Charles University in Prague

Faculty of Social Sciences
Institute of Economic Studies

RIGOROUS THESIS

Subsidy Competition for Spillovers from Inward Foreign Direct Investment

Author: **Mgr. Tomáš Havránek**

Supervisor: **doc. Ing. Tomáš Cahlík, CSc.**

Academic Year: **2009/2010**

Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

The author grants to the Charles University permission to reproduce and to distribute copies of this thesis document in whole or in part.

Prague, August 24, 2009

_____
Signature

Thank you!

I am much obliged to Zuzana Iršová for her valuable suggestions, encouragement, and overall brilliant assistance. I would also like to express my gratitude to Tomáš Cahlík of the Charles University for supervising my work on this thesis, and Pekka Ilmakunnas of the Helsinki School of Economics as well as 2 anonymous referees for insightful comments. The usual caveat applies.

A substantial part of this thesis was written while I was participating in the Erasmus Exchange Programme. I am indebted to the University of Helsinki and Helsinki School of Economics for kind support and particularly for granting me unlimited access to their databases.

Contents

Chapter 2:

Meta-Analysis of Intra-Industry FDI Spillovers: Updated Evidence

The present paper conducts a meta-analysis of literature on intra-industry productivity spillovers from foreign direct investment. Apart from the traditional approach, robust meta-regression, random effects model, and probit meta-regression are employed. Results of combined significance analysis are mixed but it is apparent that papers published in leading academic journals tend to report rather insignificant results. Our findings suggest that cross-sectional and industry-level studies are likely to find relatively strong spillover effects, and that the choice of proxy for foreign presence is important. The pattern, however, seems to weaken over time. Contrary to previous studies, evidence for publication bias was not detected.

JEL Classification	C42, D62, F21, F23, O3
Keywords	Meta-analysis, Productivity spillovers, Technology transfer, Foreign direct investment, Multinational corporations

Kapitola 2:

Meta-analýza přelivů produktivity z horizontálních FDI: Nová zjištění

Předkládaná studie je meta-analýzou literatury zkoumající přelivy produktivity z přímých zahraničních investic na firmy hostitelské země. Kromě tradičního přístupu používáme také robustní, panelovou a probitovou meta-regresi. Ačkoli kombinovaná signifikance není jednoznačná, je zřejmé, že studie publikované v nejprestižnějších časopisech mají tendenci prezentovat spíše nesignifikantní výsledky. Naše zjištění naznačují, že studie užívající průřezová data a odvětvovou agregaci obvykle nacházejí signifikantní přelivy a že volba proxy pro zahraniční přítomnost výsledky významně ovlivňuje. Tyto efekty však nejsou natolik zřetelné u nových článků. Narozdíl od předchozích studií jsme dále nenalezli stopy publikační zaujatosti.

JEL klasifikace	C42, D62, F21, F23, O3
Klíčová slova	meta-analýza, přelivy produktivity, přenos technologií, přímé zahraniční investice, nadnárodní společnosti

Chapter 3:

On the Determinants of Foreign Direct Investment Incentives

This paper examines the microeconomic motivation of governments to provide tax incentives for foreign direct investment. Author applies the classical models of oligopoly to subsidy competition, endogenousing investment incentives, but leaving tax rates exogenous. According to the conventional wisdom, subsidy competition leads to overprovision of incentives. This paper suggests that, in the oligopolistic framework, supranational coordination can either decrease or *increase* the supply of subsidies. Further, in the setting of subsidy regulation, the host country's corporate income tax rate has an ambiguous effect on the provision of incentives.

JEL Classification	F12, F21, F23, H25, H71, H87
Keywords	Investment incentives, Subsidy competition, Productivity spillovers, Oligopoly, Foreign direct investment, Multinational corporations

Kapitola 3:

Determinanty pobídek pro zahraniční investory

Tento článek zkoumá mikroekonomickou motivaci vlád k poskytování daňových úlev zahraničním investorům. Autor aplikuje klasické modely oligopolu na situaci pobídkové soutěže, kde investiční pobídky jsou endogenní veličinnou, avšak daňové sazby exogenní. Konvenční moudrost říká, že pobídková soutěž má za následek nadprodukci investičních pobídek. Tento článek naznačuje, že v situaci oligopolního soutěžení může mít nadnárodní kooperace za následek jak snížení, tak *zvýšení* poskytovaných pobídek. Dále je ukázáno, že v rámci regulace pobídek má sazba daně z příjmu právnických osob v hostitelské zemi neurčitý vliv na nabídku daňových úlev pro zahraniční investory.

JEL klasifikace	F12, F21, F23, H25, H71, H87
Klíčová slova	investiční pobídky, pobídková soutěž, přelivy produktivity, oligopol, přímé zahraniční investice, nadnárodní společnosti

Chapter 4:
Subsidy Competition for FDI: Fierce or Weak?

The objective of this paper is to empirically assess the recently introduced models of subsidy competition based on the classical oligopoly theories, using both cross-sectional and panel data. Three crucial scenarios (including coordination, weak competition, and fierce competition) are tested employing OLS, iteratively re-weighted least squares, fixed effects, and Blundell-Bond estimator. The results suggest that none of the scenarios can be strongly supported—although there is some weak support for cooperation—, and thus that empirical evidence is not in accordance with the tested models. Further, it seems that by means of FDI incentives countries try to compensate foreign investors for high wages and low productivity of their citizens.

JEL Classification	C21, C23, F21, F23, H25
Keywords	Panel data, Investment incentives, Foreign direct investment, Subsidy competition

Kapitola 4:
Soutěž o přímé zahraniční investice: Ostrá či mírná?

Cílem tohoto článku je empiricky zhodnotit nedávno představené modely pobídkového soupeření založené na klasických modelech oligopolu za použití jak průřezových, tak panelových dat. Tři nejdůležitější scénáře – nadnárodní koordinace pobídek, slabá soutěž a ostrá soutěž – jsou testovány pomocí klasických nejmenších čtverců, metody iteračních opakovaně vážených nejmenších čtverců, fixních efektů a Blundellova-Bondova estimátoru. Naše výsledky naznačují, že žádný z předložených scénářů nemůže být silně podpořen – ačkoli existuje alespoň určitá slabá podpora pro nadnárodní koordinaci –, a že tedy empirická evidence není v souladu s testovanými modely. Ukazuje se také, že země mohou nabízet vysoké pobídky jako kompenzaci zahraničním investorům za vysoké mzdové náklady a nízkou produktivitu.

JEL klasifikace	C21, C23, F21, F23, H25
Klíčová slova	panelová data, investiční pobídky, přímé zahraniční investice, pobídková soutěž

List of Tables

List of Figures

Abbreviations

BB	Blundell-Bond
CIT	Corporate Income Tax
CR	Czech Republic
CZK	Czech Koruna
EC	European Commission
FE	Fixed Effects
FEE	Federation of European Employers
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
IES	Institute of Economic Studies
IMF	International Monetary Fund
INI	Investment Incentive
IRLS	Iteratively Re-weighted Least Squares
LM	Lagrange Multiplier
MNC	Multinational Corporation
NPV	Net Present Value
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
PPP	Purchasing Power Parity
RE	Random Effects
SAOCR	Supreme Audit Office of the Czech Republic
UNCTAD	United Nations Conference on Trade and Development
USD	United States Dollar

Chapter 1

Introduction

The presented thesis is a collection of 3 papers written during my graduate studies at the Institute of Economic Studies, Faculty of Social Sciences, Charles University in Prague (2007–2009). Even though all chapters can be considered as independent articles and each one focuses on a specific problem, they are complementary to each other in their close relation to the issue of foreign direct investment incentives and subsidy competition.

Chapter 2 presents an updated version of a paper which was written in collaboration with Zuzana Iršová and published as IES working paper 2008/08. The article received Honorable Mention by the President of the Czech Economic Society in the Young Economist Award 2008 competition and has been submitted to International Business Review. Zuzana Iršová helped me particularly with gathering data—60% of the data were obtained due to her effort, making the study one of the richest meta-anylises conducted in international finance with 97 used results from 67 different papers. Zuzana also computed combined significance (Table 2.1) and constructed an informative table of all used studies (Table 2.7). I include these parts of Chapter 2 with her kind permission. I am responsible for the text itself and all employed regressions.

Chapter 2 conducts a meta-analysis of literature on intra-industry productivity spillovers from foreign direct investment. Apart from the traditional approach, robust meta-regression, random effects model, and probit meta-regression are employed. Results of combined significance analysis are mixed but it is apparent that papers published in leading academic journals tend to report rather insignificant results. Our findings suggest that cross-sectional and industry-level studies are likely to find relatively strong spillover effects, and that the choice of proxy for foreign presence is important. The pattern, however, seems to weaken over time. Contrary to previous studies, evidence for publication bias was not detected.

Chapter 3 introduces a broadly modified version of an essay that received Honorable Mention by the President of the Czech Economic Society in the Young Economist

Award 2007 competition and was accepted for publication in Prague Economic Papers (June 2009 issue). An older version was published as IES working paper 2007/31 (in Czech). The working paper built heavily on my bachelor thesis which was awarded the Bolzano Prize 2007 by the Rector of the Charles University; and although the basic idea remains, it has been improved, concentrated, the propositions and conclusions have been broadly revised, and the paper was naturally translated into English.

Chapter 3 examines the microeconomic motivation of governments to provide tax incentives for foreign direct investment. The author applies the classical models of oligopoly to subsidy competition, endogenousing investment incentives, but leaving tax rates exogenous. According to the conventional wisdom, subsidy competition leads to overprovision of incentives. This chapter suggests that, in the oligopolistic framework, supranational coordination can either decrease or *increase* the supply of subsidies. Further, in the setting of subsidy regulation, the host country's corporate income tax rate has an ambiguous effect on the provision of incentives.

Chapter 4 presents a slightly modified version of a study that was published as IES working paper 2009/07. In fact, it is the least independent one of all chapters introduced in this thesis as it is more or less tight together with Chapter 3 through empirical testing of theoretical models presented there.

The objective of Chapter 4 is to empirically assess the recently introduced models of subsidy competition based on the classical oligopoly theories, using both cross-sectional and panel data. Three crucial scenarios (including coordination, weak competition, and fierce competition) are tested employing OLS, iteratively re-weighted least squares, fixed effects, and Blundell-Bond estimator. The results suggest that none of the scenarios can be strongly supported—although there is some weak support for cooperation—, and hence that empirical evidence is not in accordance with the tested models.

Chapter 2

Meta-Analysis of Intra-Industry FDI Spillovers: Updated Evidence

2.1 Introduction

Governments all over the world pay fortunes, either in cash or as tax holidays, to attract inward foreign direct investment (FDI) under their jurisdiction. There are many reasons why governments attempt to lure multinational companies (MNCs) but the principal one resides in their expectations of positive productivity externalities spilling over from MNCs to domestic firms (see Blomström & Kokko 2003). There has been a substantial body of empirical literature on productivity spillovers since the 1970s, and many narrative literature reviews have been published (see, *inter alia*, Pack & Saggi 1997). The first quantitative survey, commonly called a meta-analysis, was conducted by Görg & Strobl (2001), followed by Meyer & Sinani (2005), and Wooster & Diebel (2006). For a discussion of the advantages and disadvantages of narrative and quantitative methods of literature reviews, see Stanley (2001).

Meta-analysis is a rather new method in economics; it has been employed only since the 1980s, and the *meta-regression* approach, which we particularly use in this paper, was developed by Stanley & Jarrell (1989). The recent economic research by means of meta-analysis covers for instance Gallet (2007) trying to uncover the extent to which study characteristics influence the estimates of tuition and income elasticities, Li *et al.* (2007) investigating systematic variation across environmental Kuznets curve studies, Fidrmuc & Korhonen (2006) who present a study on business cycle correlation between the Euro area and the Central-East European Economies, or Rose & Stanley (2005) investigating the effect of currency unions on international trade.

A meta-analyst rigorously combines the outcomes of several works that study the same phenomena. A meta-regression analyst, in the concrete, collects a number of statistics from the targeted literature—e.g., correlation coefficients or t statistics of

estimates of the effect in question—and regresses it on several proxies of the study design. If any of meta-explanatory variables is found to be significant, it is taken as an evidence that studies' results are *dependent on their design* (for a good introduction to the meta-regression technique, see Stanley 2001). Concerning the meta-analyses of the spillover literature, Görg & Strobl (2001) apply plain ordinary least squares (OLS) meta-regression, Meyer & Sinani (2005) employ panel data methods, and Wooster & Diebel (2006) perform logistic meta-regression. We combine all the three methods and include also robust estimations to get a more stable overall model. The sample of literature used in this meta-analysis is also much broader than in the previous ones, containing 67 original empirical works.

The present paper is structured as follows: Section 2.2 lists channels of transfers of intra-industry (or horizontal) spillovers from MNCs to domestic firms, and describes the standard design of empirical works on horizontal spillovers. Section 2.3 discusses in detail the literature selection procedure which was employed, and describes properties of the resulting data set. Section 2.4 investigates the combined significance of the collected t statistics. In Section 2.5, the meta-regression analysis is performed. Section 2.6 tests for the presence of publication bias in the spillover literature. Section 2.7 concludes.

2.2   Channels of Technology Transfer

The history of intra-industry productivity spillover literature[1] dates from 1960, covering works of MacDougall, Corden or Caves, who analyzed the welfare effects of FDI, its impact on optimal tariff policy, industrial level, and international trade openness. A deeper specification is provided in Blomström & Kokko (1996), embodied in the three main channels of technology transfer:

Competition effect   As emphasized e.g. in Blomström (1992), the entrance of foreign enterprises contributes to the progression on industrial, technological and managerial level and export dynamics through the creation of competitive environment. Nevertheless, multinational companies may evoke crowding-out effects as well as *unfair* competition, generating harmful externalities to the domestic firms. MNCs can acquire significant market shares or drain deficient resources. Such unwanted effects are highlighted by several researchers (for instance, Haddad & Harrison 1993, who, in fact, find evidence of *negative* horizontal spillovers).

Demonstration effect   Its realization stems from the differences in technology between foreign investors and host-country firms. MNCs enter the host-country market

---

[1]Other FDI externalities than productivity spillovers have been discussed as well, in the concrete the market access spillovers (see, e.g., Blomström & Kokko 2003) or financing spillovers (Geršl & Hlaváček 2007; Geršl 2008), but there are only a few empirical studies estimating those.

and establish affiliates which possess superior technology compared to local companies. The latter watch and imitate these affiliates in the same industry, thus becoming more productive. Sometimes only a direct contact with new technologies can overcome conservative attitudes toward the implementation of up-to-date technologies (Blomström & Kokko 1996).

Labor turnover Host country's citizens employed by the foreign investor might benefit from the contact with advanced technologies and production methods. Based on the transfer of human capital, knowledge, and skills toward the host country labor force, this labor exchange phenomena can enhance competitiveness of domestic firms. MNCs train local labor force because it is still cheaper than import skilled labor from their home country, even though, in most cases, they cannot prevent the labor turnover (see Görg & Greenaway 2004).

Since it is not possible the measure the above-mentioned effects directly, empirical works on horizontal productivity spillovers are usually performed in the following way: researchers collect data on firms' productivity or output (either on firm or industry level) and regress it on *a measure of foreign presence* in the firms' industries, controlling also for additional variables (capital/output, labor/output ratios, etc.). If the estimate of the parameter for foreign presence is found to be positive and significant, the authors conclude that there is some statistical evidence for the existence of intra-industry spillovers.

2.3   The Sample of Literature

In the present paper, 97 results from 67 different studies are used, which is a significant increase compared to Görg & Strobl (2001), who used a sample of 21 studies, or Meyer & Sinani (2005) and Wooster & Diebel (2006), who had at their disposal 41 and 32 studies, respectively. We tried to include all relevant papers listed in the previous meta-analyses; additional search was performed in the EconLit and Google Scholar databases using combinations of the keywords "foreign direct investment", "productivity spillovers", and "technology transfer".

We follow the approach of Görg & Strobl (2001) in the selection process, i.e., only those studies are included which do not *diverge significantly* from the standard methodology of productivity-spillovers empirical work as it is described in Section 2.2, and only English-written papers are considered. What does "diverge significantly" stand for? In the first place, we do not use results for inter-industry (or vertical), market access, and financing spillovers. These categories are qualitatively relative, but the tested specifications are, in our opinion, too dissimilar to be pooled together in the framework of a meta-analysis, and it would be much more appropriate to

analyze these streams of literature separately. The more distant models are used, the more heterogeneous the sample becomes and the less reliable are the results drawn from it. Random-effects meta-analysis may provide a remedy for heterogeneity (see, *inter alia*, Hedges 1992), but better approach may be to (try to) avoid the problem.

Excluding inter-industry, market access, and financing spillovers, there is still a substantial body of empirical literature dealing with horizontal productivity spillovers. Many papers present multiple models, and thus multiple results. As a rule, we tried to choose the one that was considered the best by the researchers themselves. If the preferred model was not suitable for the analysis—i.e., it diverged too much from the standard methodology—, the model with the highest R-squared (or adjusted R-squared, depending on which one was published) was selected. There are also works that examine different countries with the same methodology, or one country with different specifications which are, nevertheless, consistent with the mainstream approach. For example, Konings (2000) studies spillovers in Bulgaria, Poland, and Romania separately, thus 3 observations were included from his paper. Liu (2008) first presents a purely firm-level model but subsequently adds industry dummies, thus we obtain two observations from this paper, etc. On the other hand, Sadik & Bolbol (2001) apply not industry- or firm-, but country-level aggregation, and Zhu & Tan (2000) uses city-level data set, therefore we do not include these papers—although Wooster & Diebel (2006) use them. Rattsø & Stokke (2003) employ two proxies for foreign presence at the same time, the share of trade on GDP and FDI on overall investment, none of them belonging to the standard measures in the spillover literature—thus this paper is also excluded from the meta-analysis.

We realize that the selection process is the most vulnerable part of the present work, but the final sample is broad and represents works of researchers from dozens of countries and evidence from many economies around the world. Both journal articles and working papers were used. The list of employed studies and some of their characteristics can be found in Table 2.7 in the Appendix to Chapter 2: Section 2.A.

The first aspect of the study design that we include in the meta-analysis is the status of the country for which the data are used. From the whole sample of 97 observations, 41 models are using data for developing countries, 34 models' data are for transition countries, and 22 for advanced economies. Countries are distributed in groups according to the European Economic Association (transition countries list) and the World Bank (developing economies list). The second aspect is the (non)existence of time dimension in the data. Thirty-two models use cross-sectional data, the remaining 65 models rely on panel-data techniques. The third aspect is the definition of MNCs' presence. Thirty-two specifications define foreign presence in the industry as foreign firms' share on employment, 25 use assets, 21 output (or value added), and 19 share on sales. The fourth aspect is the level of aggregation. Forty models use purely firm-level data, whereas 35 include also industry dummies

and 22 aggregate data on the level of industries. The fifth aspect is the definition of the response variable. Thirty-nine specifications use output growth, 54 models apply labor (or total factor[2]) productivity level or log-level and the rest employ other measures (for details of different measures, see Görg & Strobl 2001). Exact definitions of all variables and their summary statistics can be found in Table 2.8 in the Appendix to the present chapter.

2.4 Combined Significance

Once we have collected a broad sample of empirical studies on intra-industry spillovers, the most natural question appears to be: can we somehow decide whether or not there is any general evidence for the existence of the spillover effect? The crucial result of every empirical work on productivity spillovers is the (non)significance, polarity, and magnitude of the estimate of the regression parameter which corresponds to the variable that is used as a proxy for foreign presence in the industry. Since every researcher can (and generally does) use different units, it is not appropriate to take the magnitude of estimates as the representative variable. The t statistic, on the other hand, is a dimension-less variable which is widely employed for the purposes of a meta-analysis (it is also used by all three existing meta-analyses of the spillover literature Görg & Strobl 2001; Meyer & Sinani 2005; Wooster & Diebel 2006).

The first possible way how to deliver the result is to employ the so-called "vote-counting method" (see, *inter alia*, Hunter & Schmidt 1990). Following this approach, one would count the median value of t statistics in the sample; let us denote it T_M. If the median value was significant, this could be taken as an evidence for the existence of the phenomenon in question, and *vice versa*. This method has been criticized, e.g., by Djankov & Murrell (2002). Instead of the vote-counting method, they examine the following statistic:

$$T = \frac{\sum_{k=1}^{K} t_k}{\sqrt{K}}, \tag{2.1}$$

where K denotes the number of models included in the meta-analysis (i.e., $K = 97$ in our case) and t_k is the t statistic taken from the k-th model. Provided that all studies are independent and have sufficiently large number of degrees of freedom, T is normally distributed and combined significance can be easily tested. Note that, from this point of view, the vote-counting method drastically *under-values* the "real" effect. Indeed, many meta-analysts (e.g., Hedges & Olkin 1985) consider it to be obsolete. Still, it is widely used especially in narrative literature reviews.

---

[2]To simplify, we abstract from the fact that there are different ways how to estimate total factor productivity, although it might also affect the extent of detected spillovers.

Table 2.1: Aggregated t statistics

Variable	# of obser.	Without outliers	All studies			Without outliers		
			T	T_W	T_M	T	T_W	T_M
all	97	87	15.5	10.1	0.4	4.41	3.99	0.3
developing	41	38	6.95	2.11	0.9	4.54	3.27	0.811
transition	34	31	9.12	8.13	−0.00423	−0.569	−0.645	−0.193
advanced	22	18	11.8	13.6	1.4	3.85	4.4	0.85
cs	32	28	21.3	16.4	2.77	10.4	9.28	2.41
panel	65	59	4.02	−1.05	0.000265	−1.8	−3.098	0.000185
empl	32	28	13.2	11.9	1.85	6.907	7.9	1.4
sales	19	16	3.102	−3.15	−0.323	−1.03	−1.98	−0.326
assets	25	23	6.81	3.55	0.0507	−0.417	−2.96	0.037
output	21	20	6.64	4.17	0.9	2.4	2.74	0.7
firm	40	35	6.031	0.491	0.312	0.214	−1.28	0.3
industry	22	21	10.8	9.57	2.41	9.22	8.17	2.4
secdum	35	31	10.8	10.4	0.000265	−0.42	0.477	$2.28 \cdot 10^{-6}$
growth	39	33	12.5	6.29	0.4	2.46	−0.358	0.324
prod	58	54	9.82	7.97	0.531	3.68	4.92	0.282
old	46	42	11.3	6.068	1	4.77	4.066	0.75
new	51	45	10.7	8.41	0.324	1.53	1.48	0.051
journal	32	28	17.4	16.2	1.42	6.19	5.64	0.811
wp	42	39	3.69	6.76	0.0258	2.086	4.73	0.000957
topjournal	23	20	6.35	1.43	0.99	−1.029	0.499	0.445

Note: T_M is median t statistic, T and T_W are based on (2.1) and (2.2), respectively.
Topjournal—articles published in the leading 60 economics journals. Journal—articles published in lesser journals. WP—working papers.
New—studies published since 2003. Characteristics of other variables are available in Table 2.8 in the Appendix to the present chapter.

Djankov & Murrell (2002) also propose another modification of (2.1):

$$T_W = \frac{\sum_{k=1}^{K} w_k t_k}{\sqrt{\sum_{k=1}^{K} w_k^2}}, \qquad (2.2)$$

where w_k are weights assigned to the k-th model, T_W being normally distributed. Both (2.1) and (2.2) are used in meta-analyses of the spillover literature. Meyer & Sinani (2005) arbitrarily assign higher weights to the models that employ "sophisticated econometric methods", Wooster & Diebel (2006) simply use the inversion of the number of models taken from a particular paper (for example, if 3 models from the paper are taken, each has the weight 1/3). We define a combined weight which accounts for *(i)* the number of models taken from a particular paper as in Wooster & Diebel (2006), and *(ii)* the "quality" of the paper. Quality is proxied by the level of publication, i.e., working papers have the lowest weight ($w = 0.25$), articles published in lesser journals have moderate weight ($w = 0.5$), and articles published in the top 60 economics journals according to the list by Kalaitzidakis *et al.* (2003) have the full weight ($w = 1$). It would be possible to take more complicated weights, e.g., some distribution of impact factors, but then there would be a problem with weights for working papers. Nevertheless, even such simple weights have significant impact on the results, as can be seen from Table 2.1.

Table 2.1 shows the combined significance of the spillover effect in different groups of the sample. Both normally distributed statistics T (2.1) and T_W (2.2), and the median value T_M are reported. Values of t_k from our sample vary significantly, from the lowest point of -11.58 to the peak of 27.7. Because such excessive values have rather dramatic effect on the combined significance, we report also T, T_W, and T_M for a narrower sample without these outliers. More concretely, we employ the restriction $|t_k| \leq 8$, thus the narrower sample contains 87 observations. From these 6 measures of combined significance, we would prefer T_W without outliers. It is evident at first sight that the weighted value (T_W) is in most cases below the simple measure T, indicating that better-quality papers may report lower t statistics, or that discounting the weights for multiple models taken from one paper has a powerful effect. Nevertheless, for the pooled sample both T and T_W are highly significant, even with the exclusion of outliers. T_M, on the other hand, is not significant. To conclude, the spillover effect is, in general, not significant according to the vote-counting method, but it is significant applying the Djankov & Murrell (2002) methodology.

