by market regulation or structure and motivates future work on service-sector FDI.

3.7 References

Aitken, B. J., & Harrison, A. E. (1999). Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela. *American Economic Review, 89(3)*, 605-618.

Alfaro, L. (2003). FDI and Economic Growth Does the Sector Matter? http://www.people.hbs.edu/lalfaro/fdisectorial.pdf, unpublished manuscript.

Alfaro, L., Areendam, C., Kalemli-Ozcan, S., & Sayek, S. (2004). FDI and Economic Growth: The Role of the Financial Markets. *Journal of International Economics, 64(1)*, 89–112.

Arnold, J., & Javorcik, B. S. (2005). Gifted Kids or Pushy Parents? Foreign Acquisitions and Plant Performance in Indonesia. *Policy Research Working Paper, 3597*, The World Bank.

Benratello, L., & Sembenelli, A. (2006). Foreign Ownership and Productivity: Is the Direction of Causality so Obvious? *International Journal of Industrial Organization, 24*, 733-751.

Barsky, R., Bound, J., Charles, K., & Lupton, J. (2002). Accounting for the Black-White Wealth Gap: A Nonparametric Approach. *Journal of the American Statistical Association, 97*, 663-673.

Blundell, R., & Costa Dias, M. (2000). Evaluation Methods for Non-Experimental Data. *Fiscal Studies, 21(4)*, 427-468.

Brown, J. D., Earle, J. S., & Telegdy, A. (2006). The Productivity Effects of Privatization: Longitudinal Estimates from Hungary, Romania, Russia, and Ukraine. *Journal of Political Economy, 114(1)*, 61-99.

[25] Similarly, using firm-level data, Gorodnichenko et al. (2007) suggest that FDI spillovers vary significantly by sectors.

Brown, J. D., Earle, J. S., & Telegdy, A. (2009). Employment and Wage Effects of Privatization: Evidence from Hungary, Romania, Russia, and Ukraine. *Economic Journal*, forthcoming.

Damijan, J. P., Knell, M., Majcen, B., & Rojec, M. (2003). The Role of FDI, R&D Accumulation and Trade in Transferring Technology to Transition Countries: Evidence from Firm Panel Data for Eight Transition Countries. *Economic Systems, 27(2)*, 189-204.

Djankov, S., & Hoekman, B. (2000). Foreign Investment and Productivity Growth in Czech Enterprises. *The World Bank Economic Review, 14(1)*, 49-64.

Djankov, S., & Murrell, P. (2002). Enterprise Restructuring in Transition: A Quantitative Survey. *Journal of Economic Literature, 40*, 739-792.

Estrin, S., Hanousek, J., Kočenda, E., & Švejnar, J. (2009). Effects of Privatization and Ownership in Transition Economies. *Journal of Economic Literature*, forthcoming.

Evenett, S., & Voicu, A. (2003). Picking Winners or Creating Them? Revisiting the Benefits of FDI in the Czech Republic. *Oxford University Working Paper.*

Girma, S., Holger, G., & Strobl, E. (2004). Exports, International Investment, and Plant Performance: Evidence from a Non-parametric Test. *Economics Letters, 83(3)*, 317-324.

Girma, S., Kneller, R., & Pisu, M. (2007). Do Exporters have Anything to Learn from Foreign Multinationals? *European Economic Review, 51*, 981-998.

Gorodnichenko, Y., Švejnar, J., & Terrell, K. (2007). When Does FDI Have Positive Spillovers? Evidence from 17 Emerging Market Economies. *IZA Discussion Paper, 3079.*

Hanousek, J., Kočenda, E., & Švejnar, J. (2007). Origin and Concentration: Corporate Ownership, Control and Performance. *Economics of Transition, 15(1)*, 1-31.

Hanousek, J., Kočenda, E., & Švejnar, J. (2009). Divestitures, Privatization and Corporate Performance in Emerging Markets. *Economics of Transition, 17(1)*, 43-73.

Helpman, E., Melitz, M. J., & Yeaple, S. R. (2004). Export Versus FDI with Heterogeneous Firms. *American Economic Review, 94(1)*, 300-316.