There are two groups in the sample for which the spillover effect is significant, independently of the methodology in use or spillovers exclusion—these are studies using cross-sectional data and studies with industry-level aggregation. Specifications that measure MNCs' presence as a share of employment are together not significant only when the combined t statistic is measured by T_M without outliers. On the

other hand, for firm-level specifications, panel data models, studies using sales as a measure of foreign presence, and papers published in the top 60 world economics journals, combined t statistics are positively significant only if they are measured simply as T and outliers are included; the remaining 5 measures are insignificant or even negatively significant. Based on this finding, one could argue that there might be a tendency in the most prestigious journals to publish rather skeptical empirical studies on productivity spillovers, or—perhaps more probably—that *papers of high quality might be more likely to find no or even negative spillover effects*. However, it seems that the effect of quality on the results is not linear, since studies published in lesser journals are more likely to find positive spillovers than studies published only as working papers. This might suggest that it does matter how we define "the best journals". In spite of that, the present authors would argue that the trend among the most respected journals is obvious and that minor changes in the definitions would not change the conclusion.

It is also interesting that—for transition countries excluding outliers—all three combined t statistics are insignificant and even negative. This can be surprising since transition countries are usually considered to be likely to benefit from FDI highly as, in their case, the technology gap between domestic firms and MNCs is not too wide (see, e.g., Blomström & Kokko 2003). Furthermore, it seems that newer studies (those published after 2002, dividing the sample approximately to 2 halves) might be more likely to report insignificant results, although the effect of studies' age does not appear to be very strong.

2.5 Meta-Regression

We have already seen that various aspects of studies' design are likely to influence the result—which is the t statistic for the estimate of the coefficient that represents the measure of foreign presence in the industry. In this section, we would like to investigate this pattern more thoroughly, using a different and more advanced approach known as the meta-regression analysis. As a benchmark case, we follow Görg & Strobl (2001) who run a plain OLS regression:

$$Y_k = \alpha + \sum_{l=1}^{L} \beta_l X_{kl} + \epsilon_k, \quad k = 1, 2, \ldots, K, \tag{2.3}$$

where the meta-response variable Y_k is the t statistic from the k-th specification and meta-explanatory variables X_{kl} reflect different aspects of studies' design according to the 5 main features from Section 2.3—i.e., those that can be chosen by the researchers *ex ante*.[3] For this reason, we do not include a dummy for the level of publication.

---

[3]Base case: data are firm-level, panel, and for a developed country, response variable is specified in productivity level, log-level, or "other", foreign presence is measured in sales.

Because in the absence of publication bias there should be a significant and positive relation between the number of degrees of freedom in the particular model and its reported (absolute) value of t statistic, the logarithm of degrees of freedom makes an additional meta-explanatory variable. Another aspect we would like to control for is the time period for which the study was conducted, thus we include the average year of study period as a meta-explanatory variable. The final model consists of 11 meta-explanatory variables for 97 observations, which gives us much more degrees of freedom than Görg & Strobl (2001) have (25 observations for 9 regressors).

Descriptions of all variables can be found in Table 2.8 in Section 2.A. All computations were conducted in Stata 10; the dataset and source code are available on the enclosed DVD (Appendix B) and the thesis website. First, we examine relationships between meta-explanatory variables. The table of correlation coefficients (Table 2.9) is included in the Appendix to this chapter, as well—the highest absolute value of all correlation coefficients, 0.63, does not seem to indicate multicollinearity. The condition number is high, but it is sufficient to exclude the average year of study period and it declines to 16. In the regression model, exclusion of this variable does not change the estimated signs neither the significances of estimates, thus we mostly work with the complete number of meta-explanatory variables. If we regress (in turn) all meta-explanatory variables on the remaining meta-explanatory variables and collect the coefficients of determination of such regressions, we obtain the linear redundancy statistics (see Table 2.2). The highest R-squared reaches 0.67, which is not excessive.

Table 2.2: Linear and non-linear relationships

Variable	Linear	Polynomial
Logarithm of degrees of freedom	0.457	0.497
Average year of study period	0.322	0.389
Dummy = 1 if data are for developing country	0.532	0.618
Dummy = 1 if data are for transition country	0.665	0.755
Dummy = 1 if data are cross-section	0.455	0.487
Dummy = 1 if response variable is output growth	0.279	0.330
Dummy = 1 if data are industry-level	0.547	0.699
Dummy = 1 if industry dummies are used	0.308	0.355
Dummy = 1 if MNC presence measured in employment	0.656	0.687
Dummy = 1 if MNC presence measured in assets	0.548	0.570
Dummy = 1 if MNC presence measured in output	0.562	0.595

An important thing—which is, nevertheless, usually omitted—is to test also for non-linear relationships between explanatory variables (Víšek 1997, p. 71). Such relationships cannot be discovered by standard correlation and redundancy analysis.

Suppose for example that we obtain the following estimate of a regression model:

$$\widehat{Y}_i = X_{i1} + 2X_{i2}, \quad i = 1, 2, \ldots, N. \tag{2.4}$$

Assume also that there is a latent relationship which would give estimate $\widehat{X}_{i2} = 1 - 10X_{i1}^4$. If one obtains (2.4) and claims on the basis of it that X_{i1} has positive impact on Y_i, it is obviously not correct. This issue is even more problematic for studies which report polarities of some regression estimates as their key results—and this is the case of empirical works on productivity spillovers. A way how to (try to) discover such non-linear relationships is to use the Weierstrass Approximation Theorem and estimate J following regressions:

$$X_{im} = \alpha + \sum_{j=1}^{J} \sum_{p=1}^{P} \beta_{jp} X_{ij}^p + \vartheta_i, \quad i = 1, \ldots, N, \quad m = 1, \ldots, J, \quad m \neq j, \tag{2.5}$$

where one must have $JP < N$ to leave a sufficient number of degrees of freedom for the regressions. We solved (2.5) with $J = 11$ and $P = 6$, the coefficients of determination are listed in Table 2.2. The highest increase in R-squared compared to simple linear redundancy was detected for variable *INDUSTRY* and reached 0.15, which is not much taking into account that the new regression has 50 more explanatory variables. Therefore we have good hope that non-linear relationships do not represent a substantial problem for our analysis.

Results of the standard meta-regression, using OLS, are reported in Table 2.10 in Section 2.A. We found it necessary to exclude the most obscure observations—with $|t_k| > 8$. There are three main reasons for such selection. Firstly, observations with such a high absolute value of t statistic reach also the largest values of Cook's distance for specification 1 of Table 2.10 and their predicted residuals are high. Secondly, there is a large gap between the observation with the absolute value of t statistic equal to 5.9 and the next higher one 8.4. Thirdly, it is a similar cut-off level as was used by Görg & Strobl (2001). Nevertheless, we report both types of specifications (with and without outliers) in Table 2.10.

Performing standard tests of suitability of the model (referring to specification 5 of Table 2.10), the Ramsey RESET test does not reject the null hypothesis, thus the selected specification is not considered to be inappropriate. Results of multicollinearity analysis and analysis of non-linear relationships do not change when outliers are excluded. To deal with a possible presence of heteroscedasticity of disturbances, we use heteroscedasticity robust standard errors computed with the Huber-White sandwich estimator, see Huber (1967) and White (1980). To test for normality of disturbances, we employ the Shapiro-Wilk test, which rejects the null hypothesis. Unfortunately, most of the meta-explanatory variables are dummies, which restricts the possibilities for transformations, and executing Box-Cox transformations on the

response variable does not bring any substantial improvement. This is one of the reasons for which we decided to employ also other methods, not only plain OLS as Görg & Strobl (2001).

The most obvious choice is to use some of robust estimators, which can also help to assess whether the selected cut-off level for outliers in OLS was the right one. We decided for two alternative estimators, iteratively re-weighted least squares (IRLS) with Huber and Tukey bisquare weight functions tuned for 95% Gaussian efficiency (see Hamilton 2006, pp. 239–256) and median regression[4] from the family of quantile regressions. Results of the robust meta-regression can be found in Table 2.11 in the Appendix to this chapter. Concerning the selection of outliers in OLS, we can see that, e.g., IRLS predicts results that are very similar to that of OLS without outliers. Therefore we can conclude that the cut-off $|t_k| \leq 8$ does not seem to be improperly chosen.

Following Meyer & Sinani (2005), we also perform a pseudo-panel data meta-regression. The cross-sectional dimension is represented by different papers, the other dimension is the order of a model taken from a particular paper. Because we have 97 observations from 67 papers at our disposal, it would not be wise to use the fixed-effects model, as many observations would be dropped and the number of degrees of freedom would diminish significantly, thus it is not even possible to test for fixed effects reliably. Therefore, we will assume that the study-specific effect is normally distributed (nevertheless, this kind of extreme unbalancedness might have an effect on the random effects estimates as well). We will test the following unbalanced panel data model:

$$Y_{ij} = \alpha_i + \sum_{l=1}^{L} \beta_l X_{ijl} + \epsilon_{ij}, \quad i = 1, 2, \ldots, 67, \quad j = 1, 2, \ldots, 8. \tag{2.6}$$

Results of random-effects meta-regression are reported in Table 2.12 in Section 2.A. It is apparent that, excluding outliers, there is no substantial difference in the predictions of plain OLS and random-effects regression. Testing for random effects, the Breusch-Pagan Lagrange multiplier test does not reject the null hypothesis (it is significant only at the 15% level), thus it might suffice to perform plain OLS in this case. But there is one other advantage of the panel-data method: as Stanley (2001) remarks, if a meta-analyst takes a lot of observations from one paper, a single researcher (or even a single work) can dominate the whole meta-regression. This is not the case of our study since the sample that we use is very diversified, but still, panel-data methods might deliver more "balanced" results.

Another approach is to restrict the meta-response variable to a binary one and employ the probit or logit models (for a related example, see Wooster & Diebel 2006). Therefore, we construct a dummy variable which equals to one when t statistic is

---

[4]The algorithm minimizes the sum of the absolute deviations about the median.

Table 2.3: Summary of conducted meta-regressions, all studies

Response variable: t statistic; dummy = 1 if positive (probit)	OLS	IRLS	Median reg.	RE	Probit
Logarithm of degrees of freedom	0.0969	0.137	0.100	0.0828	0.0666
	(0.69)	(1.06)	(0.78)	(0.60)	(0.79)
Average year of study period	−0.0119	−0.0216	−0.0239	−0.00560	−0.0195
	(−0.40)	(−0.62)	(−0.71)	(−0.18)	(−0.54)
Dummy = 1 if data are for developing country	−0.124	0.0353	−0.0411	−0.247	0.264
	(−0.23)	(0.05)	(−0.07)	(−0.47)	(0.53)
Dummy = 1 if data are for transition country	0.805	0.833	1.068	0.727	0.635
	(0.99)	(1.03)	(1.37)	(0.89)	(1.08)
Dummy = 1 if data are cross-section	2.023**	1.876**	2.363**	1.993**	1.123*
	(3.16)	(2.91)	(3.70)	(3.10)	(2.46)
Dummy = 1 if response variable is output growth	0.973†	0.880	0.839	0.756	0.162
	(1.91)	(1.64)	(1.57)	(1.47)	(0.46)
Dummy = 1 if data are industry-level	1.851**	1.884*	0.770	1.787**	1.602*
	(2.85)	(2.37)	(1.03)	(2.74)	(2.27)
Dummy = 1 if industry dummies are used	0.237	0.344	0.468	0.353	0.297
	(0.38)	(0.61)	(0.84)	(0.54)	(0.86)
Dummy = 1 if MNC presence measured in employment	1.510*	1.436†	2.216**	1.808*	1.411*
	(2.23)	(1.77)	(2.94)	(2.42)	(2.45)
Dummy = 1 if MNC presence measured in assets	0.329	0.553	1.036	0.577	0.695
	(0.47)	(0.73)	(1.42)	(0.74)	(1.42)
Dummy = 1 if MNC presence measured in output	1.159	1.148	1.856*	1.505	0.841
	(1.39)	(1.40)	(2.25)	(1.60)	(1.62)
Constant	20.85	39.86	44.44	8.379	37.03
	(0.35)	(0.57)	(0.66)	(0.13)	(0.51)
Observations	87	97	97	87	97
R^2 (pseudo R^2 for median reg. and probit)	0.342	0.258	0.128	0.335	0.238

Note: t statistics in parentheses

OLS and RE computed excluding outliers, using heteroscedasticity robust (Huber-White sandwich est.) t statistics

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Figure 2.1: Average t statistics of meta-regressors, all studies
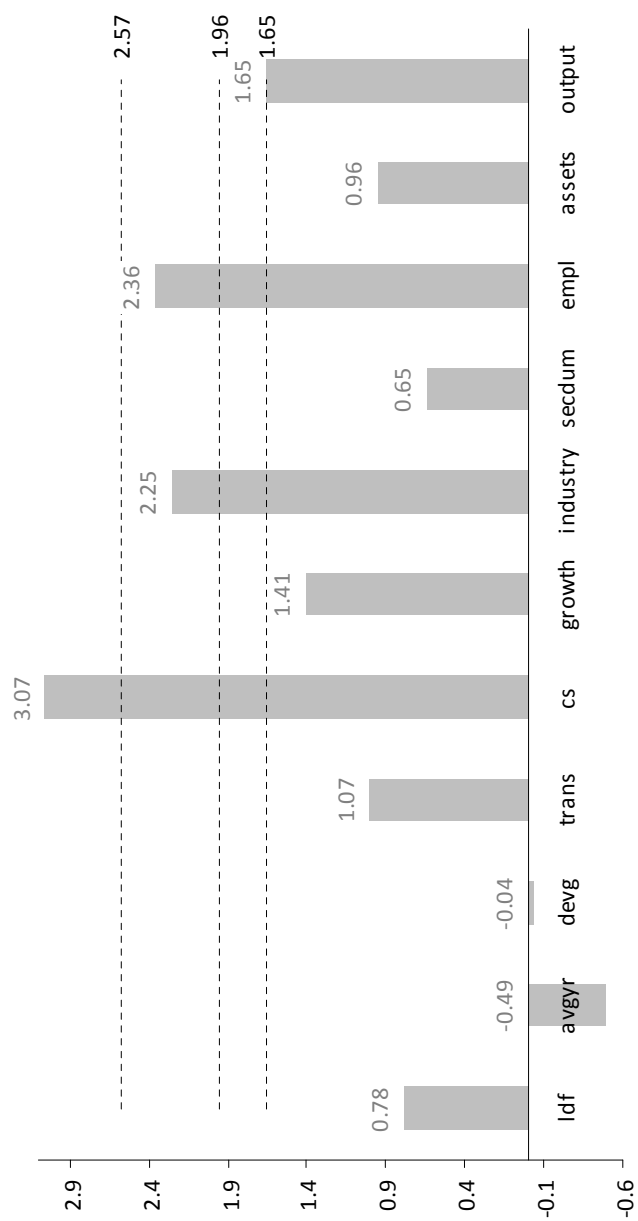
positive, and zero otherwise. Moreover, we construct a similar dummy for significance: if the absolute value of t statistic reaches the 5% critical value, the dummy equals one, and zero otherwise. Both models are estimated with normal probability regression and the results can be found in Table 2.13 in Section 2.A. Although there are slight differences between the results of the probit model when the response variable is dummy for positiveness (specification 1 from Table 2.13) and our benchmark-case OLS, basically it tells the same story in terms of significances and polarities of estimates.

When the dummy for significance is used as the meta-response variable, the only significant meta-explanatory variables are number of degrees of freedom in the study, average year of study period, and cross-sectionality of data. Our results suggest that higher number of observations leads to more significant results (either positive or negative), which is something one would expect. Cross-sectional data bring more significant t-statistics. Moreover, the reported degree of significance seems to be declining over time—studies using newer data are more likely to find insignificant results.

The results of all methods of meta-regression are summarized in Table 2.3. We do not prefer any specific model, and rather construct a "representative" one, taking a simple arithmetic average of all t statistics reported by the meta-regressions (or z statistics in the case of probit). Expression (2.1) is not used here because all specifications from Table 2.3 use the same data. We argue that the resulting model (t statistics are depicted in Figure 2.1) is much more stable than any of specifications 1–5 could be *per se*, and since all specifications seem to yield similar results, our conclusions based on the representative model should be robust. There are three meta-explanatory variables which are robustly significant at the 5% level. Our results show that cross-sectional data, industry-level aggregation,[5] and usage of share in employment as a proxy for foreign presence brings, in general, more positively significant outcomes than other specifications. It does not seem to matter, on the other hand, how the response variable is defined.

The significance of the *cross-sectionality* of data confirms the findings of Görg & Strobl (2001), who claim that the bias could be caused by time invariant variables which are not identified by the explanatory variables in cross-sectional spillover studies. Panel data methods can, on the other hand, uncover these effects, and thus are more reliable. Cross-sectional studies, especially in combination with industry-level data, can thus cause the causality problem—foreign investors may seek efficient and more productive industries for their investments, thus researchers would report a

---

[5]Meyer & Sinani (2005) emphasize that industry-level studies obviously tend to have less degrees of freedom than firm-level ones, while more observations appear to bring higher values of t statistics. Indeed, even in our case the correlation coefficient between *INDUSTRY* and *LDF* reaches -0.6. Nevertheless, as can be seen, e.g., from Table 2.10 in the Appendix to the present chapter, *INDUSTRY* stays positive and highly significant even if we exclude *LDF* from the model, thus our conclusion is not affected.

Table 2.4: Summary of conducted meta-regressions, old studies

Response variable: t statistic; dummy = 1 if positive (probit)	OLS	IRLS	Median reg.	RE	Probit
Logarithm of degrees of freedom	0.137	0.163	0.379†	0.137	−0.121
	(0.63)	(0.76)	(1.82)	(0.63)	(−0.90)
Average year of study period	0.0265	0.0185	−0.0291	0.0265	−0.0285
	(0.69)	(0.42)	(−0.63)	(0.69)	(−0.51)
Dummy = 1 if data are for developing country	0.804	0.654	−0.547	0.804	−0.0816
	(1.00)	(0.69)	(−0.63)	(1.00)	(−0.09)
Dummy = 1 if data are for transition country	3.018**	2.931*	3.444**	3.018**	0.984
	(2.84)	(2.60)	(3.49)	(2.84)	(1.18)
Dummy = 1 if data are cross-section	1.382†	1.326	2.167*	1.382†	1.810**
	(1.95)	(1.42)	(2.44)	(1.95)	(2.93)
Dummy = 1 if response variable is output growth	0.527	0.434	−0.0435	0.527	−0.161
	(0.93)	(0.60)	(−0.07)	(0.93)	(−0.27)
Dummy = 1 if data are industry-level	3.057**	3.168*	3.580**	3.057**	
	(3.29)	(2.54)	(3.08)	(3.29)	
Dummy = 1 if industry dummies are used	0.191	0.506	0.787	0.191	−0.763
	(0.16)	(0.47)	(0.84)	(0.16)	(−0.93)
Dummy = 1 if MNC presence measured in employment	2.397*	2.308*	1.650†	2.397*	0.701
	(2.30)	(2.04)	(1.71)	(2.30)	(0.80)
Dummy = 1 if MNC presence measured in assets	0.225	0.288	0.0177	0.225	1.183
	(0.21)	(0.29)	(0.02)	(0.21)	(1.60)
Dummy = 1 if MNC presence measured in output	4.433**	4.383**	4.559**	4.433**	1.718†
	(3.67)	(3.46)	(3.78)	(3.67)	(1.66)
Constant	−57.65	−41.82	51.75	−57.65	56.18
	(−0.75)	(−0.48)	(0.56)	(−0.75)	(0.51)
Observations	42	46	46	42	46
R^2 (pseudo R^2 for median reg. and probit)	0.626	0.549	0.288	0.626	0.419

Note: t statistics in parentheses

OLS and RE computed excluding outliers, using heteroscedasticity robust (Huber-White sandwich est.) t statistics

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table 2.5: Summary of conducted meta-regressions, new studies

Response variable: t statistic; dummy = 1 if positive (probit)	OLS	IRLS	Median reg.	RE	Probit
Logarithm of degrees of freedom	0.183	0.248	0.351	0.132	−0.00712
	(1.15)	(1.20)	(0.83)	(0.79)	(−0.06)
Average year of study period	−0.150	−0.256*	−0.277	−0.119	0.0000351
	(−1.26)	(−2.17)	(−0.92)	(−1.07)	(0.00)
Dummy = 1 if data are for developing country	−0.0703	0.900	1.874	−0.356	
	(−0.04)	(0.61)	(0.46)	(−0.23)	
Dummy = 1 if data are for transition country	1.092	1.881	3.141	0.751	0.234
	(0.56)	(1.12)	(0.69)	(0.39)	(0.37)
Dummy = 1 if data are cross-section	2.687*	3.213*	2.988	2.249*	0.931
	(2.72)	(2.68)	(1.07)	(2.25)	(1.04)
Dummy = 1 if response variable is output growth	1.153	1.615†	1.187	0.818	0.160
	(1.21)	(1.77)	(0.46)	(0.91)	(0.26)
Dummy = 1 if data are industry-level	3.438*	4.595**	5.020	3.199*	0.656
	(2.27)	(3.10)	(1.37)	(2.11)	(0.66)
Dummy = 1 if industry dummies are used	0.936	1.579	2.856	1.002	0.675
	(0.84)	(1.60)	(1.05)	(0.97)	(1.15)
Dummy = 1 if MNC presence measured in employment	2.046	2.299	3.765	2.108	2.283*
	(1.66)	(1.54)	(0.87)	(1.28)	(2.50)
Dummy = 1 if MNC presence measured in assets	0.651	1.118	1.537	0.757	1.400
	(0.62)	(0.79)	(0.37)	(0.49)	(1.49)
Dummy = 1 if MNC presence measured in output	0.396	1.057	0.768	0.687	0.794
	(0.33)	(0.79)	(0.20)	(0.39)	(0.97)
Constant	295.9	503.2*	544.2	234.6	−1.516
	(1.26)	(2.16)	(0.91)	(1.07)	(−0.01)
Observations	45	51	51	45	51
R^2 (pseudo R^2 for median reg. and probit)	0.314	0.348	0.099	0.302	0.208

Note: t statistics in parentheses

OLS and RE computed excluding outliers, using heteroscedasticity robust (Huber-White sandwich est.) t statistics

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

positive spillover effect, even if the particular industry had had high productivity long before MNCs entered it. On the other hand, Proença *et al.* (2006) argue that the classical panel data methods of spillover estimation may generate *downward* bias and they recommend using the extended generalized method of moments. From this point of view, cross-sectional studies tend to over-value spillovers, whilst traditional panel data studies could under-value them, thus the true effect may lie somewhere in between and there is little ground for general conclusions.

Contrary to Görg & Strobl (2001), we also find the level of aggregation and us-age of share in employment as a proxy for foreign presence significant. Concerning the former, *industry-level aggregation* over heterogeneous firms may generally lead to biased results (Görg & Greenaway 2004), since it does not cope with firm-specific effects that can be correlated with foreign presence. Concerning the latter, *employment intensive* foreign investments could generate larger spillovers through the labor turnover channel, contrary to the sales intensive foreign investors who may, on the other hand, be more involved in the competition effect which has ambiguous impacts on host-country firms (Meyer & Sinani 2005). This could explain the significant co-efficient that was obtained for the variable *EMPL* and might suggest that using a share of employment as a proxy for foreign presence is not misspecification; however, the definition of proxy for foreign presence deserves attention. Researchers should always check their outcomes on various definitions of proxies and try to explain possible different outcomes.[6]

It is also evident that the dominant specification of spillovers' testing has been changing over time. Since the first researchers followed the pioneering work of Caves (1974) and used cross-sectional data and industry-level aggregation, a little had changed before Haddad & Harrison (1993) published their study on Morocco, where they—using firm-level panel data—found evidence of negative horizontal spillovers due to the competition effect. Nevertheless, not many researchers used panel data again till 1999, where the other highly influential work (Aitken & Harrison 1999) was published. After that, panel-data and firm-level analysis has become more fre-quent and has been almost unambiguously dominating the literature since 2003, leaving cross-sectional and industry-level methods mostly for countries where de-tailed data are not easily accessible, e.g., China. Because our results suggest that the (non)presence of time dimension in the data is one of the crucial aspects of the study design, we decide to split the sample into two halves (studies published before 2003, and *vice versa*), and employ the Chow test to check whether it was appropriate to pool the data together in the first place. The Chow test is significant only at the

---

[6]There is a general problem connected with defining "foreign presence". As Castellani & Zanfei (2007) show, the common approach can cause downward bias in spillover estimates, since it assumes that changes of the same proportion in aggregate and foreign activities within an industry do not affect the response variable, whilst the contrary can be the case in reality.

23% value, thus the data were probably pooled correctly. Still, it might be benefitial to estimate the model separately for the two time periods.

The results of meta-regressions for older studies are reported in Table 2.4, more detailed specifications and regressions also with outliers can be found in Appendix A. In the case of probit, the dummy for industry-level data had to be omitted since otherwise the probit model would not have converged.[7] The Breusch-Pagan Lagrange multiplier test is significant at the 10% level, thus one might put more weight on random-effects model rather than on plain OLS. Similarly as for the pooled sample of all studies, it seems to matter whether data are cross-sectional, aggregated on the industry level, and whether the share of foreign presence is measured in employment. Contrary to the pooled sample, however, also the fact whether data for transition countries are used and whether foreign presence is measured as share in output are significant. In the older studies, firms in transition countries are more likely to benefit from horizontal FDI spillovers.

Results for newer studies can be found in Table 2.5, detailed estimates of each type of a meta-regression are available in Appendix A. In the case of probit, one dummy (developing country) had to be dropped so as for the model to converge. The Breusch-Pagan test is not significant at any reasonable level, thus we put more weight on plain OLS. Estimated dependencies are much less apparent now than for the older studies. It is again important whether data are cross-sectional and what the level of aggregation is, but no other meta-explanatory variable is significant in more than only one specification of Table 2.5. Thus it appears that the pattern, having basically still the same shape, is getting weaker over time. This would suggest that, at least recently, researchers have been aware of this dependency of results on the study design and have begun to employ more balanced approaches, maybe even to compensate for the "expected" results. Indeed, the empirical literature has been diverging a lot since the work of Görg & Strobl (2001) was published. A significant number of new studies test both for intra-industry and inter-industry spillovers, authors check multiple methodologies and compare the results. Nevertheless, there are still simple cross-sectional and/or industry-level studies, results of which can mostly be easily predicted *ex ante.*

2.6   Test of Publication Bias

Stanley (2001) highlights the "file drawer" problem that occurs when researchers tend to publish only or mostly the studies that are able to demonstrate significant results, because these are more likely to be accepted for publication in academic journals. It has been shown, e.g., by Card & Krueger (1995) that the "file drawer" problem can

---

[7]It does not mean, though, that *INDUSTRY* would be insignificant. Conversely, it predicts a perfect fit—industry-level aggregation always brings positive values of t statistics for spillovers in older studies.

be extremely significant in economic publishing. In the concrete, for the literature on minimum wages and employment they find vast evidence of a publication bias. The same phenomena was detected by Görg & Strobl (2001) in the spillover literature and both subsequent meta-analyses (Meyer & Sinani 2005; Wooster & Diebel 2006) also report similar results.

We employ the same test as was advocated by Card & Krueger (1995) and also performed by Görg & Strobl (2001). The set-up is illustrated in (2.7)—we regress the absolute value of t statistics reported by the k-th model on the natural logarithm of the square root of number of observations in the k-th model, controlling also for all other meta-explanatory variables which were included in model (2.3):

$$|t_k| = \alpha + \beta \log(\sqrt{M_k}) + \sum_{l=1}^{L-1} \gamma_l X_{kl} + \epsilon_k, \quad k = 1, 2, \ldots, K, \qquad (2.7)$$

where M_k is the number of observations in the k-th model. The crucial point of this test is the (non)significance and magnitude of the estimated parameter β. Under the null hypothesis of no publication bias, it should hold that $\beta = 1$. In other words, logarithm of square root of number of observations should increase the final model's t statistic for foreign presence proportionally angle-wise 45 degrees.

Results of the publication bias test are reported in Table 2.6. Specifications 1–4 show plain OLS regression with all observations, specifications 5–8 exclude outliers. The cut-off level for outliers is still the same ($|t_k| \leq 8$). It is a good sign that, under any specification, the estimate of β is significant at least at the 10% level and it is positive, which suggests that more degrees of freedom, *ceteris paribus*, increase the results' level of significance as it should be the case of unbiased literature.

Estimated values of β are very close to 1 for all specifications counted including large values of $|t_k|$. Testing the hypothesis $\beta = 1$ with a simple t test, we conclude that there is no sign of publication bias (the corresponding test statistics are available in Table 2.6, as well). The picture, however, changes significantly when we exclude observations with $|t_k| > 8$. Through all specifications 5–8, the estimated value of β is far from 1 and all conducted t tests result in favor of rejecting the null hypothesis powerfully.

What conclusions should one draw from such irresolute numbers? The present authors would argue that the exclusion of outliers is not entirely appropriate in this case. Model (2.7) which we test now is different from (2.1), on the basis of which the cut-off level for outliers was actually determined. The regression model without spillovers is characterised by higher R-squared, but the levels of significance of meta-explanatory variables are rather worse there. Moreover, such large values of $|t_k|$ can be very important in this regression since they can support or weaken the hypothesis very powerfully, as is in fact shown. All things considered, it seems more suitable to prefer the results of specifications 1–4, i.e., with all observations including "outliers".

Table 2.6: Test of publication bias, all studies

	OLS, including outliers				OLS, excluding outliers			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
lsrdf	1.165**	1.161**	0.865*	1.163**	0.450*	0.390*	0.299†	0.397*
	(2.95)	(2.71)	(2.33)	(2.70)	(2.61)	(2.54)	(1.71)	(2.39)
avgyr	−0.0235	−0.0168			−0.0693**	−0.0585*		
	(−0.59)	(−0.46)			(−2.88)	(−2.50)		
devg	−0.564	−0.600			0.361	0.722†		
	(−0.31)	(−0.43)			(0.98)	(1.82)		
trans	−0.976	−0.196		−0.463	−0.270	0.0592		−0.794
	(−0.38)	(−0.14)		(−0.27)	(−0.52)	(0.15)		(−1.66)
cs	3.419†	2.605		3.403*	0.322	0.474		0.718†
	(1.98)	(1.63)		(2.07)	(0.74)	(1.07)		(1.68)
growth	1.620		1.220	1.684	−0.0725		−0.0913	−0.0243
	(1.26)		(0.96)	(1.50)	(−0.21)		(−0.22)	(−0.07)
industry	−0.515		0.597	−0.670	0.357		0.795	0.466
	(−0.42)		(0.67)	(−0.57)	(0.70)		(1.59)	(0.91)
secdum	0.559		−0.534		−0.0194		−0.403	
	(0.58)		(−0.39)		(−0.05)		(−1.03)	
empl	−0.809		0.0417	−0.498	−0.463		0.110	−0.623
	(−0.29)		(0.02)	(−0.28)	(−0.88)		(0.24)	(−1.34)
assets	0.0104		0.388		0.395		0.598	
	(0.01)		(0.21)		(0.75)		(1.18)	
output	−1.532		−0.428	−1.415	−0.107		0.508	−0.174
	(−0.90)		(−0.28)	(−1.14)	(−0.19)		(0.96)	(−0.37)
Constant	45.06	31.81	−0.517	−2.177	138.1**	116.4*	0.336	0.495
	(0.56)	(0.44)	(−0.31)	(−1.09)	(2.87)	(2.50)	(0.39)	(0.58)
Observations	97	97	97	97	87	87	87	87
R^2	0.127	0.083	0.050	0.123	0.274	0.232	0.106	0.168
$t\ (H_0: \beta = 1)$	0.170	0.140	0.130	0.140	10.2**	15.8**	16.1**	13.2**

Note: heteroscedasticity robust (Huber-White sandwich est.) t statistics in parentheses

response variable: absolute value of t statistic

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

While all older meta-analyses reject the null hypothesis of no bias powerfully, we conclude that the evidence of publication bias has almost vanished from the spillover literature, and therefore it is becoming more reliable. Nevertheless, the result is quite vulnerable on regression specification, and exclusion of only a few observations could twist the outcome.

2.7   Conclusion

This paper presents a meta-analysis of the empirical literature on horizontal productivity spillovers from FDI. We gather a sample of 97 models from 67 studies published either in academic journals or as working papers. Using the vote-counting method, the spillover effect is not significant in general; employing the approach of Djankov & Murrell (2002), on the other hand, there is some evidence that positive spillovers from FDI might exist. Nevertheless, it is not the case of the narrower sample of studies that were published in the best economics journals—their combined t statistic is insignificant almost in any case. Therefore, the present authors argue that *there is no general persuasive empirical evidence on the intra-industry spillovers*. If there are any horizontal spillover effects, their signs and magnitudes vary from country to country and from industry to industry.

We also investigate which study aspects affect the reported significance and polarity of spillovers, using a meta-regression analysis which was elaborated by Stanley & Jarrell (1989). Nevertheless, we use not only the standard ordinary least squares meta-regression (like Görg & Strobl 2001) but we also employ robust methods (iteratively re-weighted least squares and median regression) as well as pseudo-panel data methods (Meyer & Sinani 2005) and probability models (Wooster & Diebel 2006). We find that, in general, *study results are affected by its design*, namely by usage of cross-sectional or panel data, industry- or firm-level aggregation, and specification of the proxy of foreign presence in the industry. Our results suggest that cross-sectional studies tend to report excessively high spillovers, as well as models with industry-level aggregation and employment as a proxy for foreign presence do. However, this pattern appears to become weaker over time, suggesting that newer studies may suffer from such a bias less.

Following Card & Krueger (1995), we test for publication bias in the spillover literature. Contrary to Görg & Strobl (2001), *we do not find evidence of publication bias* in the whole sample, suggesting that the bias might have almost vanished from the spillover literature. Nevertheless, our result is quite sensitive to the process of literature selection since exclusion of only a few papers can twist the outcome instantly.

Future research should concentrate on the inter-industry spillovers since they seem to be more promising, the number of empirical works in this field is growing

and will soon be sufficient for a meta-regression analysis. Intra-industry productivity spillovers, on the other hand, appear to stay nonexistent or undetectable, at least in the standard research framework following Caves (1974) and Haddad & Harrison (1993).

References

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

Aslanoglu, E. (2000): "Spillovers effect of foreign direct investment on Turkish manufacturing industry." *Journal of International Development* **12**: pp. 1111–1130.

Barrios, S. (2000): "Foreign Direct Investment Productivity Spillovers. Evidence From the Spanish Experience (1990-1994)." *Working Papers 2000-19*, FEDEA, Madrid.

Barrios, S., S. Dimelis, H. Louri, & E. Strobl (2002): "Efficiency Spillovers from Foreign Direct Investment in the EU Periphery: A Comparative Study of Greece, Ireland and Spain." *Working Papers 2002-02*, FEDEA, Madrid.

Blalock, G. & P. J. Gertler (2005): "Welfare Gains from Foreign Direct Investment through Technology Transfer to Local Suppliers." *Working paper*, University of California, Berkeley.

Blomström, M. (1986): "Foreign Investment and Productive Efficiency: The Case of Mexico." *Journal of Industrial Economics* **35(1)**: pp. 97–110.

Blomström, M. (1992): "Host Country Benefits of Foreign Investment." *NBER Working Papers 3615*, National Bureau of Economic Research, Inc.

Blomström, M. & A. Kokko (1996): "Multinational Corporations and Spillovers." *CEPR Discussion Papers 1365*, Center for Economic Policy Research.

Blomström, M. & A. Kokko (2003): "The Economics of Foreign Direct Investment Incentives." *NBER Working Papers 9489*, National Bureau of Economic Research, Inc.

Blomström, M. & H. Persson (1983): "Foreign investment and spillover efficiency in an underdeveloped economy: Evidence from the Mexican manufacturing industry." *World Development* **11(6)**: pp. 493–501.

BLOMSTRÖM, M. & F. SJÖHOLM (1999): "Technology transfer and spillovers: Does local participation with multinationals matter?" *European Economic Review* **43(4-6)**: pp. 915–923.

BLOMSTRÖM, M. & E. N. WOLFF (1994): *Multinational Corporations and Productivity Convergence in Mexico*, chapter Convergence of Productivity: Cross National Studies and Historical Evidence, pp. 263–283. Oxford: Oxford University Press.

BOSCO, M. G. (2001): "Does FDI contribute to technological spillovers and growth? A panel data analysis of Hungarian firms." *Transnational Corporations* **10(1)**: pp. 43–67.

BOUOIYOUR, J. (2003): "Labour Productivity, Technological Gap and Spillovers: Evidence From Moroccan Manufacturing Industries." *Working papers*, WPCATT, University of Pau.

BUCKLEY, P. J., C. WANG, & J. CLEGG (2002): "The impact of inward FDI in the performance of Chinese manufacturing firms." *Journal of International Business Studies* **33(4)**: pp. 637–655.

BUCKLEY, P. J., C. WANG, & J. CLEGG (2007): "The impact of foreign ownership, local ownership and industry characteristics on spillover benefits from foreign direct investment in China." *International Business Review* **16(2)**: pp. 142–158.

BWALYA, S. M. (2006): "Foreign direct investment and technology spillovers: Evidence from panel data analysis of manufacturing firms in Zambia." *Journal of Development Economics* **81(2)**: pp. 514–526.

CARD, D. & A. B. KRUEGER (1995): "Time-Series Minimum-Wage Studies: A Meta-analysis." *American Economic Review* **85(2)**: pp. 238–43.

CASTELLANI, D. & A. ZANFEI (2007): "Multinational companies and productivity spillovers: is there a specification error?" *Applied Economics Letters* **14(14)**: pp. 1047–1051.

CAVES, R. E. (1974): "Multinational Firms, Competition, and Productivity in Host-Country Markets." *Economica* **41(162)**: pp. 176–93.

CHUANG, Y. & C. LIN (1999): "Foreign direct investment, R&D and spillover efficiency: evidence from Taiwan's manufacturing firms." *Journal of Development Studies* **35**: pp. 117–137.

CORDEN, W. M. (1974): *Trade Policy and Economic Welfare.* London: Oxford University Press.

DAMIJAN, J. P., B. MAJCEN, M. ROJEC, & M. KNELL (2001): "The role of FDI, R&D accumulation, and trade in transferring technology to transmission countries: evidence from firm panel data for eight transition countries." *Working Papers 2001/10*, Institute for Economic Research, University of Ljubljana.

DJANKOV, S. & B. M. HOEKMAN (2000): "Foreign Investment and Productivity Growth in Czech Enterprises." *World Bank Economic Review* **14(1)**: pp. 49–64.

DJANKOV, S. & P. MURRELL (2002): "Enterprise Restructuring in Transition: A Quantitative Survey." *Journal of Economic Literature* **40(3)**: pp. 739–792.

DRIFFIELD, N. (2001): "The Impact of Domestic Productivity of Inward Investment in the UK." *Manchester School* **69(1)**: pp. 103–19.

FIDRMUC, J. & I. KORHONEN (2006): "Meta-analysis of the business cycle correlation between the euro area and the CEECs." *Journal of Comparative Economics* **34(3)**: pp. 518–537.

FLÔRES, R. G., M. P. FONTOURA, & R. G. SANTOS (2000): "Foreign direct investment spillovers: what can we learn from Portuguese data?" *Economics Working Papers (Ensaios Economicos da EPGE) 4/2000*, Graduate School of Economics, Getulio Vargas Foundation (Brazil).

GALLET, C. (2007): "A Comparative Analysis of the Demand for Higher Education: Results from a Meta-analysis of Elasticities." *Economics Bulletin* **9(7)**: pp. 1–14.

GERŠL, A. (2008): "Productivity, Export Performance and Financing of the Czech Corporate Sector: The Effects of Foreign Direct Investment." *Czech Journal of Economics and Finance* **58**: pp. 232–247.

GERŠL, A. & M. HLAVÁČEK (2007): "Foreign Direct Investment, Corporate Finance, and the Life Cycle of Investment." *Czech Journal of Economics and Finance* **57**: pp. 448–464.

GIRMA, S., D. GREENAWAY, & K. WAKELIN (2001): "Who Benefits from Foreign Direct Investment in the UK?" *Scottish Journal of Political Economy* **48(2)**: pp. 119–33.

GIRMA, S. & K. WAKELIN (2007): "Local productivity spillovers from foreign direct investment in the U.K. electronics industry." *Regional Science and Urban Economics* **37**: pp. 399–412.

GLOBERMAN, S. (1979): "Foreign Direct Investment and 'Spillover' Efficiency Benefits in Canadian Manufacturing Industries." *Canadian Journal of Economics* **12(1)**: pp. 42–56.

GÖRG, H. & D. GREENAWAY (2004): "Much Ado about Nothing? Do Domestic Firms Really Benefit from Foreign Direct Investment?" *World Bank Research Observer* **19(2)**: pp. 171–197.

GÖRG, H. & E. STROBL (2001): "Multinational Companies and Productivity Spillovers: A Meta-analysis." *Economic Journal* **111(475)**: pp. F723–39.

GÖRG, H. & E. STROBL (2004): "Foreign direct investment and local economic development: Beyond productivity spillovers." *GEP Research Paper 2004/11*, The University of Nottingham.

HADDAD, M. & A. HARRISON (1993): "Are there positive spillovers from direct foreign investment? Evidence from panel data for Morocco." *Journal of Development Economics* **42(1)**: pp. 51–74.

HAMILTON, L. C. (2006): *Statistics with STATA.* Duxbury Press.

HASKEL, J. E., S. C. PEREIRA, & M. J. SLAUGHTER (2004): "Does Inward Foreign Direct Investment Boost the Productivity of Domestic Firms?" *Working paper series*, Tuck School of Business at Darmouth.

HEDGES, L. V. (1992): "Meta-analysis." *Journal of Educational and Behavioral Statistics* **17(4)**: pp. 279–296.

HEDGES, L. V. & I. OLKIN (1985): *Statistical Methods of Meta-Analysis.* Orlando: Academic Press.

HUBER, P. J. (1967): "The Behavior of Maximum Likelihood Estimates under Nonstandard Conditions." In "Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability," volume 1, p. 221–223. Berkeley, CA: University of California Press.

HUNTER, J. & F. SCHMIDT (1990): *Methods of Meta-analysis: Correcting Error and Bias in Research Findings.* Newbury Park, California: Sage Publications, 1st. edition.

IMBRIANI, C. & F. REGANATI (1999): "Productivity spillovers and regional differences: some evidence on the Italian manufacturing sector." *Discussion Paper Series 48*, Universita degli Studi di Salerno.

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)**: pp. 605–627.

JAVORCIK, B. S. & M. SPATAREANU (2008): "To share or not to share: Does local participation matter for spillovers from foreign direct investment?" *Journal of Development Economics* **85(1-2)**: pp. 194–217.

JORDAAN, J. A. (2005): "Determinants of FDI-induced externalities: New empirical evidence for Mexican manufacturing industries." *World Development* **33(12)**: pp. 2103–2118.

KALAITZIDAKIS, P., T. P. MAMUNEAS, & T. STENGOS (2003): "Rankings of Academic Journals and Institutions in Economics." *Journal of the European Economic Association* **1(6)**: pp. 1346–1366.

KATHURIA, V. (2000): "Productivity spillovers from technology transfer to Indian manufacturing firms." *Journal of International Development* **12**: pp. 343–369.

KATHURIA, V. (2002): "Liberalisation, FDI, and productivity spillovers—an analysis of Indian manufacturing firms." *Oxford Economic Papers* **54(4)**: pp. 688–718.

KELLER, W. & S. R. YEAPLE (2003): "Multinational Enterprises, International Trade, and Productivity Growth: Firm-Level Evidence from the United States." *NBER Working Papers 9504*, National Bureau of Economic Research, Inc.

KHAWAR, M. (2003): "Productivity and foreign direct investment—evidence from Mexico." *Journal of Economic Studies* **30(1)**: pp. 66–76.

KINOSHITA, Y. (2000): "R&D and Technology Spillovers via FDI: Innovation and Absorptive Capacity." *Working Papers Series 349*, William Davidson Institute at the University of Michigan Stephen M. Ross Business School.

KOHPAIBOON, A. (2006): "Foreign direct investment and technology spillover: A cross-industry analysis of Thai manufacturing." *World Development* **34(3)**: pp. 541–556.

KOKKO, A. (1994): "Technology, market characteristics, and spillovers." *Journal of Development Economics* **43(2)**: pp. 279–293.

KOKKO, A. (1996): "Productivity spillovers from competition between local firms and foreign affiliates." *Journal of International Development* **8**: pp. 517–530.

KOKKO, A., M. ZEJAN, & R. TANSINI (1996): "Local technological capability and productivity spillovers from FDI in the Uruguayan manufacturing sector." *Journal of Development Studies* **32**: pp. 602–611.

KONINGS, J. (2000): "The Effect of Direct Foreign Investment on Domestic Firms: Evidence from Firm Level Panel Data in Emerging Economies." *Working Paper Series 344*, William Davidson Institute.

LI, H., T. GRIJALVA, & R. P. BERRENS (2007): "Economic growth and environmental quality: a meta-analysis of environmental Kuznets curve studies." *Economics Bulletin* **17(5)**: pp. 1–11.

LIU, X., D. PARKER, K. VAIYDA, & Y. WEI (2001): "The impact of foreign direct investment on labour productivity in the Chinese electronics industry." *International Business Review* **10**: p. 421–439.

LIU, X., P. SILER, C. WANG, & Y. WEI (2000): "Productivity Spillovers From Foreign Direct Investment: Evidence From UK Industry Level Panel Data." *Journal of International Business Studies* **31(3)**: pp. 407–425.

LIU, X. & C. WANG (2003): "Does foreign direct investment facilitate technological progress? Evidence from Chinese industries." *Research Policy* **32(6)**: pp. 945–953.

LIU, Z. (2002): "Foreign Direct Investment and Technology Spillover: Evidence from China." *Journal of Comparative Economics* **30(3)**: pp. 579–602.

LIU, Z. (2008): "Foreign direct investment and technology spillovers: Theory and evidence." *Journal of Development Economics* **85(1-2)**: pp. 176–193.

LUTZ, S. & O. TALAVERA (2004): "Do Ukrainian Firms Benefit from FDI?" *Economics of Planning* **37(2)**: pp. 77–98.

MACDOUGALL, G. D. A. (1960): "The Benefits and Costs of Private Investment from Abroad: A Theoretical Approach." *Economic Record* **36**: pp. 13–35.

MARIN, A. & M. BELL (2004): "Technology spillovers from foreign direct investment: the active role of MNC subsidiaries in Argentina in the 1990s." *SPRU Electronic Working Paper Series 118*, Science and Technology Policy Research, UK.

MERLEVEDE, B. & K. SCHOORS (2006): "FDI and the Consequences Towards more complete capture of spillover effects." *Working Papers 06/372*, Ghent University, Faculty of Economics and Business Administration.

MEYER, K. E. & E. SINANI (2005): "Spillovers from Foreign Direct Investment: A Meta Analysis." *Working Paper Series 59*, Center for East European Studies, Copenhagen Business School.

MURAKAMI, Y. (2007): "Technology spillover from foreign-owned firms in Japanese manufacturing industry." *Journal of Asian Economics* **18(2)**: pp. 284–293.

NARULA, R. & A. MARIN (2005): "Exploring the relationship between direct and indirect spillovers from FDI in Argentina." *Research Memoranda 024*, Maastricht Economic Research Institute on Innovation and Technology.

NGUYEN, P. L. (2008): "Productivity Spillovers from Foreign Direct Investment: Evidence from Vietnamese Firm Data." *Working paper series*, School of Commerce, University of South Australia.

PACK, H. & K. SAGGI (1997): "Inflows of Foreign Technology and Indigenous Technological Development." *Review of Development Economics* **1(1)**: pp. 81–98.

PERI, G. & D. URBAN (2006): "Catching-up to foreign technology? Evidence on the "Veblen-Gerschenkron" effect of foreign investments." *Regional Science and Urban Economics* **36(1)**: pp. 72–98.

PROENÇA, I., P. FONTOURA, & N. CRESPO (2006): "Productivity spillovers from multinational corporations in portugal: Vulnerability to deficient estimation." *Applied Econometrics and International Development* **6(1)**.

RAN, J., J. P. VOON, & G. LI (2007): "How does FDI affect China? Evidence from industries and provinces." *Journal of Comparative Economics* **35(4)**: pp. 774–799.

RATTSØ, J. & H. E. STOKKE (2003): "Learning and foreign technology spillovers in Thailand: Empirical evidence on productivity dynamics." *Working paper series*, Department of Economics, Norwegian University of Science and Technology.

ROSE, A. K. & T. D. STANLEY (2005): "A Meta-Analysis of the Effect of Common Currencies on International Trade." *Journal of Economic Surveys* **19(3)**: pp. 347–365.

RUANE, F. & A. UGUR (2003): "Foreign direct investment and productivity spillovers in Irish manufacturing industry: evidence from plant level panel data." *Working paper series*, Department of Economics, Trinity College Dublin.

SADIK, A. T. & A. A. BOLBOL (2001): "Capital Flows, FDI, and Technology Spillovers: Evidence from Arab Countries." *World Development* **29(12)**: pp. 2111–2125.

SASIDHARAN, S. & A. RAMANATHAN (2007): "Foreign Direct Investment and spillovers: evidence from Indian manufacturing." *The International Journal of Trade and Global Markets* **1(1)**: p. 5–22.

SCHOORS, K. & B. V. D. TOL (2002): "Foreign direct investment spillovers within and between sectors: Evidence from Hungarian data." *Working Papers 02/157*, Ghent University, Faculty of Economics and Business Administration.

SGARD, J. (2001): "Direct Foreign Investments And Productivity Growth In Hungarian Firms, 1992-1999." *Working Papers Series 425*, William Davidson Institute at the University of Michigan Stephen M. Ross Business School.

SINANI, E. & K. E. MEYER (2004): "Spillovers of technology transfer from FDI: the case of Estonia." *Journal of Comparative Economics* **32(3)**: pp. 445–466.

SJÖHOLM, F. (1999a): "Productivity Growth in Indonesia: The Role of Regional Characteristics and Direct Foreign Investment." *Economic Development and Cultural Change* **47(3)**: pp. 559–84.

SJÖHOLM, F. (1999b): "Technology Gap, Competition and Spillovers from Direct Foreign Investment: Evidence from Establishment Data." *Journal of Development Studies* **36**: pp. 53–73.

STANLEY, T. D. (2001): "Wheat from Chaff: Meta-analysis as Quantitative Literature Review." *Journal of Economic Perspectives* **15(3)**: pp. 131–150.

STANLEY, T. D. & S. B. JARRELL (1989): "Meta-Regression Analysis: A Quantitative Method of Literature Surveys." *Journal of Economic Surveys* **3(2)**: pp. 161–70.

TAKII, S. (2005): "Productivity spillovers and characteristics of foreign multinational plants in Indonesian manufacturing 1990–1995." *Journal of Development Economics* **76(2)**: pp. 521–542.

THUY, L. T. (2005): "Technological Spillovers from Foreign Direct Investment: the case of Vietnam." *Working paper*, Graduate School of Economics, University of Tokio.

TORLAK, E. (2004): "Foreign Direct Investment, Technology Transfer and Productivity Growth in Transition Countries: Empirical Evidence from Panel Data." *CEGE Discussion Papers 26*, Center for European, Governance and Economic Development Research, University of Goettingen (Germany).

VAHTER, P. (2004): "The Effect Of Foreign Direct Investment On Labour Productivity: Evidence From Estonia And Slovenia." *Working Paper Series 32*, Faculty of Economics and Business Administration, University of Tartu.

VÍŠEK, J. A. (1997): *Econometrics I.* Prague: Charles University.