Jarolím, M. (2000). Foreign Direct Investment and Productivity of Firms. *Czech Journal of Economics and Finance, 50(9)*, 478-487.

Javorcik, B. S. (2004). Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers through Backward Linkages. *American Economic Review, 94(3)*, 605-627.

Leuven, E., & Sianesi, B. (2003). Stata module to perform full Mahalanobis and propensity score matching, common support graphing, and covariate imbalance testing. Statistical Software Components S432001, Boston College Department of Economics.

Konings, J., Kupets, O., & Lehmann, H. (2003). Gross Job Flows in Ukraine: Size, Ownership and Trade Effects. *Economics of Transition, 11(2)*, 321-356.

Kosová, R. (2009). Do Foreign Firms Crowd Out Domestic Firms? Evidence from the Czech Republic. *Review of Economics and Statistics*, forthcoming.

Neuhaus, M. (2006). The Impact of FDI on Economic Growth: An Analysis for the Transition Countries of Central and Eastern Europe. *Contributions to Economics, 12*.

Nocke, V., & Yeaple, S. (2007). Cross-Border Mergers and Acquisitions versus Greenfield Foreign Direct Investment: the Role of Firm Heterogeneity. *Journal of International Economics, 72*, 336-365.

Rosenbaum, P., & Rubin, D. (1985). Constructing a Control Group Using Multivariate Matched Sampling Methods that Incorporate the Propensity Score. *The American Statistician, 39(1)*, 33-38.

Sabirianova, K., Švejnar, J., & Terrell, K. (2005). Foreign Investment, Corporate Ownership, and Development: Are Firms in Emerging Markets Catching Up to the World Standard? *WDI Working Paper, 734*.

Stančík, J. (2007). Horizontal and Vertical FDI Spillovers: Recent Evidence from the Czech Republic. *CERGE-EI Working Paper, 340*.

3.8 Appendix

Table 3.1: Definition of Industry-Level FDI Variables.

FDI share	Foreign direct investment divided by fixed assets at the 2-digit NACE industry level. (Source: Czech National Bank.)
FDI share by takeovers	Industry-level fixed assets of domestic companies acquired by foreign investors divided by industry fixed assets. (Source: Aspekt.)
FDI share by greenfields	Industry-level fixed assets of foreign companies built by foreign investors divided by industry fixed assets. (Source: Aspekt.)
Takeover share	Product of industry *FDI share* and *FDI share by takeovers*.
Greenfield share	Product of industry *FDI share* and *FDI share by greenfields*.

Table 3.2: Number of Companies by Year.

The column 'always domestic' gives the number of companies observed in a given year that remain domestic throughout the sample frame; the column 'before acquisition' gives the number of domestic companies observed in a given year that are to be acquired by a foreign entity later; the column 'after acquisition' gives the number of observed companies that are foreign-owned as of a given year; the column 'N' gives the total number of firm observations in the sample, which contains no greenfields. The last column 'acquisitions' gives the number of foreign acquisitions in a given year.

	firm-year observations				
year	always domestic	before acquisition	after acquisition	N	acquisitions
1995	1,841	244	0	2,085	0
1996	2,093	262	5	2,360	5
1997	2,236	210	64	2,510	57
1998	2,275	192	94	2,561	32
1999	2,302	162	126	2,590	36
2000	2,271	126	163	2,560	47
2001	2,242	81	199	2,522	51
2002	2,230	56	211	2,497	31
2003	2,159	31	221	2,411	29
2004	1,984	10	220	2,214	23
2005	1,638	0	215	1,853	13
Total	23,271	1,374	1,518	26,163	324

Table 3.3: FDI Share and Structure by Industry as of 2005.

The column 'N' gives the number of companies in the sample observed at least once, while the second column shows the (cumulative) share of these companies taken over by foreign entities. The third column presents the official FDI share on industry fixed assets as of 2005 and the last one shows the share of FDI capital in companies acquired by foreign investors (as opposed to built by them). See Table 3.1 for variable definitions. A sector is considered to be export oriented if it exports at least 50% of its production abroad on average over the 1995-2005 period.