WEI, Y. & X. LIU (2003): "Productivity spillovers among OECD, diaspora and indigenous firms in Chinese manufacturing." *Working Papers 2003/008*, Lancaster University Management School, Economics Department.

WHITE, H. (1980): "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity." *Econometrica* **48(4)**: pp. 817–38.

WOOSTER, R. B. & D. S. DIEBEL (2006): "Productivity Spillovers from Foreign Direct Investment in Developing Countries: A Meta-Regression Analysis." *Working paper series*, Available at SSRN: http://ssrn.com/abstract=898400.

YUDAEVA, K., K. KONSTANTIN, N. MELENTIEVA, & N. PONOMAREVA (2000): "Does Foreign Ownership Matter? Russian Experience." *Working Papers w0005*, Center for Economic and Financial Research (CEFIR).

ZEMPLINEROVÁ, A. & M. JAROLÍM (2001): "Modes of FDI Entry and Firm Performance in Transition: The Czech Case." *Transnational Corporations* **10**: pp. 95–111.

ZHU, G. & K. Y. TAN (2000): "Foreign direct investment and labor productivity: New evidence from China as the Host." *Thunderbird International Business Review* **42(5)**: pp. 507–528.

2.A   Supplementary Tables

On the following pages, a few illustrative tables are provided—including alternative specifications for our regression models with all observations. Additional alternative specifications for "old" and "new" subsamples can be found in Appendix A.

Table 2.7: Studies used in the meta-analysis

Authors	Country	Years	Data	Level	Presence	Response	Result (5%)
Caves (1974)	Australia	1966	cs	industry	empl	prod	+
Globerman (1979)	Canada	1972	cs	industry	output	prod	?
Blomström & Persson (1983)	Mexico	1970	cs	industry	empl	prod	+
Blomström (1986)	Mexico	1970/75	cs	industry	empl	other	+
Haddad & Harrison (1993)	Morocco	1985-90	panel	secdum	assets	prod, growth	-
Blomström & Wolff (1994)	Mexico	1970/75	cs	industry	empl	growth	+
Kokko (1994)	Mexico	1970	cs	industry	empl	prod	+
Kokko (1996)	Mexico	1970	cs	industry	empl	prod	+
Kokko et al. (1996)	Uruguay	1970	cs	firm	output	prod	?
Aitken & Harrison (1999)	Venezuela	1976-89	panel	firm	assets	growth	-
Blomström & Sjöholm (1999)	Indonesia	1991	cs	secdum	output	prod	+
Chuang & Lin (1999)	Taiwan	1991	cs	firm	assets	growth	+
Imbriani & Reganati (1999)	Italy	1992	cs	industry	empl	prod	+
Sjöholm (1999b)	Indonesia	1980-91	cs	firm	output	prod, growth	+
Sjöholm (1999a)	Indonesia	1980-91	cs	firm	output	growth	+
Aslanoglu (2000)	Turkey	1993	cs	industry	sales	prod	?
Barrios (2000)	Spain	1990-94	panel	firm	output	prod	?
Djankov & Hoekman (2000)	Czech Republic	1993-96	panel	firm	assets	growth	-
Flôres et al. (2000)	Portugal	1992-95	panel	firm	output	prod	?
Kathuria (2000)	India	1976-89	panel	firm	sales	other	-
Kinoshita (2000)	Czech Republic	1995-98	panel	secdum	empl	growth	?
Konings (2000)	Trans. countries	1993-97	panel	firm	sales	growth	?
Liu et al. (2000)	UK	1991-95	panel	industry	empl	prod	+

Continued on next page

Table 2.7: Studies used in the meta-analysis (continued)

Authors	Country	Years	Data	Level	Presence	Response	Result (5%)
Yudaeva *et al.* (2000)	Russia	1993-97	panel	secdum	output	prod	?
Bosco (2001)	Hungary	1993-97	panel	firm	sales	sales	?
Damijan *et al.* (2001)	Trans. countries	1994-98	panel	secdum	sales	growth	?
Driffield (2001)	UK	1989-92	cs	industry	sales	growth	?
Girma *et al.* (2001)	UK	1991-96	panel	firm	empl	prod, growth	?
Liu *et al.* (2001)	China	1996-97	cs	industry	assets	prod	?
Sgard (2001)	Hungary	1992-99	panel	firm	assets	prod	?
Zemplinerová & Jarolím (2001)	Czech Republic	1994-98	panel	secdum	assets	growth	?
Barrios *et al.* (2002)	Greece, Ireland, Spain	1992, 97	cs	firm	empl	prod	?
Buckley *et al.* (2002)	China	1995	cs	industry	assets, empl	prod	+
Kathuria (2002)	India	1990-96	panel	firm	sales	growth	-
Liu (2002)	China	1993-98	panel	secdum	assets	prod	?
Schoors & Tol (2002)	Hungary	1997-98	cs	firm	sales	prod	+
Bouoiyour (2003)	Morocco	1987-96	panel	industry	assets	prod	?
Khawar (2003)	Mexico	1990	cs	firm	assets	prod	?
Keller & Yeaple (2003)	USA	1987-96	panel	secdum	empl	growth	+
Liu & Wang (2003)	China	1995	cs	industry	assets	prod	+
Ruane & Ugur (2003)	Ireland	1991-98	panel	secdum	empl	growth	+
Wei & Liu (2003)	China	2000	cs	industry	assets	prod	+
Görg & Strobl (2004)	Ireland	1973-95	panel	firm	empl	growth	-
Haskel *et al.* (2004)	UK	1973-92	panel	firm	empl	growth	+
Javorcik (2004)	Lithuania	1996-00	panel	firm	assets	prod	+
Lutz & Talavera (2004)	Ukraine	1998-99	cs	secdum	assets	prod	?

2. Meta-Analysis of Intra-Industry FDI Spillovers: Updated Evidence 35

Table 2.7: Studies used in the meta-analysis (continued)

Authors	Country	Years	Data	Level	Presence	Response	Result (5%)
Marin & Bell (2004)	Argentina	1992-96	panel	firm	empl	growth	?
Sinani & Meyer (2004)	Estonia	1994-99	panel	secdum	various	growth	+
Torlak (2004)	Trans. countries	1993-00	panel	secdum	output	prod	?
Vahter (2004)	Estonia, Slovenia	1994-01	panel	secdum	assets	prod	?
Blalock & Gertler (2005)	Indonesia	1988-96	panel	firm	output	prod	?
Jordaan (2005)	Mexico	1993	cs	firm	empl	prod	?
Narula & Marin (2005)	Argentina	92-96, 98-01	panel	secdum	empl	growth	?
Takii (2005)	Indonesia	1990-95	panel	firm	empl	prod	?
Thuy (2005)	Vietnam	1995-02	panel	industry	empl	prod	?
Bwalya (2006)	Zambia	1993-95	panel	firm	empl	growth	?
Kohpaiboon (2006)	Thailand	1996	cs	firm	output	prod	-
Merlevede & Schoors (2006)	Romania	1996-01	panel	firm	output	growth	?
Peri & Urban (2006)	Germany, Italy	1993-99	panel	secdum	empl	prod	+
Ran *et al.* (2007)	China	2001-03	panel	industry	assets	prod	?
Buckley *et al.* (2007)	China	2001	cs	industry	assets	prod	+
Girma & Wakelin (2007)	UK	1980-92	panel	firm	empl	prod	?
Murakami (2007)	Japan	1994-98	panel	secdum	empl	growth	?
Sasidharan & Ramanathan (2007)	India	1994-02	panel	secdum	output	growth	?
Javorcik & Spatareanu (2008)	Romania	1998-03	panel	firm	output	growth	?
Liu (2008)	China	1995-99	panel	secdum	assets	prod	-
Nguyen (2008)	Vietnam	2000-05	panel	secdum	output	prod	?

Note: The column "Result" does not necessarily report researchers' conclusion; the significance of spillover effect is based on simple average of specifications which were included to our analysis from the particular paper (employing the 5 % level of significance).

Table 2.8: Variable characteristics

Variable	Definition	Summary stat.
Response variable		
tstat	papers' t-statistic for foreign presence; meta-response variable	1.576 (5.65)
growth	= 1 if growth is response variable used in literature, = 0 if labor productivity	39
Foreign Presence Measures		
empl	= 1 if MNC presence measured in employment, = 0 if otherwise (as output, assets, sales)	32
output	= 1 if MNC presence measured in output, = 0 if otherwise (as employment, assets, sales)	21
assets	= 1 if MNC presence measured in assets, = 0 if otherwise (as employment, output, sales)	25
Data Specification		
cs	= 1 if data are cross-section, = 0 if panel data	32
industry	= 1 if data are industry-level, =0 if firm-level	22
secdum	= 1 if industry dummies are used, = 0 if otherwise	35
trans	= 1 if data are for transition country, = 0 if otherwise (developing, advanced)	34
devg	= 1 if data are for developing country, = 0 if otherwise (transition, advanced)	41
avgyr	Average year of study period	1992.286 (7.835)
ldf	Logarithm of degrees of freedom	7.377 (2.356)

Note: For tstat, avgyr and ldf, the summary statistic is the mean with standard error in parenthesis, for all others it is the number of observations for which dummy variable equals 1.

Table 2.9: Table of correlation coefficients

	ldf	avgyr	devg	trans	cs	growth	industry	secdum	empl	assets	output
ldf	1										
avgyr	.289	1									
devg	-.235	-.245	1								
trans	.153	.383	-.629	1							
cs	-.423	-.431	.376	-.424	1						
growth	.185	.093	-.276	.279	-.352	1					
industry	-.602	-.310	.384	-.398	.510	-.344	1				
secdum	.272	.33	-.295	.438	-.436	.216	-.407	1			
empl	-.0665	-.274	-.0233	-.424	.0673	.006	.196	-.162	1		
assets	-.0259	.207	.212	.0117	.0377	-.147	.131	-.001	-.413	1	
output	.223	-.045	.0569	.0335	.0571	-.176	-.225	.0742	-.369	-.31	1

Table 2.10: Standard meta-regression, all studies

	OLS, including outliers				OLS, excluding outliers			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ldf	0.340	0.317			0.0969	0.00201		
	(1.26)	(1.28)			(0.69)	(0.02)		
avgyr	0.0635	0.0457			−0.0119	−0.0301		
	(1.29)	(0.98)			(−0.40)	(−0.93)		
devg	−1.323	−1.972			−0.124	−0.461		
	(−0.65)	(−1.26)			(−0.23)	(−0.74)		
trans	1.080	0.338		2.173	0.805	−0.0612		0.824
	(0.40)	(0.21)		(1.17)	(0.99)	(−0.10)		(1.35)
cs	6.106**	5.185**		4.901**	2.023**	2.118**		1.910**
	(3.06)	(3.01)		(2.80)	(3.16)	(2.90)		(3.59)
growth	1.995		1.376	1.682	0.973†		0.839	0.923*
	(1.44)		(0.93)	(1.32)	(1.91)		(1.56)	(2.01)
industry	1.153		1.704	−0.535	1.851**		2.333**	1.547*
	(0.83)		(1.61)	(−0.33)	(2.85)		(4.19)	(2.63)
secdum	1.627		0.902		0.237		0.0251	
	(1.46)		(0.57)		(0.38)		(0.04)	
empl	2.376		1.878	1.988	1.510*		1.276*	1.365*
	(0.87)		(0.98)	(1.04)	(2.23)		(2.34)	(2.45)
assets	1.118		1.016		0.329		0.165	
	(0.55)		(0.46)		(0.47)		(0.23)	
output	1.019		1.563	0.501	1.159		1.390†	1.076†
	(0.55)		(0.86)	(0.37)	(1.39)		(1.95)	(1.69)
Constant	−132.1	−92.86	−0.909	−2.122	20.85	59.93	−1.191†	−1.846**
	(−1.35)	(−1.00)	(−0.49)	(−1.49)	(0.35)	(0.93)	(−1.82)	(−2.70)
Observations	97	97	97	97	87	87	87	87
R^2	0.185	0.131	0.031	0.133	0.342	0.222	0.232	0.331

Note: heteroscedasticity robust (Huber–White sandwich est.) t statistics in parentheses

response variable: t statistic

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table 2.11: Robust meta-regression, all studies

	IRLS				Median regression			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ldf	0.137	0.0387			0.100	0.110		
	(1.06)	(0.35)			(0.78)	(1.13)		
avgyr	−0.0216	−0.0356			−0.0239	−0.0250		
	(−0.62)	(−1.05)			(−0.71)	(−0.84)		
devg	0.0353	−0.0384			−0.0411	−0.183		
	(0.05)	(−0.06)			(−0.07)	(−0.34)		
trans	0.833	0.0195		0.784	1.068	−0.0503		1.000†
	(1.03)	(0.03)		(1.33)	(1.37)	(−0.09)		(1.67)
cs	1.876**	1.965**	2.299**	1.821**	2.363**	2.835**	2.120**	2.579**
	(2.91)	(3.25)	(3.45)	(3.09)	(3.70)	(5.21)	(2.95)	(4.34)
growth	0.880		0.757	0.849	0.839		0.160	0.360
	(1.64)		(1.38)	(1.66)	(1.57)		(0.27)	(0.68)
industry	1.884*		2.299**	1.552*	0.770		2.120**	0.481
	(2.37)		(3.45)	(2.28)	(1.03)		(2.95)	(0.70)
secdum	0.344		0.126		0.468		0.457	
	(0.61)		(0.23)		(0.84)		(0.80)	
empl	1.436†		1.282†	1.216*	2.216**		1.240†	1.593**
	(1.77)		(1.85)	(2.14)	(2.94)		(1.67)	(2.78)
assets	0.553		0.442		1.036		0.483	
	(0.73)		(0.60)		(1.42)		(0.61)	
output	1.148		1.334†	1.097†	1.856*		1.280	1.553*
	(1.40)		(1.71)	(1.76)	(2.25)		(1.55)	(2.44)
Constant	39.86	70.61	−1.165	−1.679**	44.44	49.06	−0.940	−1.553*
	(0.57)	(1.05)	(−1.61)	(−2.81)	(0.66)	(0.83)	(−1.21)	(−2.56)
Observations	97	97	97	97	97	97	97	97
R^2	0.258	0.183	0.173	0.248	0.128	0.091	0.073	0.102

Note: t statistics in parentheses

response variable: *t* statistic

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table 2.12: Panel meta-regression, all studies

	Random effects, including outliers				Random effects, excluding outliers			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ldf	0.351	0.298			0.0828	0.0141		
	(1.29)	(1.17)			(0.60)	(0.12)		
avgyr	0.122*	0.0754			−0.00560	−0.0202		
	(2.02)	(1.49)			(−0.18)	(−0.60)		
devg	−1.752	−2.493			−0.247	−0.662		
	(−0.80)	(−1.50)			(−0.47)	(−1.06)		
trans	0.619	−0.243		2.345	0.727	−0.296		0.874
	(0.20)	(−0.13)		(1.12)	(0.89)	(−0.43)		(1.31)
cs	6.330**	5.452**		4.859*	1.993**	2.182**		1.819**
	(2.68)	(2.95)		(2.46)	(3.10)	(2.89)		(3.47)
growth	0.837		0.284	1.000	0.756		0.582	0.651
	(0.57)		(0.18)	(0.69)	(1.47)		(1.04)	(1.34)
industry	0.898		1.552	−0.747	1.787**		2.313**	1.467*
	(0.55)		(1.32)	(−0.41)	(2.74)		(4.02)	(2.44)
secdum	1.427		1.111		0.353		0.230	
	(1.16)		(0.69)		(0.54)		(0.37)	
empl	2.066		1.446	2.226	1.808*		1.680*	1.492**
	(0.58)		(0.51)	(1.03)	(2.42)		(2.42)	(2.61)
assets	−0.459		−0.255		0.577		0.537	
	(−0.16)		(−0.08)		(0.74)		(0.62)	
output	0.0349		0.596	0.378	1.505		1.829*	1.215†
	(0.01)		(0.23)	(0.22)	(1.60)		(2.13)	(1.77)
Constant	−246.2*	−151.5	0.189	−1.871	8.379	40.39	−1.426†	−1.691*
	(−2.04)	(−1.50)	(0.07)	(−1.21)	(0.13)	(0.60)	(−1.77)	(−2.39)
Observations	97	97	97	97	87	87	87	87
R^2	0.166	0.129	0.021	0.130	0.335	0.220	0.222	0.327

Note: heteroscedasticity robust (Huber-White sandwich est.) t statistics in parentheses

response variable: t statistic

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table 2.13: Probability meta-regression, all studies

	Probit—positiveness, all observations				Probit—significance, all observations			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ldf	0.0666	0.00737			0.260**	0.144*		0.146*
	(0.79)	(0.11)			(2.78)	(2.13)		(2.15)
avgyr	−0.0195	−0.00244			−0.0640*	−0.0498*		−0.0561**
	(−0.54)	(−0.10)			(−2.51)	(−2.34)		(−2.62)
devg	0.264	−0.0107			0.427	0.261		
	(0.53)	(−0.03)			(0.95)	(0.74)		
trans	0.635	−0.290		0.397	0.413	0.153		
	(1.08)	(−0.74)		(1.01)	(0.74)	(0.40)		
cs	1.123*	1.100**		0.982*	0.873*	0.680†		0.630†
	(2.46)	(2.72)		(2.35)	(2.10)	(1.87)		(1.75)
growth	0.162		0.0380	0.202	0.378		0.317	
	(0.46)		(0.12)	(0.59)	(1.12)		(1.04)	
industry	1.602*		1.528**	1.311*	0.667		0.366	
	(2.27)		(2.77)	(2.13)	(1.30)		(0.99)	
secdum	0.297		0.0868		0.0283		−0.310	−0.0592
	(0.86)		(0.28)		(0.08)		(−1.03)	(−0.19)
empl	1.411*		1.114**	1.344**	0.0173		0.293	
	(2.45)		(2.63)	(2.60)	(0.03)		(0.76)	
assets	0.695		0.611	0.785†	0.197		0.423	0.485
	(1.42)		(1.41)	(1.65)	(0.44)		(1.03)	(1.53)
output	0.841		0.900*	0.959†	−0.738		0.0651	
	(1.62)		(1.97)	(1.93)	(−1.41)		(0.15)	
Constant	37.03	5.059	−0.558	−1.088*	124.6*	97.63*	−0.467	110.3**
	(0.51)	(0.10)	(−1.31)	(−1.97)	(2.47)	(2.31)	(−1.16)	(2.59)
Observations	97	97	97	97	97	97	97	97
Pseudo R^2	0.238	0.126	0.176	0.224	0.190	0.123	0.044	0.137

Note: t statistics in parentheses

response variable: dummy = 1 if t stat is positive (columns 1–4); dummy = 1 if t stat is significant (columns 5–8)

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Chapter 3

On the Determinants of Foreign Direct Investment Incentives

3.1 Introduction

In the last decades, a rivalry for foreign direct investment (FDI) has been catching the attention of economists increasingly. With loosing restraints to international trade and investment since the early 1980s, competition for FDI has been progressively escalating; and thus the question of foreign direct investment incentives (INIs) is getting on urgency. In an effort to obtain FDI under their legislation, governments offer extensive support at all levels, capable of granting hundreds of thousands USD per one generated working station.[1] Sympathizers of INIs maintain that worldwide subsidy competition is a game with a positive outcome—positive externalities linked to FDI are being internalized and the total allocation of investments is said to be more efficient than without INIs. But the majority of economists is rather skeptical toward subsidy competition. They claim that the increase in allocation efficiency is nowise guaranteed; INIs can *per contra* bring extensive distortions to various markets, and globally a race to the bottom in the form of constantly lower tax revenues and loosening of ecological standards—or impeding socially efficient tightening of these standards, which would follow otherwise—much like a threat to employees' rights.[2]

As all available meta-analyses (Görg & Strobl 2001; Meyer & Sinani 2005; Wooster & Diebel 2006; Havránek & Iršová 2008) illustrate, there is no persuasive empirical evidence of technological and knowledge diffusion, which—in the form of productivity spillovers—presents the most important theoretical background for the provision of INIs. This holds especially for intra-industry spillovers, while an elaborate empirical analysis of inter-industry spillovers is only at its beginnings. Until a satisfactory

---

[1]See, e.g., Brazil incentives for Renault and Mercedes in the 1990s (da Motta Veiga & Iglesias 1998, pg. 59).

[2]Oman (2000, pg. 20) compares the process to the wave of devaluations and protectionism of the 1930s; issue has a character of the prisoner's dilemma.

resolution of this problem will be given, one can hardly draw any relevant conclusions about the efficiency of INIs.

Which aspects affect an offered INI volume the most? To what degree is the international subsidy competition intense? To help with the discussion of such problems, we will present two supply-of-investment-incentives models; the first one for the minimal sufficient INI, the other one for the optimal INI; and we will attempt to integrate them into a more general model.

Most of theoretical works call for some form of global coordination of INIs (see, *inter alia*, UNCTAD 1996), hoping that such agreement would decrease the provision of INIs—thus implicitly assuming that free subsidy competition leads to overprovision of FDI incentives. To our knowledge, the first formalized model which shows that this need not be the case is Haufler & Wooton (2006). In the present paper, we support their claim, using a very different, regime-competition model.[3] It is also shown that higher corporate income tax (CIT) rate does not necessarily increase the optimal subsidy levels, as could be intuitively expected.

The paper is structured as follows: Section 3.2 provides a survey of related literature; the Minimal Sufficient INI Model (a targeted-competition model) is going to be proposed. Section 3.3 introduces the Optimal INI Model (a regime-competition model) and lists a few modifications. Section 3.4 concludes the paper.

3.2 The Minimal Sufficient INI Model

3.2.1 Related Work

There has been a substantial body of literature concerning with formalized modeling of the provision of INIs. Absolute majority of models varies in assumptions rather than in methodology—different premises mean different definitions of corresponding public utility functions. From our perspective, the key precondition is the presence of positive externalities from FDI, i.e. *productivity spillovers*, because this presumption offers a fundamental line of reasoning for the very existence of subsidy systems. Let us outline the most relevant works:

Haaparanta (1996) postulates that countries maximize wage income of their citizens resulting from working for foreign investors. Incentive schemes upset optimal investment allocation—in the equilibrium, even countries with relatively high wages can attract investments, although all countries grant optimal INIs from their point of view. Therefore, in comparison to the situation when no one granted subsidies, countries with lower competitiveness can augment the volume of attracted FDI.

In Haaland & Wooton (1999), the entry of a multinational company (MNC) to the local market increases demand for intermediate products made in the host coun-

---

[3]For an excellent discussion of different types of competition, see OECD (2003).

try, which leads to other companies' entry to the imperfect competition market of intermediates. Improved competing background motivates other foreign investors to enter the country, thereby multiplicatively raises national income and social welfare. Governments are aware of these effects—thus they grant INIs in an effort to compete with other countries, awaiting the same benefits.

Barros & Cabral (2000) study competition between a smaller country with high unemployment rate and a larger country without this problem. They assume that there are no such firms capable of competing with the MNC. In the absence of subsidies, the country with larger domestic market is more attractive but has less motivation to lure the investment. Subsequently, a rivalry by means of incentives could end in locating the investment into the smaller country. The authors argue that incentives can increase total welfare—the smaller country needs the investment more and has a higher benefit from attracting it.

Pennings (2001) presents a two-agent model of a country and a foreign monopolistic producer. The company can choose whether to export its products into the country or to undergo a horizontal FDI. In conclusion, for a country which maximizes public utility, an optimal strategy is to compensate investor's expenses fully by incentives and subsequently by taxes to reduce income which exceeds his alternative profit from importing into the country.

Haufler & Wooton (2006) decompose competition between two countries facing the third one simultaneously. They are the first to show that in comparison to "free subsidy competition", coordinated policy of two countries could bring a decrease as well as an *increase* of offered INIs.

Bjorvatn & Eckel (2006) analyze FDI competition between asymmetric countries, differing both in market size and structure. They consider a presence of domestic firms and show that competition tends to be strong especially when both countries are similar in terms of business conditions. In such cases, countries can provide really significant INIs, and *vice versa*.

Ma (2007) supposes that inflow of FDI has certain redistribution effects in the domestic economy. He investigates the influence of interest groups on the competition intensity between competing countries. Due to this tension, the winner can be also the country that would not otherwise have a chance to succeed; and the costs of attracting FDI increase for both countries.

Although we got inspired by the aforementioned models, we shall use a different methodology. Our intention is to demonstrate which influences are the most powerful toward the amount of INIs provision—we are interested in their determinants, not in the efficiency of provision. Let us start from the model of Haufler & Wooton (1999) and its later application by Sedmihradský (2002).[4] Firstly, we adjust their model for its consecutive application for the expression of minimal sustainable tax relief.

---

[4]It is worth mentioning that none of these models directly deals with INIs.

3.2.2 Methodology and Basic Assumptions

Definition 3.1. Minimal sustainable tax relief of country i or *critical rate of tax relief* of country i means the smallest feasible incentive of country i which makes an investor indifferent between the alternatives of countries i and j ($i, j \in \{1, 2\}$).

Assumption 3.1. Assume two countries of different size that vary except GDP also in the level of wage costs and corporate income tax (CIT) rate. Think of an MNC producing a sole product. The company faces descending demand curve—to simplify, it is a global monopoly. Let individual demand functions be in the form:

$$d(q) = \frac{a - q}{b},$$

where q is price and a, b are respective parameters of the demand.

Assumption 3.2. Investor's home country does not tax its residents' foreign-earned incomes. Furthermore, there is no transfer pricing within the MNC.

The investor considers investing into a production capacity. Since we do not consider any other markets, the company can choose ideally from these possibilities: (i) to invest in Country 1 and export part of its production to Country 2, (ii) to invest in Country 2 and import into Country 1, (iii) to invest in both countries, or (iv) not to invest at all. If we presume the existence of transaction costs of goods transportation from Country 1 to Country 2 and *vice versa* (e.g., expenses connected with transport, distribution, marketing, market research, etc.), investor may select the third option.

Assumption 3.3. Assume prohibitively high fixed costs with respect to the third possibility. Suppose also that the company's hypothetical profit would be positive in both countries.

May Country 2 have number of inhabitants equal to m. Suppose that Country 1 has n-times higher GDP than Country 2. Using this proportion as a weight, let us postulate that individual demands in both countries are symmetric.[5] Demand functions in both countries can be formulated in the following way, all parameters being positive:

$$D_1(q) = \frac{m \cdot n(a - q)}{b} \tag{3.1}$$

for Country 1 and similarly

$$D_2(q) = \frac{m(a - q)}{b} \tag{3.2}$$

---

[5]It may seem more natural to use a proportion of the number of inhabitants for aggregation. In our opinion, GDP recalculated according to purchasing power parity gives a better picture of the market size. Such a definition of a weight can partially remove the restriction following from the assumption of symmetrical demand functions in both countries.

for Country 2.

Our thought, following Haufler & Wooton (1999), is based on comparison of gains of the company in dependence on its choice of the country. May the company decide for an investment into Country 1. Then it will produce in Country 1 and export part of this production to Country 2. In Country 1, the company sells its products for the optimal price p_1. However, in consequence of the existence of transaction costs, in the second country's market the demand price is raised by t, while the MNC still obtains p_1.

Let q_i be the final demand price of goods in country i. Assume a linear production function with the only variable factor—labor. For Country 1 suppose that the wage costs are k-times higher than in Country 2:

$$w_1 = kw_2. \tag{3.3}$$

Assumption 3.4 (Similarity). Investment risk is the same for both countries and there is no further relevant difference between the countries than is expressed by the CIT rate (τ_i) and parameters n and k.

3.2.3 Optimization

Because the only production factor is wage costs, we can directly write down an MNC's profit function for the first country:

$$\pi_1 = (p_1 - w_1) \left[D_1(q_1) + D_2(q_2) \right]. \tag{3.4}$$

Substituting (3.1), (3.2) and (3.3) into (3.4) and rearranging, we obtain

$$\pi_1 = \frac{m(p_1 - kw_2)}{b} \left[(a - p_1)(n + 1) - t \right].$$

The condition of the first order is

$$\frac{\partial \pi_1}{\partial p_1} = \frac{m(n+1)}{b} \left(a - 2p_1 + kw_2 - \frac{t}{n+1} \right) = 0. \tag{3.5}$$

Formulating price p_1 from (3.5), we get

$$p_1 = \frac{1}{2} \left(a + kw_2 - \frac{t}{n+1} \right).$$

The maximum can be verified by the condition of the second order:

$$\frac{\partial^2 \pi_1}{\partial p_1^2} \left[\frac{1}{2} \left(a + kw_2 - \frac{t}{n+1} \right) \right] = -2 \frac{m(n+1)}{b}.$$

Substituting the optimal price into the profit function yields

$$\pi_1 = \frac{m\left[(n+1)(a - kw_2) - t\right]^2}{4b(n+1)}.$$ (3.6)

In the same manner it is necessary to derive the formula for the second country. Let us proceed analogically to get

$$\pi_2 = \frac{m\left[(n+1)(a - w_2) - nt\right]^2}{4b(n+1)}.$$ (3.7)

Until this moment we followed the approach of Haufler & Wooton (1999) and Sedmihradský (2002), only several smaller modifications have been made. The continuation varies.

Let us define the net present value of investment in Country 1 as

$$NPV_1 = \sum_{i=1}^{Y_1} \frac{\pi_1}{(1+r)^i} + \sum_{j=Y_1+1}^{M} \frac{\pi_1(1 - \tau_1)}{(1+r)^j} - F,$$ (3.8)

where Y_1 denotes the duration of investor's total tax relief granted by Country 1.

Assumption 3.5. There is no other form of INIs except the total CIT relief.[6]

Let M denote investment's lifetime, F investment volume, τ_1 statutory CIT rate, and r discount rate. No inflation is considered. All parameters are positive and $\tau_1 \in (0, 1)$.

We shall formulate the model in discrete time. In period 0, the company does not generate any profit, but expends fixed costs F. Then there is a constant flow of profits in periods 1 to M. In periods 1 to Y_1, the company exercises INIs. From year $Y_1 + 1$ till the end of investment's lifetime, the profit of the company is taxed by the usual CIT rate of Country 1. Discount rate is constant throughout the investment's lifetime and is the same for both countries. Substituting (3.6) into (3.8) yields

$$NPV_1 = \sum_{i=1}^{Y_1} \frac{m\left[(n+1)(a - kw_2) - t\right]^2}{4b(n+1)(1+r)^i}$$
$$+ \sum_{j=Y_1+1}^{M} \frac{m\left[(n+1)(a - kw_2) - t\right]^2 (1 - \tau_1)}{4b(n+1)(1+r)^j} - F.$$

---

[6]With regard to this assumption let us use the terms "total tax relief", "tax allowances", "tax holidays" and "INIs" as synonyms on the following pages.

The similar stands for Country 2:

$$NPV_2 = \sum_{i=1}^{Y_2} \frac{m\left[(n+1)(a-w_2)-nt\right]^2}{4b(n+1)(1+r)^i}$$

$$+ \sum_{j=Y_2+1}^{M} \frac{m\left[(n+1)(a-w_2)-nt\right]^2(1-\tau_2)}{4b(n+1)(1+r)^j} - F.$$

If profit parity is valid for both countries, that means if investor is indifferent when deciding to which country to place his investment, the following must stand:

$$\sum_{i=1}^{Y_1} \frac{\left[(n+1)(a-kw_2)-t\right]^2}{(1+r)^i} + \sum_{j=Y_1+1}^{M} \frac{\left[(n+1)(a-kw_2)-t\right]^2(1-\tau_1)}{(1+r)^j} =$$

$$= \sum_{i=1}^{Y_2} \frac{\left[(n+1)(a-w_2)-nt\right]^2}{(1+r)^i} + \sum_{j=Y_2+1}^{M} \frac{\left[(n+1)(a-w_2)-nt\right]^2(1-\tau_2)}{(1+r)^j}.$$

Consequently, neither the number of inhabitants of Country 2 nor fixed investment costs will have any influence on the result. We facilitate the situation by installing zero discount rate for further steps.[7] Thus we can write

$$Y_1\left[(n+1)(a-kw_2)-t\right]^2 + (M-Y_1)(1-\tau_1)\left[(n+1)(a-kw_2)-t\right]^2 =$$

$$= Y_2\left[(n+1)(a-w_2)-nt\right]^2 + (M-Y_2)(1-\tau_2)\left[(n+1)(a-w_2)-nt\right]^2.$$

After rearrangements and extraction of Y_1, we get

$$Y_1 = \left[\frac{(n+1)(a-w_2)-nt}{(n+1)(a-kw_2)-t}\right]^2 \frac{M(1-\tau_2)+Y_2\tau_2}{\tau_1} - \frac{M(1-\tau_1)}{\tau_1}. \qquad (3.9)$$

Due to (3.6) and (3.7), (3.9) can be also written as

$$Y_1 = \frac{\frac{\pi_2}{\pi_1}\left[M(1-\tau_2)+Y_2\tau_2\right]-M(1-\tau_1)}{\tau_1}. \qquad (3.10)$$

3.2.4 Comparative Statics

Definition 3.2. Let us define the relative quality of entrepreneurial environment in country i as the ratio π_i/π_j. If this is more than 1, the environment in country i is better than in country j.

Proposition 3.1. *Minimal sustainable tax benefit of country* i *is* ceteris paribus *descending in the quality level of the entrepreneurial environment in* i.

---

[7]Counting with nonzero discount rate does not bring any additional value added regarding the key results of the model; and it can be shown that there exists no closed-form solution in such a case. Moreover, since there is a constant flow of profits, we find this simplification even consistent. One could equivalently suppose that the flow of profits is rising each year by such a coefficient that would compensate the fact of future profits being discounted. *Ad libitum.*

Proof. First, let us differentiate (3.10):

$$\frac{\partial Y_1}{\partial \left(\frac{\pi_1}{\pi_2}\right)} = \frac{-\left(\frac{\pi_1}{\pi_2}\right)^{-2}[M(1-\tau_2)+Y_2\tau_2]}{\tau_1}.$$

For $\tau_2 \in (0,1)$, the expression $M(1-\tau_2)+Y_2\tau_2$ is always nonnegative, as the duration of tax holidays cannot exceed investment's lifetime. Thus, the numerator is negative as well as the whole derivative. $\square$

Proposition 3.2. *Minimal sustainable incentive level in country* i *is increasing in the relative price of its labor power.*

Proof. Realizing that k negatively influences the profit of the company in Country 1, but does not affect its profit in Country 2, π_2/π_1 increases and the attractiveness of Country 1's entrepreneurial environment decreases. Following Proposition 3.1, the critical subsidy level in Country 1 must increase. $\square$

Proposition 3.3 (Strong competition). *Minimal sustainable* INI *in country* i *is increasing in* CIT *of country* i, *if relative entrepreneurial environment in country* i *is better than in country* j.

Proof. Examining an influence of the CIT rate on the critical benefit period, let us differentiate:

$$\frac{\partial Y_1}{\partial \tau_1} = \frac{M - \frac{\pi_2}{\pi_1}[M(1-\tau_2)+Y_2\tau_2]}{\tau_1^2}. \tag{3.11}$$

Because $M(1-\tau_2)+Y_2\tau_2$ is always less or equal to M and since the ratio π_2/π_1 is less than 1, numerator in (3.11) will be positive. Note that if the last condition does not stand, nothing about the sign of the derivation can be said. Thus it is possible that Y_1 need not be increasing in τ_1; for instance, if Country 2 is much larger, richer or notably cheaper in terms of labor costs, and τ_2 is simultaneously close to zero (or, analogically, $Y_2 \to M$). But such counter-intuitive result requires drastic assumptions, therefore we do not consider it to be a representative feature of this model. $\square$

Proposition 3.4 (Regime competition). *Minimal sustainable incentive level in country* i *is increasing in the subsidy range of country* j.

Proof. Dependence of the critical incentive level in country i on the stimuli duration of country j is very simple:

$$\frac{\partial Y_1}{\partial Y_2} = \frac{\pi_2\tau_2}{\pi_1\tau_1}.$$

The result is evident due to Assumption 3.3 and positive τ_i. $\square$

Instead of differentiating (3.10) with respect to all variables, it is more convenient to demonstrate model functioning on a simple example (which is provided in an Excel file on the enclosed DVD and also on the thesis website). Let us choose initial parameters (row 1 in Table 3.1) and calibrate the model, followed by the discussion of relatively more relevant parameters.

Example 3.1. Presumed investment's lifetime is 20 years. Let a, the parameter of investors' demand, be 100. Workload needed to produce a unit of commodity is $10 for Country 2, $12 for Country 1. Country 1 has twice as large market as its rival. Transportation of goods to the other country means additional costs of $10. CIT rate is 30% in both countries; Country 2 provides tax holidays to each foreign investment for 10 years, automatically. The competitor decides *ad hoc*, individually for each investor. The question is, how rich incentives Country 1 has to grant to make investors indifferent between the two countries.

Table 3.1: Sensibility of the Minimal Sufficient INI Model

Line no.	Y_1	Y_2	τ_1	τ_2	a	n	k	M	t
1	8.23	10	0.3	0.3	100	2	1.2	20	10
2	13.07	15	0.3	0.3	100	2	1.2	20	10
3	3.39	5	0.3	0.3	100	2	1.2	20	10
4	11.17	10	0.4	0.3	100	2	1.2	20	10
5	2.34	10	0.2	0.3	100	2	1.2	20	10
6	5.00	10	0.3	0.4	100	2	1.2	20	10
7	11.46	10	0.3	0.2	100	2	1.2	20	10
8	9.85	10	0.3	0.3	1	2	1.2	20	10
9	5.72	10	0.3	0.3	50	2	1.2	20	10
10	4.04	10	0.3	0.3	100	5	1.2	20	10
11	12.76	10	0.3	0.3	100	1	1.2	20	10
12	12.34	10	0.3	0.3	100	2	1.5	20	10
13	3.39	10	0.3	0.3	100	2	0.8	20	10
14	7.86	10	0.3	0.3	100	2	1.2	25	10
15	8.96	10	0.3	0.3	100	2	1.2	10	10
16	3.68	10	0.3	0.3	100	2	1.2	20	20
17	10.44	10	0.3	0.3	100	2	1.2	20	5

Source: author's computations on the basis of result (3.10).

First column of the first row of Table 3.1 shows the situation from Example 3.1, where tax exemption of 8.2 years suffices. What happens if Country 2 changes its strategy? Apparently, increases in the duration of tax holidays in Country 2 force the first country to raise its incentive almost proportionally. This results already from Proposition 3.4.

In accordance with Proposition 3.3, raising CIT in Country 1 by one third increases

the minimal sufficient INI by 3 years, and *vice versa.* Changes in CIT of the rival country will have an antagonistic effect. Rising CIT of Country 2 to 40% results in a decrease of the critical period of tax relief to 5 years; on the other hand, a shift to 20% will lead to an increase of subsidy to 11.5 years.

It is obvious that multiple changes in parameter a may influence incentives only a little. The next two lines show an impact of changes in relative economic power—the stronger purchasing power Country 1 has, the smaller amount of INIs the country has to provide. In lines 12 and 13 changes in relative wage costs are itemized. The growth in costs of Country 1 (represented by the rise of k from 1.2 to 1.5) means an escalation in minimal sufficient incentive to 12.3 years—wage costs have a noticeable impact on the critical length of subsidy, in line with Proposition 3.2. Conversely, a change in investment's lifetime M will not influence critical length of subsidy very much for *such selected parameters' values.*

Proposition 3.5 (Investment's lifetime neutrality). *If both countries have the same CIT and quality of entrepreneurial environment, the investment's lifetime does not affect the critical rate of INI.*

Proof. Differentiating (3.10) with respect to M yields:

$$\frac{\partial Y_1}{\partial M} = \frac{\frac{\pi_2}{\pi_1}(1-\tau_2) - (1-\tau_1)}{\tau_1}.$$

Employing both assumptions, the result is evident.   □

Simultaneously, if Country 1 has better entrepreneurial environment than Country 2 but higher CIT, the critical rate of incentive will grow in M. In this case, competing with a more populous, poorer country with lower CIT rate (say, the Czech Republic vs. Poland), a relatively smaller and richer country with higher CIT has to offer noticeably higher incentives for long-term investments. This fact is overestimated because of the condition of zero discount rate (in comparative statics, influence of M is the only aspect strongly affected by this condition). Finally, if transaction costs are relatively high (line 16), the market of the larger country (Country 1) is worse accessible and the company will rather decide to invest directly there. Minimal sustainable incentive for this country decreases relatively fast.

3.2.5   Application on the Visegrad Countries

Definition 3.3. The term *incentive parity* signifies a situation, when potential NPV of the investment is the same for both countries.

In Table 3.2, all essential parameters are summarized for all four countries of Visegrad group as of 2007. They were chosen on purpose; these countries are competitors to large extent and there are no drastic divergences in economic performance

and institutional system, so that they largely satisfy the assumption of similarity (Assumption 3.4).

Table 3.2: Chosen indicators for surveyed countries

2007	Czech Rep.	Slovakia	Poland	Hungary
GDP	250,057	109,672	621,984	191,453
W	1,208	710	1,166	900
CIT	24%	19%	19%	16%
Y	10	10	F/2	8

Note: GDP—value in millions of USD according to PPP.

W—wage costs in USD per month, calculated using the exchange rate at the end of the year.

Poland does not have any time limit of tax relief utilization, but (in most of the country) it allows to use allowances up to one half of initial investment—it takes an advantage of effective European legislation. Since it is a higher allowance than in the Czech Republic, let us approximate it to, for instance, 12 years (a rather conservative estimation).

Hungary provides 80% CIT reliefs for up to 10 years, which is approximated to 8 years of total tax relief.

Source: IMF (2008), FEE (2008), EC (2008), www.czechinvest.cz, www.sario.sk, www.paiz.gov.pl, www.itd.hu.

On the basis of line 1 from Table 3.2, let us calculate n, i.e. population purchasing power ratio, while from the second row we ascertain k for all countries regarding the Czech Republic (CR). The question is how rich incentive the CR has to offer to keep the investor indifferent.

Table 3.3: Results of critical tax-relief period rate for the Czech Republic

Case	Y_1	Y_2	τ_1	τ_2	a	n	k	w_2	M	t
CR—Slovakia	11.0	10	0.24	0.19	1,000	2.28	1.70	5	15	10
CR—Poland	13.2	12	0.24	0.19	1,000	0.40	1.04	5	15	10
CR—Hungary	10.4	8	0.24	0.16	1,000	1.31	1.34	5	15	10
CR—Slovakia	8.6	10	0.15	0.19	1,000	2.28	1.70	5	15	10
CR—Poland	12.1	12	0.15	0.19	1,000	0.40	1.04	5	15	10
CR—Hungary	7.6	8	0.15	0.16	1,000	1.31	1.34	5	15	10

Source: author's computations from Table 3.2 and result (3.10).

In the first part of Table 3.3, let us examine the case of 24% CIT rate in the Czech Republic, as of 2007. In the second part, we try to analyze how the result would change if the Czech CIT rate decreased to, say, 15%. As we see, in the first case (the default situation), INIs were set broadly at par to Slovakia and Hungary—the model results give 11.0 and 10.4 respectively, not far from the actual real value (10 years). However, Poland had the parity much higher—at 13.2 years. The market size has the

greatest impact on this outcome; recalling that the model does not assume purely vertical FDI, this result is not really surprising.

If tax rate had been reduced all the way to 15% in the Czech Republic, incentive parity would have decreased noticeably toward Hungary as well as toward Slovakia. The CR could allow decreasing amount of INIs, admittedly at the risk of losing some marginal investors in favour of Poland (with Poland, parity stays steadily above 10 years). If the incentive provision is fully stopped after tax reduction to 15%, parity would not hold even *vis-à-vis* Hungary and Slovakia, and it would not be convenient for the investor in this model to invest in the CR. For instance *vis-à-vis* Slovakia, the Czech Republic would have to reduce CIT down to 6.5% to compensate the investor for the abolition of present INIs.

3.2.6   Limitations & Extensions

It stands to reason that model results from Table 3.3 should be taken "with a grain of salt". We do not claim that incentive parity actually holds (or hold) in Central Europe, it was merely an illustrative example. The model is very simple in methodology, also engaging only in a restricted number of parameters—certainly there is a different labor productivity among the examined countries, regardless of many other FDI determinants. Each country has certain specific assets (e.g., location) important for investors, but hardly quantifiable. The other possible improvement is to use effective instead of statutory corporate income tax rate.

Naturally, income tax relief is not the only form of INIs that governments keep at disposition, although it is probably the most utilized one (Newton 2003). For advanced countries, which usually prioritize financial subsidies,[8] such precondition is particularly restrictive while in other countries, tax holidays make usually a noticeable part of the whole INI. For instance according to the Czech Supreme Audit Office report (SAOCR 2006, pg. 9), the CR provided CIT reliefs in the amount of 5,102 million CZK in 1998–2005, compared to financial INIs of 247 million CZK. CIT reliefs thus represented more than 95% of the total provided volume of INIs. However, it might be useful to expand the model by other kinds of incentives, especially the financial ones.

3.3   The Optimal INI Model

3.3.1   Intuition and Methodology

While the model introduced in the last section formulated the minimal INI adequate to keep investor indifferent in decision-making between both countries, now we try to determine how large INI is really optimal for the given country. With reference, *inter*

---

[8]One of the exceptions is for instance Singapore (Sieh Lee 1998).

alia, to Blomstrom & Kokko (2003), we consider FDI as a public good associated with externalities (naturally under certain circumstances, which is not a subject of discussion here). For this chapter let us consider only positive FDI externalities—*positive productivity spillovers*.

The model from the last chapter is solved from investor's point of view—the government has only a possibility to change the volume of INIs in reaction to investor's profit parity. In this model, we will approach the situation directly from the chosen country's view. Nevertheless, the attitude toward the problem will be opposite to what is common in available literature. Very often we can encounter such a formulation that—by means of incentives—governments *buy* spillovers (e.g. Newton 2003; Ma 2007). Sometimes, the competition for FDI is directly compared to an auction: the MNC auctions FDI, governments try to outbid each other (see Besley & Seabright 1999).

In such a case, one would assume INIs to be a form of a *price which countries pay for FDI*, or directly for spillovers connected to it. Our approach in this chapter is, however, not so straightforward. The introduced model is based on understanding INIs as *commodities* of some kind produced by the government and demanded by potential investors. Nevertheless, INIs of both countries are not identical for the MNC—let us simply assume that the MNC perceives incentives of Country 1 and Country 2 as different, although related, goods. To formalize, we see a certain analogy with the Cournot oligopoly model, because the way of maximization (modifications of the offered quantity) corresponds to our thinking about incentives-based competition for FDI the best.

Why did we decide to interpret the issue precisely in this manner, quite differently from formulations of existing models? If an MNC plans to invest, it usually makes a list of several acceptable countries or regions. Their governments are then contacted in an effort to obtain the best INI possible (see, e.g., Oman 2000). At this stage, FDI competition is reduced to the incentives-based rivalry concerning usually only a few countries—therefore we consider oligopoly in our model. Since we want to apply the Cournot oligopoly model, MNC's inverse demand functions (quasiprice which the MNC "pays" for INIs) need to be derived. However, we simply assume here that the inverse demand functions have the shape described in the following paragraphs.

Let us divide host country's benefits from FDI into (i) productivity spillovers and (ii) other effects (nonexternalities). The MNC is aware of positive externalities generated by its investments (denoted by ξ), but it cannot influence the size of such spillovers (denoted by ξ). Hence this value will form the autonomous term in inverse demand function (3.12). May the MNC's *willingness to pay* for INIs refer to the other FDI effects in our model. These are determined by the MNC itself and can be either positive or negative. The higher CIT rate in a certain country, the more willing the MNC is to pay for INIs offered by this country (the product of parameter α_i and tax

rate τ_i in (3.12) will have a positive influence). Higher tax burden in the country providing INIs means that the incentive presents a higher utility for the investor—and he is now willing to "pay" a higher quasiprice.

Analogically, the higher the CIT rate in the rival country, the less ready the MNC is to pay for incentives of the first country (the product of parameter β_i and rival country's tax rate τ_j will be negative). As with the CIT increase in Country 2 the MNC does not demand high incentives in Country 1 (Country 2 is getting *ceteris paribus* less competitive and the negotiating power of Country 1 strengthens), its willingness to pay for INIs of Country 1 decreases. Finally, the quasiprice will fall with an increase of provided volume of INIs by the given country—the same as with an increase of INIs of the rival country since the MNC perceives them as relatively close substitutes. In other words, we assume downward-sloping demand curves.

3.3.2 Basic Assumptions

Assumption 3.6 (Separation). Consider the decision making to be separate for INIs and the CIT rate. The latter is set exogenously and government seeks the optimal INI.

Assumption 3.7 (Exclusivity). The government has merely one form of INIs at its disposal—the total CIT relief for Y years. Furthermore, tax holidays are granted automatically so that each foreign investor can be sure to obtain them.

Assumption 3.8. For the sake of simplicity, let us consider a model of duopoly competitors. Both countries have certain specific assets for investors (e.g., a favorable location), so that after a simultaneous reduction of incentives from the Cournot equilibrium, investor does not decide to exit into a third country. Let the inverse demand functions be linear in τ_i and Y_i.

May the inverse demand functions for INIs be (see discussion in Subsection 3.3.1)

$$\phi_i(Y_i, Y_j) = \xi_i + \alpha_i \tau_i - \beta_i \tau_j - \gamma_i Y_i - \delta_i Y_j, \quad i, j \in \{1, 2\}, \quad i \neq j, \quad (3.12)$$

where ξ_i stands for spillovers, $\tau_i \in (0,1)$ is statutory CIT rate in country i, and Y_i is the length of the total CIT relief in years. All the parameters are positive and it is assumed that $\alpha_i > \beta_i > \gamma_i > \delta_i$ holds. The reason is the following: taking into account that investor's preferences about the CIT rate and duration of tax holidays probably do not differ significantly and since α_i and β_i influence the tax rate for which the restriction $\tau \in (0,1)$ holds, they should be higher than γ_i and δ_i. It is also reasonable to assume that in each inverse demand function for country i's INIs, τ_i has higher impact than τ_j as well as the importance of Y_i exceeds that of Y_j, therefore $\alpha_i > \beta_i$ and $\gamma_i > \delta_i$ holds.

To form a model, we need to choose a way of countries' costs-of-incentives expres-

sion. The methodology differs; usually one can encounter an erosion of tax system and home firms' discrimination, since they are often unable to obtain INIs (Oman 2000). However, these factors can be quantified only with difficulties. In the present paper, we use Wells *et al.* (2001): the costs of tax holidays can be understood as the relief duration in years multiplied by the CIT rate, overall FDI coming to the country (I), expected gross investment rate of return (J) and so-called *redundancy rate* (R):

$$TC_i = \tau_i R_i I_i J_i Y_i, \tag{3.13}$$

where $R_i \in (0, 1]$ is that part of investors that would have come to the country even without any INIs. Expression (3.13) then forms the lost tax income.

Assumption 3.9 (Weak INIs' efficiency). The received incentive is for all investors the smallest necessary to make them invest into the country.