NACE	N	Share of takeovers	FDI share	Takeover share on FDI
Non-exporting manufacturing				
15 Food products and beverages	327	0.09	0.23	0.03
20 Wood and wood products	154	0.08	0.19	0.02
21 Pulp, paper and paper products	29	0.14	0.51	0.02
22 Publishing and printing	162	0.12	0.23	0.01
23 Coke, refined petroleum and nuclear fuel	14	0.21	0.28	0.07
26 Other non-metallic mineral products	161	0.08	0.38	0.01
27 Basic metals	99	0.12	0.29	0.01
28 Fabricated metal products	461	0.10	0.22	0.01
Total	1,407	0.10	0.28	0.03
Exporting manufacturing				
17 Textiles	95	0.09	0.17	0.02
18 Wearing apparel; dressing and dyeing of fur	22	0.00	0.08	0.00
19 Leather and leather products	25	0.08	0.03	0.00
24 Chemicals and chemical products	139	0.12	0.31	0.03
25 Rubber and plastic products	68	0.15	0.41	0.01
29 Machinery and equipment n.e.c.	119	0.13	0.28	0.06
30 Office machinery and computers	22	0.09	0.50	0.02
31 Electrical machinery and apparatus n.e.c.	86	0.05	0.44	0.04
32 Radio, TV and communication equipment	38	0.08	0.65	0.01
33 Medical, precision and optical instruments	49	0.06	0.42	0.01
34 Motor vehicles, trailers and semi-trailers	15	0.20	0.57	0.44
35 Other transport equipment	13	0.08	0.13	0.04
36 Furniture; manufacturing n.e.c.	27	0.07	0.12	0.01
37 Recycling	36	0.03	0.17	0.03
Total	754	0.10	0.38	0.04
Services				
50 Sale and repair of motor vehicles	140	0.06	0.14	0.01
51 Wholesale trade, except of motor vehicles	663	0.06	0.32	0.01
52 Retail trade; repair of personal goods	290	0.05	0.27	0.03
55 Hotels and restaurants	49	0.04	0.06	0.01
60 Land transport; transport via pipelines	22	0.09	0.08	0.00
63 Supporting and auxiliary transport activities	10	0.00	0.01	0.00
64 Post and telecommunications	9	0.11	0.52	0.05
65 Financial intermediation	152	0.08	0.73	0.06
66 Insurance and pension funding	26	0.15	0.80	0.06
67 Activities auxiliary to financial intermediation	32	0.13	0.38	0.05
70 Real estate services	65	0.09	0.03	0.00
72 Computer and related services	15	0.07	0.38	0.01
73 Research and development	8	0.00	0.02	0.00
74 Other business services	51	0.12	0.35	0.02
Total	1,532	0.07	0.13	0.01
Other industries				
10 Mining of coal and lignite	19	0.00	0.01	0.00
11 Extraction of crude petroleum and natural gas	4	0.00	0.05	0.00
14 Other mining and quarrying	57	0.11	0.34	0.02
45 Construction	276	0.08	0.10	0.00
Total	356	0.08	0.08	0.01

Table 3.4: Summary Statistics.

All financial variables are in millions of 2000 Euros. Total factor productivity (TFP) is measured as residuals from regressions of Value added on Fixed assets and Staff costs by 2-digit NACE industry. Matching is based on p-score estimation from the first column of Table 3.5.

	whole sample			matched sample		
variable	observations	mean	std. deviation	observations	mean	std. deviation
Total assets	26,143	21.29	146.79	10,247	24.02	174.67
Age	26,055	6.61	4.37	10,247	6.97	3.86
Profit	26,145	0.54	10.41	10,247	0.49	10.49
Value added	24,077	4.08	23.26	9,922	4.42	25.22
Liabilities	26,111	10.51	59.85	10,246	11.58	70.32
Wage bill	17,528	1.73	5.86	7,647	1.81	6.47
Fixed assets	25,503	13.35	126.35	10,201	15.65	149.58
Staff costs	25,127	1.95	7.28	10,229	2.19	8.49
Profit to total assets	26,125	0.00	2.23	10,247	0.02	0.20
Debt to total assets	26,125	0.79	12.06	10,246	0.54	0.65
TFP	22,590	0.02	23.91	9,623	-0.11	20.87

Table 3.5: P-score Estimation.

The table presents the marginal effects from Logit estimation asking whether a domestic company becomes foreign-owned.