I_i and R_i are dependent on Y_i, so they are not parameters. R is in fact a function of Y, comprehended in form of

$$R(Y) = 1 - w(Y),$$

where $w(Y)$ stands for the function for which the following properties apply:

$$w \in C^1(\mathbb{R}),\ w(0) = 0,\ \lim_{Y \to \infty} w(Y) = 1,\ w'(Y) \geq 0,\ w''(Y) \leq 0.$$

Lemma 3.1. *If $TC_i = \tau_i R_i I_i J_i Y_i$ holds, then $TC_i = \tau_i I_i^0 J_i Y_i$ holds as well, where I_i^0 is the investment volume in the case of nonexistence of INIs.*

Explanation. If a country does not provide INIs, then $R = 1$; i.e., all investors naturally come into the country without any INIs and $I = I^0$. As soon as the country starts to increase INIs, from the definition of R, incoming investment volume will rise according to the equation $I = I^0 + (1 - R)I$. Sensibility of investors to INIs is represented by $(1 - R)$, which is precisely $w(Y)$. Then, the investment can be derived easily as $I = I^0/R$ and after insertion into (3.13), we obtain the desired expression. □

Assumption 3.10 (Symmetry). Spillover value and the average rate of return on investment is the same for both countries. In the case of nonexistence of INIs, let the investment inflow be identical for both countries.

Assumption 3.11. Countries provide generic incentive schemes—we do not consider for now that governments have a possibility to negotiate with individual investors. Countries offer INIs *ex ante*, being the same for all investors.

3.3.3   Decentralized Equilibrium

Let both countries be Cournot duopolists maximizing their individual profit. None of the countries has perfect information about the exact volume of INIs offered by the second country at its disposal. The total revenue from INIs of Country 1 will then be

$$TR_1(Y_1, Y_2) = \xi Y_1 + \alpha_1 \tau_1 Y_1 - \beta_1 \tau_2 Y_1 - \gamma_1 Y_1^2 - \delta_1 Y_1 Y_2. \tag{3.14}$$

Applying Lemma 3.1, the total costs of INIs will reach

$$TC_1 = \tau_1 I^0 J Y_1. \tag{3.15}$$

On the basis of (3.14) and (3.15), one can formulate the profit function (where as the "profit" we consider the utility of the given country from provided INIs):

$$\Pi_1 = \xi Y_1 + \alpha_1 \tau_1 Y_1 - \beta_1 \tau_2 Y_1 - \gamma_1 Y_1^2 - \delta_1 Y_1 Y_2 - Y_1 \tau_1 I^0 J.$$

From the condition of the first order, we solve for Y_1 and obtain the reaction function of Country 1:

$$Y_1 = \frac{\xi + \alpha_1 \tau_1 - \beta_1 \tau_2 - \delta_1 Y_2 - \tau_1 I^0 J}{2\gamma_1}. \tag{3.16}$$

Similarly, let us derive the reaction function of Country 2:

$$Y_2 = \frac{\xi + \alpha_2 \tau_2 - \beta_2 \tau_1 - \delta_2 Y_1 - \tau_2 I^0 J}{2\gamma_2}. \tag{3.17}$$

Terms (3.16) and (3.17) give together a system of equations—two reaction curves. The final Cournot equilibrium will be reached in the point of intersection of these curves. After modifications and substitution, the equilibrium value will have the form of

$$\begin{aligned} Y_1^C = &\frac{\xi(2\gamma_2 - \delta_1) + \tau_1(2\alpha_1\gamma_2 + \delta_1\beta_2 - 2\gamma_2 I^0 J)}{4\gamma_1\gamma_2 - \delta_1\delta_2} \\ &- \frac{\tau_2(2\beta_1\gamma_2 + \alpha_2\delta_1 - \delta_1 I^0 J)}{4\gamma_1\gamma_2 - \delta_1\delta_2}. \end{aligned} \tag{3.18}$$

Expression (3.18) sets the optimal volume of INIs for Country 1, provided no country has "an advantage of the first move" and no agreement is possible—we deal with a simultaneous noncooperative one-shot game.

All propositions in this subsection are straightforward applications of equilibrium condition (3.18). Let us start with the influence of spillovers.

Proposition 3.6. *The amount of incentives under "free subsidy competition" in the Cournot equilibrium is an increasing function of positive FDI spillovers.*

Proof. Let us simply differentiate (3.18):

$$\frac{\partial Y_1^C}{\partial \xi} = \frac{2\gamma_2 - \delta_1}{4\gamma_1\gamma_2 - \delta_1\delta_2}.$$

Being aware of the primary condition $\gamma_i > \delta_i$, we get the result.   □

Proposition 3.7. *If the CIT rate in country i (τ_i) exceeds at least one half of the CIT rate in country j, then higher returns to investments lower the country i's optimal level of INIs.*

Proof. Differentiation of (3.18) with respect to J yields

$$\frac{\partial Y_1^C}{\partial J} = \frac{I^0(\tau_2\delta_1 - 2\tau_1\gamma_2)}{4\gamma_1\gamma_2 - \delta_1\delta_2}.$$

Applying the condition $\gamma_i > \delta_i$ once again, the result is obvious. Notice that the influence of I^0 on Y_1^C is exactly the same.   □

Proposition 3.8. *The host country's CIT rate has an ambiguous effect on the optimal level of INIs. The effect tends to be negative if many MNCs are willing to invest into the country even without any incentives and if the returns on such investments are high.*

Proof. It is necessary to differentiate (3.18) with respect to τ_1:

$$\frac{\partial Y_1^C}{\partial \tau_1} = \frac{2\alpha_1\gamma_2 + \delta_1\beta_2 - 2\gamma_2 I^0 J}{4\gamma_1\gamma_2 - \delta_1\delta_2}.$$

The denominator of is positive, but we cannot say anything about the sign of the nominator. This can be surprising because the CIT rate is naturally closely related to tax incentives in MNCs' decision-making and one would expect the influence to be clearly positive. However, in the current model, the amount of lost taxation rises with the increasing CIT and, on the other hand, the higher CIT, the more INIs investors require since their net rate of return declines—see definition of the respective demands in (3.12)—, which increases government's revenue from the provision of INIs. The total effect is slight and unclear. Differentiation with respect to τ_2 yields a very similar formula with opposite signs—thus it seems that if τ_1 increases Y_1, τ_2 tends to decrease it, and *vice versa*.   □

Parameter γ_1 raises the denominator in (3.18), but does not affect the numerator, thus the optimal volume of INIs decreases with its growth. Parameter δ_2 has a contrary influence; it decreases the denominator, but does not occur in the numerator. It is not so simple to estimate the impact of other parameters; therefore we project the performance of the model on an example and in particular on Table 3.4.

Example 3.2. For illustration, let the Czech and Slovak republics be competitors and the respective demand functions for INIs be symmetrical. Let us select the following demand parameters: $\alpha_i = 100$, $\beta_i = 50$, $\gamma_i = 20$, $\delta_i = 10$. Spillovers are assessed to be 400. Assume that the investment value which would come to the country even without incentives is equal to 1000 and its average rate of return is 10%. In 2007, the CIT rate was 19% in Slovakia and 24% in the Czech Republic. This example is described in the first row of Table 3.4—the optimal tax relief provided by the CR will last for 7.8 years under these conditions. What happens if the spillover effect rises by 50% to 600? The optimal INI increases to 11.8 years.

3.3.4 Stackelberg Leadership

Admittedly, simultaneous game principle does not have to be fulfilled in practice. Suppose that the government of Country 1 has "an advantage of the first move", so that Country 1 is a quantity leader in the sense of Stackelberg. The country that is the first one to provide INIs in the region or which is the most successful in attracting foreign investors can become such a leader. In the last decades, Singapore can serve as an example for the region of Southeastern Asia (see Charlton 2003). Country 1 (leader) knows *ex ante* that Country 2 (follower) will react to its move. Government in Country 1 knows the reaction function of Country 2:

$$Y_2 = \frac{\xi + \alpha_2 \tau_2 - \beta_2 \tau_1 - \delta_2 Y_1 - \tau_2 I^0 J}{2\gamma_2},$$
(3.19)

Thus Country 1 uses the reaction function of Country 2 in its profit function:

$$\Pi_1 = \xi Y_1 + \alpha_1 \tau_1 Y_1 - \beta_1 \tau_2 Y_1 - \gamma_1 Y_1^2$$
$$- \delta_1 Y_1 \frac{\xi + \alpha_2 \tau_2 - \beta_2 \tau_1 - \delta_2 Y_1 - \tau_2 I^0 J}{2\gamma_2} - Y_1 \tau_1 I^0 J.$$

From the condition of the first order we derive Y_1 and get the optimal amount of incentives in Country 1 for the leader of the sequential game:

$$Y_1^S = \frac{\xi(2\gamma_2 - \delta_1) + \tau_1(2\alpha_1\gamma_2 + \delta_1\beta_2 - 2\gamma_2 I^0 J)}{4\gamma_1\gamma_2 - 2\delta_1\delta_2}$$
$$- \frac{\tau_2(2\beta_1\gamma_2 + \alpha_2\delta_1 - \delta_1 I^0 J)}{4\gamma_1\gamma_2 - 2\delta_1\delta_2}.$$
(3.20)

Proposition 3.9. *Duration of tax relief in the case of the Stackelberg leadership stays greater than in the case of Cournot competition.*

Proof. The new term has a higher denominator, while the numerator stays the same, therefore $Y_1^C < Y_1^S$ always holds. □

Analogically to the standard model of the Stackelberg leader, the results are

higher provision of INIs and higher "income" for Country 1. Thanks to the similarity of expressions, discussion of parameters influences of the Stackelberg equilibrium will not be necessary because they will not differ from the case of Cournot. Proposition 3.6, Proposition 3.7, Proposition 3.8, and also all the conclusions made in the discussion of (3.18) are valid here as well.

Example 3.3. Let all parameters be the same as in Example 3.2. The Czech Republic and Slovakia are again duopolists providing INIs, but the Czech Republic is now the Stackelberg leader—this modification changes optimal duration of tax holidays to 8.4 years.

3.3.5 Supranational Coordination

Even if the absolute majority of theoretical works calls for some form of global regulation of INIs (see, *inter alia*, UNCTAD 1996), it has not appeared in a noticeable extent till nowadays; apparently no credible threat for the case of violation of such agreements exists.

A typical example can be found in Charlton (2003, pg. 29): in 1991, the states of New York, New Jersey, and Connecticut made an agreement on restrictions of incentives for investors transferring their activities from one state to another. However, New Jersey promptly violated this contract, trying to attract (by means of an incentive of 50 million USD) First Chicago Corporation, which employed at that time 1,500 workers in the neighboring New York. New York reacted with even a more generous incentive and made the company stay. As a result, the inter-state agreement lasted for only four days.

Our model changes with the assumption of coordination. To maximize the common profit from INIs, the supranational entity maximizes the profit function

$$\Pi_{1+2} = \xi Y_1 + \alpha_1 \tau_1 Y_1 - \beta_1 \tau_2 Y_1 - \gamma_1 Y_1^2 - \delta_1 Y_1 Y_2 - Y_1 \tau_1 I^0 J$$
$$+ \xi Y_2 + \alpha_2 \tau_2 Y_2 - \beta_2 \tau_1 Y_2 - \gamma_2 Y_2^2 - \delta_2 Y_1 Y_2 - Y_2 \tau_2 I^0 J.$$

From the first order condition with respect to Y_1 we derive

$$Y_1 = \frac{\xi + \alpha_1 \tau_1 - \beta_1 \tau_2 - \delta_1 Y_2 - \tau_1 I^0 J - \delta_2 Y_2}{2\gamma_1}. \tag{3.21}$$

Similarly from the first order condition with respect to Y_2 we calculate

$$Y_2 = \frac{\xi + \alpha_2 \tau_2 - \beta_2 \tau_1 - \delta_2 Y_1 - \tau_2 I^0 J - \delta_1 Y_1}{2\gamma_2}. \tag{3.22}$$

In the case of both countries' agreement, substituting (3.22) into (3.21) we obtain

for Y_1:

$$Y_1^K = \frac{\xi(2\gamma_2 - \delta_1 - \delta_2) + \tau_1\left[2\gamma_2(\alpha_1 - I^0 J) + \beta_2(\delta_1 + \delta_2)\right]}{4\gamma_1\gamma_2 - (\delta_1 + \delta_2)^2}$$
$$- \frac{\tau_2\left[2\beta_1\gamma_2 + (\delta_1 + \delta_2)(\alpha_2 - I^0 J)\right]}{4\gamma_1\gamma_2 - (\delta_1 + \delta_2)^2}. \tag{3.23}$$

Example 3.4. Following Example 3.2, the chosen parameters and countries stay the same. Providing both countries are able to agree on incentives-system coordination, the optimal duration of incentive in the Czech Republic will decrease to 6.6 years. However, this conclusion cannot be generalized.

Proposition 3.10. *If both countries are able to coordinate their INI schemes, the offered INIs can either decrease or* increase, *depending mainly on the assumed spillover value.*

Proof. This can be seen easily, e.g., from Table 3.4 which tests the sensibility of model's results to individual parameters. Through most of the modifications of our example, the optimal tax-relief duration in the case of coordination stays lower than in the decentralized equilibrium. But note the third line—in the case of coordination, INI is higher for such selected parameters' values. □

Notice that Proposition 3.6 and Proposition 3.8 are valid even in the case of coordination (for the same reasons as in the Cournot model).[9] Also, γ_1 affects the optimal incentive value negatively; nonetheless we cannot say anything about parameter δ_2 *prima facie*—it occurs both in numerator and denominator of (3.23). Proposition 3.7 needs to be changed for the case of coordination:

Proposition 3.11. *If the competition is subject to supranational coordination and the CIT rate in country i (τ_i) exceeds the CIT rate in country j, then higher returns to investments lower the country i's optimal level of INIs.*

Proof. Differentiation of (3.23) with respect to J yields

$$\frac{\partial Y_1}{\partial J} = \frac{I^0\left[\tau_2(\delta_1 + \delta_2) - 2\tau_1\gamma_2\right]}{4\gamma_1\gamma_2 - (\delta_1 + \delta_2)^2}.$$

The result is obvious due to the initial conditions (see Footnote 9). Compared to Proposition 3.7, the assumptions behind Proposition 3.11 are more restrictive. □

---

[9]Illustration for Proposition 3.6: $\frac{\partial Y_1^K}{\partial \xi} = \frac{2\gamma_2 - \delta_1 - \delta_2}{4\gamma_1\gamma_2 - (\delta_1 + \delta_2)^2}$, denominator can be written as $(\gamma_1\gamma_2 - \delta_1^2) + (2\gamma_1\gamma_2 - 2\delta_1\delta_2) + (\gamma_1\gamma_2 - \delta_2^2)$, thus the whole derivative is clearly positive applying the condition $\gamma_i > \delta_i$.

3.3.6 Sensibility Analysis

We analyze the sensibility of the model in Table 3.4, proceeding analogously to Section 3.2 (line 1 corresponds to our previous examples in this section, and in all lines we have to respect the condition $\alpha_i > \beta_i$ and $\gamma_i > \delta_i$). Results of optimal tax-holidays period correspond to Country 1 and our modifications (first column provides the value for the Cournot equilibrium, the second one for the Stackelberg leadership, the third column shows supranational coordination).

Table 3.4: Sensibility of the Optimal INI Model

Y_1^C	Y_1^S	Y_1^K	ξ	α_1	α_2	β_1	β_2	γ_1	γ_2	τ_1	τ_2	J
7,8	8,4	6,6	400	100	100	50	50	20	20	0,24	0,19	0,1
11,8	12,7	9,9	600	100	100	50	50	20	20	0,24	0,19	0,1
0,1	0,1	0,2	10	100	100	50	50	20	20	0,24	0,19	0,1
10,4	11,1	9,8	400	500	100	50	50	20	20	0,24	0,19	0,1
7,3	7,8	5,8	400	10	100	50	50	20	20	0,24	0,19	0,1
7,3	7,8	5,3	400	100	500	50	50	20	20	0,24	0,19	0,1
7,9	8,5	6,8	400	100	10	50	50	20	20	0,24	0,19	0,1
5,5	5,9	3,7	400	100	100	500	50	20	20	0,24	0,19	0,1
8,0	8,6	6,8	400	100	100	10	50	20	20	0,24	0,19	0,1
8,5	9,2	8,4	400	100	100	50	500	20	20	0,24	0,19	0,1
7,8	8,3	6,4	400	100	100	50	10	20	20	0,24	0,19	0,1
3,0	3,1	2,2	400	100	100	50	50	50	20	0,24	0,19	0,1
10,7	11,7	9,8	400	100	100	50	50	15	20	0,24	0,19	0,1
9,4	9,5	9,3	400	100	100	50	50	20	100	0,24	0,19	0,1
5,6	6,6	0,1	400	100	100	50	50	20	10	0,24	0,19	0,1
7,9	8,5	6,8	400	100	100	50	50	20	20	0,5	0,19	0,1
7,8	8,3	6,4	400	100	100	50	50	20	20	0,1	0,19	0,1
7,4	7,9	6,0	400	100	100	50	50	20	20	0,24	0,5	0,1
7,9	8,5	6,7	400	100	100	50	50	20	20	0,24	0,1	0,1
7,3	7,8	6,1	400	100	100	50	50	20	20	0,24	0,19	0,2
8,1	8,7	6,8	400	100	100	50	50	20	20	0,24	0,19	0,05

Source: author's computations in accordance to (3.18), (3.20) and (3.23).

From Table 3.4 let us comment only the most important findings. The change of FDI externalities has a highly considerable impact on the optimal incentive quantity. On the contrary, the influence of changes in parameters α_i and β_i of the demand function appears to be insignificant. More substantial is the influence of γ_i. Increase in γ_1 causes comparatively noticeable fall in incentive duration for all modifications (Cournot, Stackelberg leadership, collusion). Parameter γ_2 works with a lower intensity in the opposite direction. In this example, the CIT rate of Country 1 (Czech Republic) exceeds that of Country 2 (Slovakia), thus higher return on investment (J) means lower optimal INIs for the Czech Republic, although the effect is not dramatic.

3.3.7 Limitations & Extensions

Determining the costs of tax holidays, we started from Wells *et al.* (2001), who remind that a lost tax income is not the only expense. An important issue is the latent form of other costs, hard to be researched and separated into a longer period, i.e. difficult to quantify. If we admitted that such "lateral" costs could reach significant values, the model would have to be modified broadly.

The model has also another limitation—it would be interesting to loose the assumption of equivalent spillover values for both countries and study how the changes in different levels of spillovers influence the result. Furthermore, the equal level of I^0—investments that flow into the country independently of the provision of INIs—is required for both countries. Parameter of investment rate of return J approximates π_i/F from the first model. Initial Assumption 3.10 is again restrictive—nevertheless a simple solution with different values of J_i is possible.

Finally, (3.12) does not cover all the parameters that can influence investor's "willingness to pay" for INIs. It can include the price of labor, its qualification, macroeconomic or political stability, etc.; lots of FDI determinants can be envisioned here.

Also, the simplification hidden in Assumption 3.11 is very significant—the country has to provide each foreign investor with equivalent INI. We do not consider negotiations between the MNC and governments that race in offering INIs to attract investments—which is perhaps a relatively frequent phenomenon (see Oman 2000; Charlton 2003). However, our assumption is justifiable because we model *fiscal* incentives, particularly tax holidays—and because the legislation in taxation field changes difficultly and relatively slowly in democratic countries, fiscal INIs use to be provided via generic schemes (see OECD 2003).

It is useful to indicate what consequences an embodiment of negotiations between the investor and involved countries during the decision-making process would bring to the previous model (in other words, governments can decide *ad hoc* and offer incentives tailored to the needs of the MNC). Besides, if we suppose that governments know their own minimal sufficient INI, we can illustrate the interaction between both models. The summary is depicted in Figure 3.1.

Status quo (situation without INIs) is disrupted by some external factors in nodal point A. If both countries choose cooperation, they get to point B—a situation of "collusion" from our model, which satisfies the optimal INI supply Y_1^K for Country 1. Let us label $Y_1^{MIN}(Y_2^K)$ as the value of minimal sufficient incentive, which corresponds to the given INI of the second country. If $Y_1^K > Y_1^{MIN}(Y_2^K)$, Country 1 will succeed in investment allurement. If the equality sets in, investor will be indifferent between both countries (incentive parity).

Figure 3.1: The general model of INIs' supply
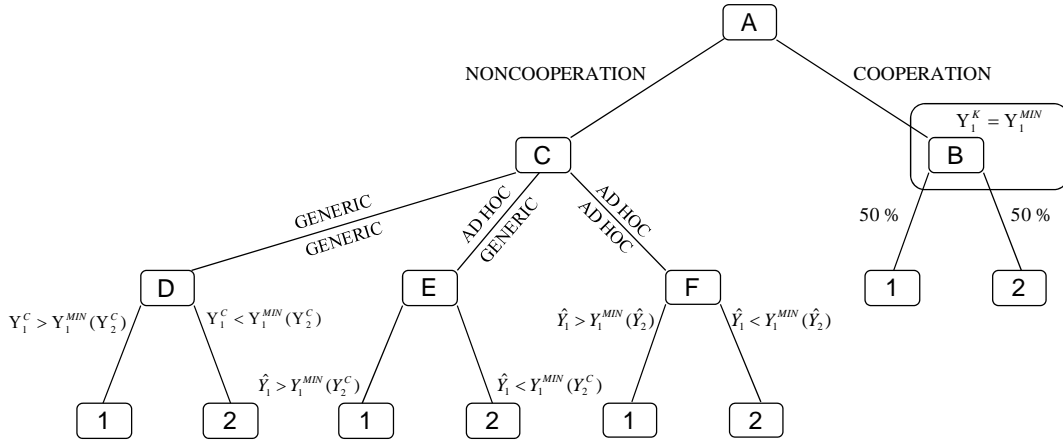
Source: author's scheme on the basis of the presented models.

Proposition 3.12 (Unsustainability). *Any collusion agreement can hold neither one round if $Y_1^K = Y_1^{MIN}(Y_2^K)$ does not stand.*

Proof. No country will willingly abandon all the chances to get FDI (if one does not think about any kind of compensation). For more long-term stability, INIs of both countries will be equal to their minimal sufficient INI.[10] $\square$

If countries do not cooperate, they will reach point C. Now each country sets whether to provide generic or *ad hoc* INIs. If both countries decide for the first possibility, they meet in point D—the situation modeled by the Cournot competition. Country 1 gains the investment if $Y_1^C > Y_1^{MIN}(Y_2^C)$.

Let Country 1 decide to offer INIs *ad hoc*, while Country 2 still uses a generic scheme (point E).

Proposition 3.13. *Expected utility of Country 1 in point E is higher or equal to its expected utility in point D.*

Proof. Country 1 has an evident strategic advantage: if $Y_1^C > Y_1^{MIN}(Y_2^C)$, it decreases Y_1 close to $Y_1^{MIN}(Y_2^C)$, but can still offer more convenient conditions to investors. The MNC then chooses Country 1 which will moreover get better, compared to the Cournot equilibrium. If $Y_1^C \leq Y_1^{MIN}(Y_2^C)$, Country 1 still has a chance of attracting the investment. It identifies such a level of provided INIs by which its total utility from transaction is equal to zero (marked as $\hat{Y}_1$) and is willing to increase Y_1 until this point and gains the investment if $\hat{Y}_1 > Y_1^{MIN}(Y_2^C)$. $\square$

---

[10]Realize that $Y_1 = Y_1^{MIN}(Y_2)$ can be valid if and only if $Y_2 = Y_2^{MIN}(Y_1)$. What is more, naturally $Y_1 > Y_1^{MIN}(Y_2)$ can hold if and only if $Y_2 < Y_2^{MIN}(Y_1)$.

The last possibility is that both countries provide INIs *ad hoc* (point F). For each country individually it is optimal to select such a Y which will slightly exceed its minimal sufficient incentive and so will attract investment with the smallest costs possible. This process of action and reaction ends right in the point where at least one country provides INIs for which $Y_i = \hat{Y}_i$. If also $\hat{Y}_i < Y_i^{MIN}(\hat{Y}_j)$, country i loses investment for the benefit of country j which will have positive utility from the whole transaction.

Proposition 3.14 (Competition efficiency). *If $Y_i = \hat{Y}_i$ as well as $\hat{Y}_i = Y_i^{MIN}(\hat{Y}_j)$ hold, perfect spillover internalization follows.*

Proof. It comes to incentive parity; the investor is indifferent between both countries and the winner has zero utility from the transaction. The benefit is fully taken away by the investor because each country bids up to the spillover value. □

Figure 3.1 also indicates that apart from the classical dilemma of cooperation-noncooperation, another problem in the decision-making field of the government can exist which can have the nature of the prisoner's dilemma. Each country hungers for being Country 1 in point E—where it has broader margin of maneuver, since the second country is not flexible. If both countries strive for this flexibility and offer INIs *ad hoc* (point F), apparently they will suffer in comparison to the situation of generic provision (point D). In general, the winner will have to offer a substantially higher incentive.[11]

Point F represents (the only pure-strategy) Nash equilibrium of the game because for none of the countries it pays off to deviate unilaterally from the strategy heading to F. It implies that we should observe FDI competition "using all weapons", i.e. escalation of supplied incentives until the last competitor fails. However, *ad hoc* application of INIs is often regulated. For example, Besley & Seabright (1999) discuss restrictions of *ad hoc* incentives in the EU.

This implies that point D can be instead of F the equilibrium for country competing inside the EU—point B is still not accessible because of the prisoner's dilemma, points E and F are inaccessible because of regulation. While in point D countries provide Cournot INIs, in point F supplied INIs are close or equal to countries' minimal sufficient INIs.

---

[11]Notice that movement from point D to point F can eventually pay off only to country i. Its Cournot level of INIs must be under the minimum sufficient INI in point D, but moreover $\hat{Y}_i > Y_i^{MIN}(\hat{Y}_j)$ must hold. Only in case when $Y_1^C = Y_1^{MIN}(Y_2^C)$ & $\hat{Y}_1 = Y_1^{MIN}(\hat{Y}_2)$, we have the pure prisoner's dilemma.

3.4   Conclusion

The main aim of this paper is to contribute to a better comprehension of the inward foreign direct investment incentives (INIs) phenomena by studying their determinants. We introduced two simple microeconomic models, each dealing with a different specification of the problem, and used them as tools for describing the foreign direct investment policy-making.

The Minimal Sufficient INI Model, based on the profit parity, is solved primarily from the point of view of a foreign investor—the government's task is only to set such a level of INIs which does not threaten its relative competitiveness with respect to a rival country. We have deduced that toward the equilibrium level of incentives, both country's corporate income tax (CIT) rate and the generosity of incentive systems of its rival countries have a principal influence. Market size plays an important part as well.

The Optimal INI Model was tackled from the point of view of a government maximizing public utility. The basis of the model lies in the application of the classical models of oligopoly (Cournot, Stackelberg) to the situation of subsidy competition. The most important conclusions include as the significance of spillovers for explanation of the optimal level of INIs, so the ambiguous influence of the corporate income tax (CIT) rate. We show that possible supranational coordination of incentives can either decrease or *increase* the supply of such subsidies, depending mainly on assumed spillover value. Thus, using a different methodology, we support the findings of Haufler & Wooton (2006).

Free competition between producers of INIs will lead to stimuli schemes of the Minimal Sufficient INI Model. On the contrary, if their supply is regulated (e.g., by prohibition of *ad hoc* incentives), the equilibrium level corresponds to the Optimal INI Model. This implies that on the background of the regulation of INIs, the host country's CIT rate does not have to represent a significant determinant of the provision of INIs.

Our results are sensitive to the assumed type of competition, which is equivalent to the usage of the Cournot model. But the framework (in a nutshell, formalizing INI as a commodity) is general enough to apply other models of oligopoly—starting, e.g., with the Bertrand model. It would not be difficult to allow for some broader differences between the studied countries (i.e., relaxing Assumption 3.10), as well as for non-linear investors' demands in the CIT rate, modifying the definition of inverse demand functions in (3.12). It is also possible to extend the analysis to more than only 2 countries. Such modifications are left for further research.

References

BARROS, P. P. & L. CABRAL (2000): "Competing for Foreign Direct Investment." *Review of International Economics* **8(2)**: pp. 360–71.

BESLEY, T. & P. SEABRIGHT (1999): "The Effects and Policy Implications of State Aids to Industry: An Economic Analysis." *Economic Policy* **14(28)**: pp. 13–53.

BJORVATN, K. & C. ECKEL (2006): "Policy Competition for Foreign Direct Investment Between Asymmetric Countries." *European Economic Review* **50(7)**: pp. 1891–1907.

BLOMSTROM, M. & A. KOKKO (2003): "The Economics of Foreign Direct Investment Incentives." *NBER Working Papers 9489*, National Bureau of Economic Research.

CHARLTON, A. (2003): "Incentive Bidding for Mobile Investment: Economic Consequences and Potential Responses." *Working Paper 203*, OECD Development Centre.

EC (2008): "Taxes in Europe Database." December 2008. Downloaded on 03/01/2009. Available at http://ec.europa.eu/taxation.

FEE (2008): "Competitive Wage Costs." February 2008. Downloaded on 03/01/2009. Available at http://www.fedee.com/payinasia.shtml.

GÖRG, H. & E. STROBL (2001): "Multinational Companies and Productivity Spillovers: A Meta-Analysis." *The Economic Journal* **111(475)**: pp. 723–739.

HAALAND, J. I. & I. WOOTON (1999): "International competition for multinational investment." *Scandinavian Journal of Economics* **101(4)**: pp. 631–49.

HAAPARANTA, P. (1996): "Competition for Foreign Direct Investment." *Journal of Public Economics* **63(1)**: pp. 141–53.

HAUFLER, A. & I. WOOTON (1999): "Country Size and Tax Competition for Foreign Direct Investment." *Journal of Public Economics* **71(1)**: pp. 121–139.

HAUFLER, A. & I. WOOTON (2006): "The Effects of Regional Tax and Subsidy Coordination on Foreign Direct Investment." *European Economic Review* **50(2)**: pp. 285–305.

HAVRÁNEK, T. & Z. IRŠOVÁ (2008): "Intra-Industry Spillovers from Inward FDI: A Meta-Regression Analysis." *Working Papers IES 2008/08*, Charles University Prague, Faculty of Social Sciences, Institute of Economic Studies.

IMF (2008): "World Economic Outlook." November 2008, downloaded on 03/01/2009. Available at http://www.imf.org/external/data.htm.

MA, J. (2007): *Double-Edged Incentive Competition for Foreign Direct Investment.* Ph.D. thesis, Peking University.

MEYER, K. E. & E. SINANI (2005): "Spillovers from Foreign Direct Investment: A Meta Analysis." *Working paper 59*, Center for East European Studies.

DA MOTTA VEIGA, P. & R. IGLESIAS (1998): "Policy Competition and Foreign Direct Investment in Brazil." *Technical report*, OECD.

NEWTON (2003): "FDI Incentives and Their Efficiency." *Macroeconomic analysis 1/2003*, NEWTON. Available at http://www.newton.cz/analyzy.

OECD (2003): "Checklist for Foreign Direct Investment Incentive Policies." *Technical report*, OECD.

OMAN, C. (2000): *Policy Competition for Foreign Direct Investment: A Study of Competition Among Governments to Attract FDI.* Paris: OECD Development Centre.

PENNINGS, E. (2001): "How to Maximize Domestic Benefits from Irreversible Foreign Investments." *Working Paper 205*, Innocenzo Gasparini Institute for Economic Research, Bocconi University.

SAOCR (2006): "Management of the State Budget Funds Spent for Providing of Investment Incentives and Investment Aids on the Basis of 'Memorandum of Understanding Declaring Common Intention'." *Technical report*, Supreme Audit Office of the Czech Republic.

SEDMIHRADSKÝ, M. (2002): "Daňové zatížení jako konkurenční faktor v mezinárodní soutěži." *Czech Journal of Economics and Finance* **52**: pp. 550–565. In Czech.

SIEH LEE, M. L. (1998): "Competing for Foreign Direct Investment: The Case of Malaysia." *Technical report*, OECD, mimeo.

UNCTAD (1996): *Incentives and Foreign Direct Investment.* New York: United Nations.

WELLS, L. T., N. ALLEN, J. MORISSET, & N. PIRNIA (2001): *Using Tax Incentives to Compete for Foreign Investment: Are They Worth the Cost?* Washington, DC: FIAS.

WOOSTER, R. B. & D. S. DIEBEL (2006): "Productivity Spillovers from Foreign Direct Investment in Developing Countries: A Meta-Regression Analysis." *Working paper series*, Available at SSRN: http://ssrn.com/abstract=898400.

Chapter 4

Subsidy Competition for FDI: Fierce or Weak?

4.1 Introduction

Although over a few recent years we might have been witnessing a stagnating interest of economic theorists in foreign direct investment incentives—and some countries seemingly saturated with foreign direct investment, e.g., the Czech Republic, have even been considering reducing the benefits for some types of foreign investors—, it is not unlikely that the ongoing economic crisis will once again bring the topic to the sunlight of international financial community's focus, as worldwide foreign direct investment (FDI) is expected to drop significantly (UNCTAD 2009). This is the reason why we believe that it is important to study not only the effectiveness of investment incentives *per se*, but (aside from the traditional macroeconomic view) also the microeconomic motivation which leads governments to use these instruments of attracting foreign investors.

There are two rich streams of empirical literature related to the present paper. The first one concerns in FDI determinants (for a review, see, e.g., Blonigen 2005), where the volume of inward FDI can be explained—among other things—by corporate income tax rates and sometimes also proxies for investment incentives. The second stream of research focuses on empirical estimation of tax competition (for instance, Devereux *et al.* 2008; Ghinamo *et al.* 2008), where countries' tax rates are influenced—aside from other factors—by FDI inflows and outflows or other countries' tax rates. However, to our knowledge, there is no empirical study concerning specifically with the determinants of foreign direct investment incentives—i.e., taking a proxy for FDI incentives as a response variable.

In this paper, we intend to empirically test the predictions of the models of subsidy competition and supply of FDI incentives recently presented in Havránek (2008) and compare it to the results of Havránek (2007), who tested older versions

of these models using very basic cross-sectional methods. The theoretical models distinguish cases of cooperation, weak competition, and fierce competition; simple hypotheses can be formulated to test for each of the scenarios separately. We are going to employ (aside from the traditional regression methods) also iteratively re-weighted least squares (Hamilton 2006) for cross-sectional data and Blundell & Bond (1998) methodology for panel data. We do not prefer any particular model, but use all the estimates obtained employing different approaches to get a more stable overall outcome.

The present paper is structured as follows: in Section 4.2, we summarize the models developed by Havránek (2008) and formulate the most important hypotheses. Section 4.3 describes the dataset that we have at our disposal and discusses variables constructed on the basis of this data. In Section 4.4, the employed econometric techniques and tests are described. Section 4.5 presents the results and a corresponding discussion. Section 4.6 concludes the paper and lists a few limitations of the used methodology.

4.2 Crucial Hypotheses

There are two—formally not entirely consistent,[1] but still easily comparable—main methodological approaches in Havránek (2008). The first one is called "Minimal sufficient investment incentive model" and predicts sharp competition between governments up to the point where one country gives up or where both countries have zero utility from attracting the foreign investor. It is based on a simple comparison of alternative profits—there are 2 countries and a monopolistic investor; the MNCs invests in the country which assures him the highest return possible and the countries try to match their attractiveness with the rival. The other one is called "Optimal investment incentive model" and does not conclude that the competition between rival countries necessarily has to be strong enough to shift all the benefits emanating from FDI spillovers to the foreign investor. This model is based on classical oligopolic theories, where investment incentive is viewed as a commodity (i.e., governments are oligopolies competing among each other). Finally, these models are integrated into a more general one.

There are several possible outcomes of the general model. Either the governments choose cooperation (which is equivalent to some sort of supranational coordination in this case—this is in fact a special case of the Optimal investment incentive model), or they both behave according to other versions of the models (the Minimal sufficient investment incentive model or the "free competition version" of the Optimal investment incentive model), or each government uses a different strategy. The situation

---

[1]The model of minimal sufficient investment incentive is dynamic, whereas the model of optimal investment incentive is static.

is depicted in Figure 3.1 in Havránek (2008). Surely, another possibility should be added: that in reality the competition does not follow any of the models developed in Havránek (2008). Thus we obtain the following set of outcome scenarios:

Scenario 1 There exists an effective supranational coordination or governments are cooperating (point B in Figure 3.1).

Scenario 2 The competition proceeds according to the "free competition version" of the Optimal investment incentive model (point D in Figure 3.1). Based on the discussion in the original paper, it can be labeled as weak competition.

Scenario 3 One country uses the Optimal investment incentive model, the other relies on the Minimal sufficient investment incentive model (point E in Figure 3.1).

Scenario 4 The competition proceeds according to the Minimal sufficient investment incentive model (point F in Figure 3.1). It can be labeled as fierce competition.

Scenario 5 None of the models described in Havránek (2008) explains subsidy competition reasonably well.

In the original paper, Scenario 3 was found to be highly improbable with respect to the other options (it is much less stable); therefore, we will not test for it. Concerning the others, there is a large number of propositions raised by Havránek (2008) that can be straightforwardly tested. First, let us concentrate on Scenario 4. This means that the Minimal sufficient investment incentive model has to be tested. The central equation for this model is

$$INI_1 = \frac{\frac{1}{ENT}\left[M(1 - CIT_2) + INI_2 \cdot CIT_2\right] - M(1 - CIT_1)}{CIT_1}, \qquad (4.1)$$

where INI_i stands for tax relief, ENT stands for the relative quality of entrepreneurial environment in Country 1 with respect to Country 2, M is duration of the investment, and τ_i is the corporate income tax (CIT) rate; see Havránek (2008) for details. The following hypotheses can be raised to support Scenario 4[2] (detailed explanations of all variables used in this study can be found in Section 4.3):

- Provision of investment incentives is a decreasing function of the quality of entrepreneurial environment (based on Proposition 3.1). $H_1 : ENT \downarrow$

- Provision of investment incentives is an increasing function of labor costs (based on Proposition 3.2). $H_2 : k \uparrow$

- If country's entrepreneurial environment is better than that of its rival, provision of investment incentives is an increasing function of the CIT rate (based on Proposition 3.3, "Strong competition"). $H_3 : ENT > 1 \Rightarrow CIT_1 \uparrow$

---

[2]The simplification behind these hypotheses is assumed linearity of the relationships.

- Provision of country's investment incentives is an increasing function of investment incentives provided by its rival (based on Proposition 3.4, "Regime competition"). $H_4 : INI_2 \uparrow$

The hypotheses for Scenario 4 can be summarized as follows:

$$INI_1 = f(\overbrace{ENT,}^{-} \overbrace{k,}^{+} \underbrace{CIT_1,}_{+ \, if \, ENT > 1} \overbrace{INI_2}^{+}). \qquad (4.2)$$

Three of the hypotheses are unconditioned, one is conditioned—it will be tested on a subsample of countries for which the condition applies. We simplified the concept of entrepreneurial environment (ENT) in the model to n/k (details are to be found in Section 4.3). Concerning Scenario 2, the Optimal investment incentive model (to be more specific, its "free competition version") is used. The central equation of the model is

$$
\begin{aligned}
INI_1 = {} & \frac{SPILL(2\gamma_2 - \delta_1) + CIT_1(2\alpha_1\gamma_2 + \delta_1\beta_2 - 2\gamma_2 I^0 \cdot RET)}{4\gamma_1\gamma_2 - \delta_1\delta_2} \\
& - \frac{CIT_2(2\beta_1\gamma_2 + \alpha_2\delta_1 - \delta_1 I^0 \cdot RET)}{4\gamma_1\gamma_2 - \delta_1\delta_2},
\end{aligned}
\qquad (4.3)
$$

where INI_i stands for investment incentives, $SPILL$ stands for spillovers, RET return on investments, CIT for the corporate income tax rate, and the rest are demand parameters. The corresponding hypotheses are the following:

- Provision of investment incentives is an increasing function of FDI spillovers (based on Proposition 3.6). $H_5 : SPILL \uparrow$

- The CIT rate has an ambiguous effect on the provision of investment incentives. However, if the influence of country's own CIT rate is negative, the influence of its rival's CIT tends to be positive, and *vice versa* (based on Proposition 3.8). $H_6 : CIT_1 \uparrow \Leftrightarrow CIT_2 \downarrow, \; CIT_1 \downarrow \Leftrightarrow CIT_2 \uparrow$

- If country's CIT rate exceeds at least one half of its rival country's CIT rate, then the provision of investment incentives is a decreasing function of the return on investments (based on Proposition 3.7). $H_7 : CIT_1 > \frac{1}{2} CIT_2 \; \Rightarrow RET \downarrow$

The hypotheses for Scenario 2 can be summarized as follows:

$$INI_1 = f(\overbrace{SPILL,}^{+} \underbrace{RET,}_{- \, if \, CIT_1 > \frac{1}{2} CIT_2} \overbrace{CIT_1,}^{opposite \, to \, CIT_2} \underbrace{CIT_2}_{opposite \, to \, CIT_1}). \qquad (4.4)$$

Let us turn our attention to Scenario 1. This is a special case of the Optimal investment incentive model, labeled as "supranational coordination". The central

equation of the model is

$$INI_1 = \frac{SPILL(2\gamma_2 - \delta_1 - \delta_2) + CIT_1 \left[2\gamma_2(\alpha_1 - I^0 \cdot RET) + \beta_2(\delta_1 + \delta_2)\right]}{4\gamma_1\gamma_2 - (\delta_1 + \delta_2)^2}$$
$$- \frac{CIT_2 \left[2\beta_1\gamma_2 + (\delta_1 + \delta_2)(\alpha_2 - I^0 \cdot RET)\right]}{4\gamma_1\gamma_2 - (\delta_1 + \delta_2)^2}. \tag{4.5}$$

The hypotheses are the same as for Scenario 2, with the exception of the last one which now changes to the following statement:

- If country's CIT rate exceeds its rival country's CIT rate, then the provision of investment incentives is a decreasing function of the return on investments (based on Proposition 3.11). $H_8 : CIT_1 > CIT_2 \Rightarrow RET \downarrow$

The hypotheses for Scenario 1 can be summarized as follows:

$$INI_1 = f(\overbrace{SPILL,}^{+} \underbrace{RET,}_{-\ if\ CIT_1 > CIT_2} \overbrace{CIT_1,}^{opposite\ to\ CIT_2} \underbrace{CIT_2}_{opposite\ to\ CIT_1}). \tag{4.6}$$

It is apparent that the hypotheses behind Scenario 1 and Scenario 2 are very similar and that it will be difficult to distinguish between the two cases.[3] Nevertheless, we believe that it is still meaningful to consider these two scenarios separately. Finally, the hypothesis consistent with Scenario 5 is simple:

- No other scenario can be supported, which would be the case if our findings did not support (or did even reject) majority of hypotheses for any of the 3 other scenarios, or if the resulting support for hypotheses was in logical contradiction (for instance, if H_8 was supported and H_7 was not).

4.3 Data and Variables Description

One reason why there probably has not been any study estimating determinants of the provision of investment incentives is that it is very difficult to obtain some reliable data on the subject. Not surprisingly, most governments do not publish data on how much money they provided to foreign investors—the field seems to be quite competitive. And even if they did with good faith, it would still be questionable, since there are many forms of government support that cannot be directly quantified. Governments can simply provide cash to the investors, but they can also offer fuzzier fiscal incentives, lower tax rates for MNC's employees, infrastructure construction, temporary wage subsidies, administrative help, easing of environmental or labor-market related requirements, and so forth (see, *inter alia*, OECD 2003).

---

[3]H_8 is in fact a stronger version of H_7, thus the theory would suggest that if Scenario 1 is supported, Scenario 2 should be technically supported as well. Of course, in such a case, Scenario 1 would be selected as the "proper" outcome.

Being aware of the fact that there are—at least to our knowledge—no hard data on the variable we are most interested in, we have to choose an alternative methodology. In the World Competitiveness Yearbook, attractiveness of investment incentive systems in many countries is evaluated every year. The evaluation has the form of research survey; i.e., investors are asked which incentive systems they find more attractive and which less. The scale is 0–10, 0 for lowest attractiveness, 10 for the best incentives. It has to be admitted that this is not an ideal measure of investment incentives, nevertheless it is probably the best available one and should, in our opinion, approximate the "real" variable even better than some hypothetical official data provided by governments.

We use the World Competitiveness Online database with time span 1997–2006 as the source of our data (with the exception of variable *ENT* which was obtained from World Banks' World Development Indicators). There are 61 cross-sectional units in the dataset, but some of them are provinces of countries already included in the dataset (Bavaria, Catalonia, Île-de-France, Lombardy, Maharashtra, Sao Paulo, Scotland, Zhejiang), hence we will exclude them from our dataset, since we have data on their mother countries at our disposal. World Competitiveness data are also strongly unbalanced and we have to exclude Bulgaria, Croatia, Estonia, Jordan, Luxembourg, Romania, Slovakia, Slovenia, Venezuela, and year 2006 to get a (strongly) balanced panel.[4] Finally, we are left with 44 countries observed during 1997–2005.

The explanatory variables needed for tests of the hypotheses raised in Section 4.2 are the following (the shortcuts that we use later in the regression model are typeset in sans serif):

k The relative price of labor power in the original model. However, it is useful to adjust it for different labor productivity in rival countries. Therefore, the definition we use here is

$$k_{it} = \frac{PROD_{it}^{RIV}/WAGES_{it}^{RIV}}{PROD_{it}/WAGES_{it}}, \tag{4.7}$$

where $PROD_{it}$ is labor productivity (GDP in USD at PPP per person employed per hour) for country i and year t, $WAGES_{it}$ stands for labor costs (wages + supplementary benefits, USD) in country i and year t, and the other variables correspond to the rival country. The higher k is, the less competitive our country becomes with respect to the rival country and *vice versa*.

SPILL The value of spillovers that country receives from foreign direct investment in the original model. This is the most problematic variable to measure (even more than investment incentives), since there is not even a consensus upon whether

---

[4]Data on those countries from this source are so incomplete that they cannot be used for any reasonable panel study.

productivity spillovers from FDI are positive and/or significant (see, *inter alia*, Havránek & Iršová 2008).[5] Nevertheless, there are theoretical approaches to measure the *absorption capacity* of economies with respect to FDI spillovers. For example, we can use a measure that could be called "macro-level technology gap":

$$TGAP_{it} = \frac{PROD_t^{MAX} - PROD_{it}}{PROD_t^{MAX}}, \tag{4.8}$$

which is based roughly on Kokko (1994) (here defined at the macro level, however; much more about technology gap can be found in Sjöholm 1999). $PROD_{it}$ stands for labor productivity in country i and year t, $PROD_t^{MAX}$ for the highest labor productivity in the sample for year t. The standard hypothesis is that broader technology gap prevents the economy from receiving FDI spillovers (thus we can use $-TGAP$ in our model as a measure of positive spillovers). Another way—and that is what we focus on—can be to rely on the knowledge adoption concept. In this paper, we apply the knowledge adoption function used by Papageorgiou (2002).[6] The function is described by (4.9) and depicted in Figure 4.1.

$$SPILL_{it} = \max\left\{0, \left[(1+b)\frac{PROD_t^{MAX}}{PROD_{it}} - \left(\frac{PROD_t^{MAX}}{PROD_{it}}\right)^2 - b\right]\right\}. \tag{4.9}$$

Figure 4.1: Assumed mechanism of spillover adoption
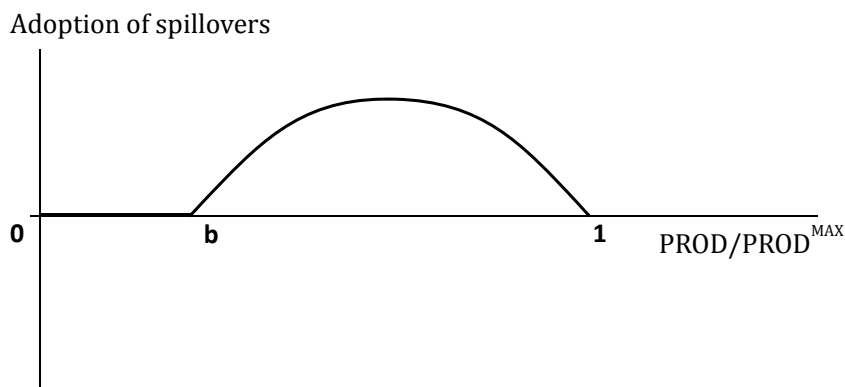
It should be noted that Papageorgiou (2002) does not deal with FDI spillovers directly in his paper; he employs a general knowledge/technology adoption concept. We use this function because we believe that it could describe the absorption capacity of economies reasonably well. Significantly undeveloped countries have no or very limited possibility to enjoy productivity spillovers

---

[5]In this paper, we consider only positive FDI spillovers.

[6]This can become a subject of criticism since the function is defined *ad hoc*, without any elaborate underlying theory. However, we believe that the intuition in this case is reasonable enough.

from foreign investments, because the technological difference between investors and domestic firms are too large to be overcome *ceteris paribus*. The coefficient b determines how productive (relatively to the most productive country in the sample) a country has to be to begin exploiting FDI spillovers. We consider 2 different values of b, specifically 0.25 (forming variable $SPILLA$) and 0.5 (variable $SPILLB$).

ENT Relative quality of entrepreneurial environment. In the original model, it is a rather complex formula covering market size, labor costs, transaction costs, and demand parameters. For the purpose of this paper, we decided to simplify the formula to n/k, where n stands for the relative size of country's market (the country has n-times higher GDP in terms of purchasing power parity than its rival), and k for the relative price of labor (adjusted for different labor productivity, see above). If n/k exceeds 1, we conclude that country's entrepreneurial environment is better than that of its rival.[7] This approximately covers the idea of "entrepreneurial environment" in Havránek (2008).

CIT_1 Statutory corporate income tax in the country.

CIT_2 Statutory corporate income tax in the rival country.

RET Rate of return on investment. The assumption in the original model (rather restrictive) is that the country and its competitor have the same rate of return on investments. In our case, that would mean the same rate of return for all the countries (countries do not necessarily create "competing pairs", one country can be the rival for many others, see the concept of rival country below), but then it would not be meaningful to include rate of return into the regression since we would have only observations from 9 years at our disposal. Therefore, we decided to split the sample into 3 parts according to the geographical position of the countries—the Americas, Europe (+ Middle East), and Asia (+ Oceania). Variable RET for each country is then driven by real interest rate of the leading financial power of the group: USA for the Americas, Germany for Europe, and Japan for Asia. Because in almost all cases countries compete within these groups, the model's assumption is not violated in principal.

INI_1 Foreign direct investment incentives in the country.

INI_2 Foreign direct investment incentives in the rival country.

Rival country   When constructing the variables, one of the most important concepts was the definition of "rival country". Probably the easiest and most intuitive way

---

[7]The term "entrepreneurial environment" is only a label used by Havránek (2008) to refer to the aforementioned formula, not the other way round.

is to combine the geographic and cost perspectives. Let us imagine, for instance, an automobile manufacturer planning its investment in central Europe. It certainly considers the cost and productivity of labor (the higher $PROD/WAGES$, the better), but it also highly values proximity to its main markets—logistics plays a significant role (not only) in the auto industry. Thus we can often witness two neighboring countries, similar in productivity and labor costs, competing for an investment.