Age	0.015***	0.015***	0.015***	0.017***
	(0.002)	(0.002)	(0.002)	(0.002)
Age^2	-0.0003***	-0.0003***	-0.0002***	-0.0003***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
$\ln SC_{t-1}$	0.017***	0.016***		
	(0.002)	(0.002)		
$\ln FA_{t-1}$			0.014***	
			(0.003)	
$PROFIT/TA_{t-1}$	0.004			
	(0.004)			
$PROFIT/TA_{t-2}$	-0.005**			
	(0.002)			
$LIAB/TA_{t-1}$		-0.004		
		(0.006)		
$LIAB/TA_{t-2}$		0.0002***		
		(0.0000)		
$\ln WAGES_{t-1}$			-0.009	
			(0.010)	
$\ln WAGES_{t-2}$			0.015	
			(0.010)	
$\ln TFP_{t-1}$				0.005
				(0.004)
$\ln TFP_{t-2}$				0.011***
				(0.004)
N	17,274	17,268	12,149	16,194
χ^2	188.132	192.442	125.229	141.553
$pseudoR^2$	0.065	0.065	0.076	0.045

Note: Age stands for years since company incorporation, FA stands for company fixed assets, SC is staff costs, TA is total assets, $WAGES$ is wage bill, $PROFIT$ stands for profit/loss, $LIAB$ denotes company liabilities, and TFP denotes company total factor productivity. All financial variables are in thousands of CZK. Robust standard errors are in parentheses; they have been corrected for clustering at company level. Significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Table 3.6: P-score Estimation with Foreign Shares included.

The table presents the marginal effects from Logit estimation asking whether a domestic company becomes foreign-owned.

	All	Manufacturing		Services
	industries	Nonexporting	Exporting	
Age	0.014***	0.016***	0.011***	0.022***
	(0.002)	(0.003)	(0.004)	(0.005)
Age^2	-0.0002***	-0.0003***	-0.0002*	-0.0007***
	(0.0001)	(0.0001)	(0.0001)	(0.0002)
$\ln SC_{t-1}$	0.017***	0.020***	0.024***	0.008**
	(0.002)	(0.004)	(0.006)	(0.004)
$PROFIT/TA_{t-1}$	0.004	-0.012	0.010	0.003
	(0.004)	(0.014)	(0.008)	(0.003)
$PROFIT/TA_{t-2}$	-0.004**	-0.007	-0.010	-0.004**
	(0.002)	(0.015)	(0.010)	(0.002)
Takeover share	0.223**	0.426	0.219	0.293**
	(0.101)	(0.344)	(0.143)	(0.119)
Greenfield share	0.047	-0.003	0.056	0.066
	(0.039)	(0.080)	(0.054)	(0.059)
N	17274	7299	3820	4748
χ^2	201.831	99.703	37.660	64.732
$pseudoR^2$	0.068	0.076	0.059	0.076

Note: *Age* stands for years since company incorporation, SC is staff costs, TA is total assets, and $PROFIT$ stands for profit/loss. See Table 3.1 for definitions of 'Takeover share' and 'Greenfield share'. A sector is considered to be export oriented if it exports at least 50% of its production abroad on average over the 1995-2005 period. All financial variables are in thousands of CZK. Robust standard errors are in parentheses; they have been corrected for clustering at company level. Significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Table 3.7: Matching Results – Profit per Total Assets.

The table presents a comparison of the change in performance of companies taken over by foreign investors between the moment of acquisition and one to three years later with the corresponding change in performance of matched domestic companies. See Table 3.3 for industry grouping. The performance measure is profit over total assets (*PROFIT/TA*).

	All	Manufacturing		Services
	industries	Nonexporting	Exporting	
$t+1$	0.038	0.061*	0.019	-0.008
	(0.026)	(0.034)	(0.035)	(0.027)
N treated matched	206	101	46	41
N controls matched	12,760	5,469	2,844	3,416
$t+2$	0.191*	0.141***	0.017	0.004
	(0.099)	(0.045)	(0.029)	(0.138)
N treated matched	172	84	40	33
N controls matched	10,075	4,383	2,282	2,609
$t+3$	-0.057	-0.082	-0.002	-0.006
	(0.044)	(0.121)	(0.044)	(0.038)
N treated matched	144	68	38	25
N controls matched	7,766	3,421	1,788	1,954

Note: Bootstrapped standard errors are in parentheses; they have been corrected for clustering at company level. Significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Table 3.8: Matching Results – Liabilities per Total Assets.

The table presents a comparison of the change in performance of companies taken over by foreign investors between the moment of acquisition and one to three years later with the corresponding change in performance of matched domestic companies. See Table 3.3 for industry grouping. The performance measure is liabilities over total assets (*LIAB/TA*).

	All	Manufacturing		Services
	industries	Nonexporting	Exporting	
$t+1$	-0.008	-0.035	0.019	0.004
	(0.048)	(0.342)	(0.133)	(0.049)
N	12,984	5,579	2,898	3,457
N treated matched	207	99	47	43
N controls matched	12,751	5,469	2,843	3,410
$t+2$	-0.332	-0.672**	-0.019	0.009
	(0.360)	(0.297)	(0.254)	(0.077)
N	10,267	4,476	2,331	2,642
N treated matched	172	85	42	36
N controls matched	10,067	4,382	2,281	2,604
$t+3$	-0.327**	-0.357**	0.038	-0.080
	(0.134)	(0.171)	(0.111)	(0.108)
N	7,928	3,499	1,832	1,980
N treated matched	143	69	38	24
N controls matched	7,759	3,420	1,787	1,950

Note: Bootstrapped standard errors are in parentheses; they have been corrected for clustering at company level. Significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Table 3.9: Matching Results – Wage Bill.

The table presents a comparison of the change in performance of companies taken over by foreign investors between the moment of acquisition and one to three years later with the corresponding change in performance of matched domestic companies. See Table 3.3 for industry grouping. The performance measure variable is the logarithm of the company wage bill (ln *WAGES*).

	All	Manufacturing		Services
	industries	Nonexporting	Exporting	
$t+1$	0.069*	0.169**	-0.085	0.158
	(0.041)	(0.070)	(0.071)	(0.178)
N	9,182	4,276	2,165	2,116
N treated matched	134	71	34	24
N controls matched	9,021	4,193	2,126	2,086
$t+2$	0.114	0.254**	-0.115	-0.150
	(0.073)	(0.101)	(0.109)	(0.265)
N	7,295	3,438	1,749	1,626
N treated matched	115	60	30	18
N controls matched	7,155	3,366	1,713	1,601
$t+3$	0.013	0.401**	-0.326**	-0.747**
	(0.083)	(0.192)	(0.155)	(0.341)
N	5,655	2,698	1,379	1,219
N treated matched	90	50	28	12
N controls matched	5,534	2,638	1,345	1,198

Note: Bootstrapped standard errors are in parentheses; they have been corrected for clustering at company level. Significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Table 3.10: Matching Results – Total Factor Productivity.

The table presents a comparison of the change in performance of companies taken over by foreign investors between the moment of acquisition and one to three years later with the corresponding change in performance of matched domestic companies. See Table 3.3 for industry grouping. The performance measure is the logarithm of total factor productivity (ln *TFP*); see Table 3.4 for the definition of TFP.

	All	Manufacturing		Services
	industries	Nonexporting	Exporting	
$t+1$	-0.003	-0.003	-0.037	-0.143
	(0.035)	(0.050)	(0.049)	(0.156)
N	12,209	5,401	2,796	3,039
N treated matched	205	104	44	34
N controls matched	11,991	5,292	2,746	2,999
$t+2$	0.021	0.034	-0.052	-0.160
	(0.038)	(0.078)	(0.131)	(0.201)
N	9,635	4,315	2,239	2,327
N treated matched	176	85	40	28
N controls matched	9,447	4,224	2,191	2,295
$t+3$	0.166**	0.183***	-0.007	-0.085
	(0.082)	(0.071)	(0.134)	(0.129)
N	7,418	3,357	1,756	1,738
N treated matched	147	73	34	23
N controls matched	7,261	3,281	1,714	1,714

Note: Bootstrapped standard errors are in parentheses; they have been corrected for clustering at company level. Significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.