Based on this example, we constructed the following mechanism: preferably, the rival country to country i should be one of its neighbors. Among them, the one with ratio $PROD/WAGES$ closest to that of country i is chosen. If there is no neighbor of country i in our sample or if country i is an island, we choose from the group of 3 countries that are closest to its shore. Generally, the result of this algorithm might vary each year for a particular country. We made the simplification of computing the result only for year 2005 and holding the rival country constant through time span 1997–2005.

Control variables In the World Competitiveness Online database, there are other variables that could significantly influence the level of provided investment incentives as well. We concentrated on the following 5 of them:

FDI Total stock of inward FDI divided by total GDP (PPP). The hypothesis we raise is that country saturated with FDI is less willing to provide substantial incentives to foreign investors. $H_9 : FDI \downarrow$

RISK Defined as the risk of relocation of production facilities from the country. It can be assumed that the higher risk of relocation the government feels, the higher incentives it is willing to provide to foreign investors. $H_{10} : RISK \uparrow$

CLEG Efficiency of competition legislation in preventing unfair competition. The hypothesis is that countries with poor legislation have to provide much higher incentives to foreign investors as an offset. $H_{11} : CLEG \downarrow$

BUDGET Country's budget surplus/deficit. The hypothesis is that countries with substantial budget deficits are not able or willing to provide high investment incentives. $H_{12} : BUDGET \uparrow$[8]

GDPG Real GDP growth in the country. We expect that countries experiencing fast GDP growth do not need FDI as much as countries with sluggish growth, hence they will also not desire to provide high investment incentives. $H_{13} : GDPG \downarrow$

---

[8]On the other hand—if greenfield investments account for only a small portion of total (potential) FDI inflow, it might be tempting for indebted governments to provide incentives to foreign investors that are willing to buy privatized companies, and thus bring quick cash.

4.4 Methods of Estimation

In an attempt to test the hypotheses introduced in Section 4.2, we construct a linear regression model. We use both cross-sectional techniques for 2005 and panel data approaches for the whole time span 1997–2005. First, it appears that variables *BUDGET* and *GDPG* do not bring any value added to explaining variance in *INI1* in any of the specifications that we employ. Since we only intended to use them as control variables and they are not important for the testing of our main hypotheses, we exclude them from the regression. Therefore, the model reduces to

$$INI1_{it} = \alpha + \beta_1 k_{it} + \beta_2 SPILLA_{it} + \beta_3 ENT_{it}$$
$$+ \beta_4 CIT1_{it} + \beta_5 CIT2_{it} + \beta_6 RET_{it} + \beta_7 INI2_{it}$$
$$+ \beta_8 FDI_{it} + \beta_9 RISK_{it} + \beta_{10} CLEG_{it} + \epsilon_{it}, \tag{4.10}$$

where we have $i = 1, \ldots, 44$; $t = 1997, \ldots, 2005$.

Acronyms of all used variables can be found in Table 4.7 in the Appendix to the present chapter (Section 4.A) and their detailed description in Section 4.3. The specification introduced in (4.10) will be called *complete*. The *pure* specification will label the situation when we exclude all 3 control variables (*FDI*, *RISK*, *CLEG*) from the model and keep only those regressors that we need to test the hypotheses from Section 4.2. The *best* specification will be unique for each method of estimation and will be formed in such a way that the resulting model includes as many significant explanatory variables as possible.[9] Some of our hypotheses are conditioned; therefore, we need to define the conditions we are using:

Condition 1 $ENT > 1$

Condition 2 $CIT1 > \frac{1}{2} CIT2$

Condition 3 $CIT1 > CIT2$

Apart from *SPILLA*, we will also try to use alternative measures for spillovers, namely *SPILLB* and *TGAP*. It should be noted that *TGAP* is a measure for *negative* spillovers, since the theory suggests that the higher technology gap, the lower opportunities for domestic firms to benefit from inward foreign direct investment. As a consequence, we should observe opposite signs of the estimates for *SPILLA* (or *SPILLB*) and *TGAP*. The alternative measures will be applied to the *complete* model and if the model shows higher performance, these alternatives will be used in other specifications as well.

---

[9]The *best* specification is not crucial for our later discussion. Its purpose is to extract the closest-as-possible empirical match for the response variable; it can be also viewed as a robustness check (abrupt changes of polarities or significances might suggest problems with the *complete* specification).

Cross-sectional methods   We start with the year 2005 and standard cross-sectional approaches, beginning with OLS. We have 44 observations at our disposal; all computations were conducted in Stata 10. The data as well as the source code can be found on the enclosed DVD (Appendix B) and the thesis website. First, let us focus on the problem of collinearity. Table 4.8 in the Appendix to this chapter shows correlation coefficients between explanatory variables. None of them exceeds 0.5, which is a safe value. The condition number of the *complete* model reaches 43.8, which is above the usual threshold of 30—nonetheless, it is not drastically excessive and in other specifications falls well below 30 (24.5 for the *best* model).

Table 4.1: Linear and non-linear relationships

Variable	Linear	Polynomial
Relative price of labor	0.12	0.45
Spillover absorption capacity ($b = 0.25$)	0.21	0.49
Quality of entrepreneurial environment	0.14	0.45
Corporate income tax	0.34	0.59
Rival's corporate income tax	0.24	0.50
Return on investment	0.15	0.35
Rival's investment incentives	0.28	0.52
FDI stock on GDP	0.38	0.69
Risk of relocation	0.10	0.37
Efficiency of competition legislation	0.27	0.66

Considering possible non-linear relationships, we use the Weierstrass Approximation Theorem (see Víšek 1997, p. 71) and estimate J following regressions (we regress powers of explanatory variables of (4.10) on each other; $t = 2005$):

$$X_{im} = \alpha + \sum_{j=1}^{J} \sum_{p=1}^{P} \beta_{jp} X_{ij}^{p} + \vartheta_i, \quad i = 1, \ldots, N, \quad m = 1, \ldots, J, \quad m \neq j. \quad (4.11)$$

We computed (4.11) with $J = 10$ and $P = 6$, the coefficients of determination of such regressions are listed in Table 4.1 together with what is usually called linear redundancy (i.e., with $P = 1$). Most of the values oscillates around 0.5, the highest number is 0.69, which is also not excessive—thus we can conclude that, although there is some increase compared to linear redundancy, non-linear dependencies among explanatory variables should not represent a significant problem in our regressions.

To deal with possible heteroscedasticity of disturbances, we employ heteroscedasticity robust standard errors computed with the Huber-White sandwich estimator, see Huber (1967) and White (1980). In order to test for normality of disturbances of the *complete* model, we use the Shapiro-Wilk test, which unfortunately rejects the null hypothesis at the 5% level. We tried to employ several transformations, but the result did not change significantly. Ramsey RESET test (which tests for

Table 4.2: Ordinary least squares, 2005

	Complete	Spillb	Tgap	Cond. 1	Cond. 2	Cond. 3	Best	Pure
k	0.763	0.688	0.664	−0.515	0.792	3.539	0.838†	1.316†
	(1.37)	(1.23)	(1.20)	(−0.26)	(1.41)	(1.43)	(1.72)	(2.00)
spilla	−3.820			−11.19	−2.145	−4.924	−3.793	−0.255
	(−1.21)			(−1.62)	(−0.67)	(−0.91)	(−1.25)	(−0.08)
ent	0.0126	0.0227	0.0243	0.0946	0.0140	0.0342		0.0228
	(0.23)	(0.42)	(0.42)	(0.52)	(0.26)	(0.26)		(0.34)
cit1	−0.0536*	−0.0496†	−0.0550*	−0.0176	−0.0401	−0.0719	−0.0531*	−0.0790**
	(−2.32)	(−1.89)	(−2.12)	(−0.24)	(−1.69)	(−0.75)	(−2.57)	(−2.72)
cit2	−0.00309	0.000475	0.00275	−0.0326	0.00168	0.0277		−0.000539
	(−0.09)	(0.01)	(0.08)	(−0.28)	(0.05)	(0.36)		(−0.02)
ret	0.395	0.346	0.139	1.559	0.552	−1.069		−0.0146
	(0.41)	(0.34)	(0.15)	(0.57)	(0.58)	(−1.02)		(−0.01)
ini2	0.0493	0.0350	0.0457	0.147	0.0594	−0.168		−0.200
	(0.22)	(0.16)	(0.20)	(0.18)	(0.28)	(−0.42)		(−0.91)
fdi	0.700*	0.715*	0.736†	1.759	0.572*	−0.533	0.710*	
	(2.36)	(2.05)	(1.96)	(0.34)	(2.27)	(−0.22)	(2.64)	
risk	−0.293*	−0.302*	−0.278†	−0.579	−0.339*	−0.304	−0.258*	
	(−2.26)	(−2.28)	(−2.03)	(−0.93)	(−2.66)	(−0.42)	(−2.28)	
cleg	0.358†	0.328†	0.360†	0.368	0.322	−0.174	0.330*	
	(1.91)	(1.73)	(1.83)	(0.44)	(1.68)	(−0.63)	(2.22)	
spillb		−4.615						
		(−0.65)						
tgap			0.547					
			(0.76)					
Constant	1.973	1.984	2.278	−3.091	0.699	8.638	3.691**	8.164*
	(0.46)	(0.46)	(0.53)	(−0.18)	(0.17)	(1.76)	(3.83)	(2.29)
Observations	44	44	44	17	43	16	44	44
R^2	0.492	0.476	0.476	0.526	0.462	0.769	0.485	0.285

t statistics in parentheses

Note: Computed using heteroscedasticity robust (Huber-White sandwich est.) t statistics

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table 4.3: Iteratively re-weighted least squares, 2005

	Complete	Spillb	Tgap	Cond. 1	Cond. 2	Cond. 3	Best	Pure
k	0.375	0.449	0.286	−0.613	0.446	0.295		1.311†
	(0.64)	(0.74)	(0.50)	(−0.25)	(0.79)	(0.11)		(1.95)
spilla	−4.534			−12.02	−2.728	−46.31†		−0.107
	(−1.39)			(−1.16)	(−0.82)	(−2.28)		(−0.03)
ent	0.000261	0.0109	0.0118	0.0914	0.00297	−0.206		0.0190
	(0.00)	(0.19)	(0.21)	(0.51)	(0.05)	(−2.06)		(0.29)
cit1	−0.0469†	−0.0426	−0.0407	−0.0174	−0.0341	0.470	−0.0483†	−0.0742*
	(−1.71)	(−1.40)	(−1.49)	(−0.17)	(−1.23)	(2.01)	(−1.80)	(−2.46)
cit2	0.0259	0.0188	0.0348	−0.0400	0.0291	−0.328		0.00624
	(0.94)	(0.66)	(1.27)	(−0.28)	(1.09)	(−2.10)		(0.19)
ret	0.881	0.707	0.598	1.346	0.933	−9.024†		−0.0394
	(1.02)	(0.77)	(0.61)	(0.40)	(1.11)	(−2.24)		(−0.04)
imi2	0.222	0.150	0.236	0.119	0.216	−1.373*		−0.159
	(1.10)	(0.71)	(1.17)	(0.13)	(1.11)	(−2.78)		(−0.77)
fdi	0.672	0.677	0.738	1.568	0.567	7.900	0.711†	
	(1.60)	(1.50)	(1.66)	(0.27)	(1.38)	(1.62)	(1.77)	
risk	−0.245	−0.274	−0.231	−0.556	−0.291†	0.0177	−0.278†	
	(−1.48)	(−1.58)	(−1.34)	(−0.69)	(−1.79)	(0.07)	(−1.89)	
cleg	0.483**	0.404*	0.501*	0.393	0.427*	−0.506	0.317*	
	(2.92)	(2.35)	(2.69)	(0.48)	(2.65)	(−2.13)	(2.34)	
spillb		−4.315						
		(−0.58)						
tgap			0.832					
			(0.96)					
Constant	−1.817	−0.721	−2.155	−1.808	−2.537	42.40†	4.040**	7.662†
	(−0.47)	(−0.18)	(−0.55)	(−0.09)	(−0.66)	(2.59)	(3.38)	(1.95)
Observations	44	44	44	17	43	15	44	44
R^2	0.477	0.436	0.457	0.417	0.447	0.956	0.394	0.234

t statistics in parentheses
† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

omitted variables and can be also interpreted as a test of linearity) does not reject the null hypothesis of no omitted variables at the 5% level. These tests provide us with identic results in the case of the *best* model as well.

The results of OLS estimation can be found in Table 4.2. One the one hand, the coefficient of determination oscillates around 0.5, which is not a small number considering the nature of the data. On the other hand, there are only few significant explanatory variables. The *best* model was obtained by gradual excluding the most insignificant explanatory variables until further exclusions would lower the number of significant (at the 10% level) regressors. It should be also noted that applying Condition 1 and Condition 3, we obtain only 17 (and 16, respectively) observations we can use—this does not give us enough degrees of freedom to take these regressions very seriously. Conversely, Condition 2 is much less restrictive and leaves 43 observations for the regression.

Until now, we did not discuss data contamination, and OLS was performed using all observations as a benchmark case. Now let us focus on a robust method—iteratively re-weighted least squares (IRLS). Details about this estimator can be found for example in Hamilton (2006, pp. 239–256). It can be explained easily in the following way: first, OLS is estimated and we exclude observations with Cook's distance higher than 1. Then we calculate weights using a Huber function—it assigns lower weights to observations with large residuals. We perform weighted least squares and after a few iterations, we shift the weight function to a Tukey biweight function tuned for 95% Gaussian efficiency. For estimating standard errors and testing hypotheses, IRLS uses a pseudovalues method that does not assume normality.

Estimates with the help of IRLS are summarized in Table 4.3. Results are quite different from OLS, that is why we suspect there can be influential outliers in the data and decide to rely more on IRLS.

Panel data techniques Now let us turn our attention to the whole period 1997–2005. First, we perform a test of poolability using a variant of the Chow test with fixed effects as the null hypothesis. The test of poolability is important, because fixed effects also impose restrictions on the structure of the model, and it is not sufficient to employ only Hausman test to choose between fixed effects and random effects (see Baltagi 2005, p. 19). The Chow test does not reject the null hypothesis at the 5% level; therefore, pooling of our data does not seem unreasonable. Then we employ the Hausman test to determine whether or not it would be more appropriate to use the random effects model instead of fixed effects. The resulting test statistic is 53.4, thus the null hypothesis is rejected powerfully—we should use the fixed effects estimator.

We would like to identify at least the most influential outliers in our data, thus we choose the following approach: pooled OLS is performed and Cook's distance and residuals computed for each observation. In the next step, we order observations

according to the absolute value of residuals and Cook's distance. It is apparent that especially values for Russia and Hong Kong (both Cook's distance and residuals) are very excessive for most of the years; therefore, we label these two groups of observations as possible outliers. There are (at least) 2 problems with this approach: firstly, there is the so-called masking effect (Bramati & Croux 2007), which means that outliers can affect the non-robust estimator in such a way that any diagnostic based on this estimator is not capable of detecting them. Secondly, we identified the outliers on the basis of pooled OLS, but we are going to employ the fixed effects model. Certainly one can find many proposed robust estimators for fixed effects, for example in Bramati & Croux (2007), but these are still not widely used. Hence we will simply compare the result of our model with "outliers" specified above to a specification without them and choose the one with better performance.

Comparing the results of fixed effects estimates with and without spillovers, we conclude that the specifications without spillovers are preferable (the models have much more significant explanatory variables and also coefficients of determination are usually higher). We present the results of fixed effects without outliers in Table 4.4 and leave specifications with all observations for the Appendix to the present chapter (Table 4.9, Section 4.A). We can see that, compared to cross-sectional estimators in 2005, much more explanatory variables are significant now. We have a sufficient number of degrees of freedom to test more reliably also our hypotheses connected to Condition 1 and Condition 3.[10]

The performance of the model could increase significantly if we added a lagged value of the response variable to the set of explanatory variables. We cannot estimate such a model using ordinary fixed effects, though. By construction, unobserved panel-level effects are correlated with the lag of explanatory variable, which makes the standard fixed effects estimator inconsistent. Taking this into account, we could use the estimator developed by Arellano & Bond (1991), which is based on general method of moments. But as Blundell & Bond (1998) note, the Arellano & Bond (1991) estimator can produce misleading results in some cases (e.g., if the autoregressive parameter is large). Therefore, we will employ a more "robust" estimator developed by Blundell & Bond (1998), who build on Arellano & Bover (1995).

Because *SPILLA* was not found to be significant in the *complete* model whilst *SPILLB* was, the rest of the specifications (with the exception of the *best* specification, naturally) was computed using *SPILLB* instead of *SPILLA*. When we compare the specifications with all observations with the ones without outliers, it seems that the models with all observations perform better. Their results can be found in Table 4.5—now majority of regressors are significant. The specifications without outliers are left for the Appendix to this chapter (see Table 4.10, Section 4.A). As

---

[10]Application of these conditions will introduce slight unbalancedness to the corresponding specifications, but it should not be systematic.

Table 4.4: Fixed effects estimator, 1997–2005, "outliers" excluded

	Complete	Spillb	Tgap	Cond. 1	Cond. 2	Cond. 3	Best	Pure
k	0.460*	0.531*	0.554*	0.0569	0.456*	1.111*	0.474*	0.505†
	(2.05)	(2.38)	(2.49)	(0.16)	(2.02)	(2.37)	(2.15)	(1.87)
spilla	5.104*			11.58**	5.366*	0.500	5.241*	9.168**
	(2.12)			(2.76)	(2.14)	(0.11)	(2.21)	(3.20)
ent	0.179**	0.186**	0.184**	0.139*	0.178**	0.219	0.183**	0.285**
	(3.09)	(3.19)	(3.17)	(2.25)	(3.07)	(1.33)	(3.24)	(4.17)
cit1	−0.00585	−0.00554	−0.00360	0.0265	−0.00420	−0.0184		−0.00598
	(−0.51)	(−0.48)	(−0.31)	(1.59)	(−0.34)	(−1.03)		(−0.45)
cit2	−0.00155	−0.00351	−0.00441	0.0164	−0.00164	−0.0357		−0.0162
	(−0.15)	(−0.33)	(−0.41)	(1.04)	(−0.15)	(−1.46)		(−1.28)
ret	0.0444†	0.0414	0.0366	0.150**	0.0435†	0.0858†	0.0406†	0.0182
	(1.72)	(1.59)	(1.40)	(3.73)	(1.67)	(1.80)	(1.73)	(0.62)
imi2	0.0301	0.0375	0.0409	0.117†	0.0318	0.0779		0.0156
	(0.64)	(0.80)	(0.87)	(1.73)	(0.67)	(0.94)		(0.28)
fdi	0.813*	0.863*	0.887*	1.696†	0.786*	1.663*	0.849*	
	(2.32)	(2.45)	(2.51)	(1.87)	(2.17)	(2.11)	(2.57)	
risk	−0.335**	−0.345**	−0.350**	−0.303**	−0.335**	−0.324**	−0.334**	
	(−7.59)	(−7.78)	(−7.97)	(−4.76)	(−7.55)	(−4.14)	(−7.61)	
cleg	0.512**	0.516**	0.509**	0.560**	0.514**	0.699**	0.515**	
	(7.00)	(7.00)	(6.89)	(4.90)	(6.97)	(6.14)	(7.07)	
spillb		2.423						
		(0.58)						
tgap			−0.836					
			(−0.83)					
Constant	0.0626	0.233	0.614	−2.876*	−0.0333	−0.537	−0.0289	4.926**
	(0.08)	(0.28)	(0.66)	(−2.25)	(−0.04)	(−0.35)	(−0.05)	(6.46)
Observations	378	378	378	160	375	157	378	378
R^2	0.384	0.376	0.376	0.532	0.382	0.486	0.382	0.094

t statistics in parentheses

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table 4.5: Blundell-Bond estimator, 1997–2005, all observations

	Complete	Spillb	Tgap	Cond. 1	Cond. 2	Cond. 3	Best	Pure
L.imi1	0.516**	0.456**	0.441**	0.467**	0.464**	0.260**	0.463**	0.609**
	(6.08)	(5.52)	(5.21)	(4.07)	(5.69)	(3.22)	(5.73)	(7.00)
k	1.125**	0.958**	0.948**	−0.0289	0.918**	2.163**	0.969**	0.772*
	(3.45)	(3.02)	(2.99)	(−0.05)	(2.80)	(5.31)	(3.05)	(2.15)
spilla	−2.808							
	(−0.98)							
ent	0.162†	0.141†	0.158†	−0.00673	0.117	0.0296	0.140†	0.0614
	(1.78)	(1.69)	(1.93)	(−0.07)	(1.42)	(0.58)	(1.70)	(0.67)
cit1	−0.0402*	−0.0329†	−0.0380*	−0.0595*	−0.0288	−0.0614*	−0.0312†	−0.0162
	(−2.17)	(−1.83)	(−2.16)	(−2.11)	(−1.54)	(−2.50)	(−1.86)	(−0.83)
cit2	0.00907	0.00744	−0.000524	0.0181	0.0138	−0.00846		−0.0129
	(0.53)	(0.45)	(−0.03)	(0.60)	(0.83)	(−0.38)		(−0.74)
ret	0.0759†	0.0651†	0.106**	0.123†	0.0858*	0.0935	0.0698*	0.0840*
	(1.88)	(1.70)	(2.76)	(1.76)	(2.13)	(1.54)	(1.98)	(2.01)
ini2	0.173**	0.145*	0.148*	0.00508	0.167**	0.254**	0.142*	0.150*
	(2.67)	(2.31)	(2.38)	(0.05)	(2.58)	(3.47)	(2.30)	(2.12)
fdi	0.130	0.0458	0.255	−0.353	0.584	1.482		
	(0.35)	(0.13)	(0.72)	(−0.24)	(1.04)	(1.63)		
risk	−0.162**	−0.184**	−0.189**	−0.161†	−0.200**	−0.0681	−0.182**	
	(−2.78)	(−3.26)	(−3.34)	(−1.83)	(−3.37)	(−0.88)	(−3.24)	
cleg	0.274**	0.294**	0.280**	0.135	0.288**	0.399**	0.284**	
	(3.08)	(3.42)	(3.29)	(0.88)	(3.18)	(3.39)	(3.40)	
spillb		−17.59**		−4.196	−17.13**	−17.63**	−17.58**	−12.50*
		(−3.43)		(−0.47)	(−3.21)	(−2.80)	(−3.42)	(−2.18)
tgap			2.372**					
			(3.06)					
Constant	−1.010	−0.382	−1.536	2.665	−1.092	0.275	−0.160	1.500
	(−0.74)	(−0.30)	(−1.24)	(1.40)	(−0.80)	(0.24)	(−0.16)	(1.32)
Observations	352	352	352	142	342	145	352	352

t statistics in parentheses
† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

a benchmark, we also computed the models using the older Arellano & Bond (1991) estimator (Table 4.11 in Section 4.A).

4.5 Discussion of Results

In Section 4.4, we employed various econometric techniques to get more stable overall results. Most of the hypotheses from Section 4.2 and Section 4.3 are very easy to test (including $H_1, H_2, H_4, H_5, H_9, H_{10}, H_{11}$). Simple t-tests—or their alternatives in the case of non-OLS regressions—are applied on the *complete* model. If the estimate of the coefficient of the variable in question is found to be significant and in line with our hypothesis, we say that the particular method of estimation *supports* the hypothesis (of course, that does not mean that we would accept the hypothesis). If the estimate is found to be significant but in contrast to the hypothesis, we say that the hypothesis is *rejected*. If the estimate is not significant, then we cannot support nor reject the hypothesis, thus we say it is *not rejected* and the test is inconclusive. If the estimate is not significant in the *complete* model, we first look at the *best* and *pure* specifications. When it gains significance in one of them, we use that particular specification.[11]

However, some of the hypotheses are conditioned (including H_3, H_6, H_7, H_8). H_6 is a special case; we say that it is supported when at least one of the explanatory variables CIT_1 and CIT_2 is significant, their estimated signs are opposite, and the hypothesis $\gamma_1 + \gamma_2 = 0$, where the gammas are the respective regression coefficients, cannot be rejected at the 10% level of significance. H_3, H_7 and H_8 are tested on subsamples of observations satisfying Condition 1, Condition 2, and Condition 3, respectively.

We tried different definitions of spillovers ($SPILLA$, $SPILLB$, $TGAP$). The estimated coefficient was rarely found to be significant; never in the case of $TGAP$. Nonetheless, the estimated signs of $SPILLA$ (or $SPILLB$) and $TGAP$ differ in all cases, which is quite logical. What is not in line with the theory, however, is that—for example, using the Blundell-Bond estimator—the estimated coefficient for $SPILLB$ is negatively significant.

The results are summarized in Table 4.6. It is apparent that, in the case of OLS, the tests are mostly inconclusive. There are more significant outcomes for IRLS and fixed effects estimator, but mainly for Blundell-Bond estimator.

Scenario 4 Starting with H_1 (provision of investment incentives is a decreasing function of the quality of entrepreneurial environment), we can see that while cross-sectional techniques for 2005 do not reject the hypothesis, panel data methods reject

---

[11]Nevertheless, it should be noted that if we took into account only the *complete* specifications, our results concerning the support for scenarios would not change.

Table 4.6: Summary of conducted regressions and tests

Hypothesis	OLS	IRLS	FE	BB	Result
Scenario 4					**inconclusive**
$H_1 : ENT \downarrow$	NR	NR	R	R	reject
$H_2 : k \uparrow$	S	S	S	S	strongly support
$H_3 : ENT > 1 \Rightarrow CIT_1 \uparrow$	NR	NR	NR	R	weakly reject
$H_4 : INI_2 \uparrow$	NR	NR	NR	S	weakly support
Scenario 2					**inconclusive**
$H_5 : SPILL \uparrow$	NR	NR	S	R	inconclusive
$H_6 : CIT_1 \uparrow \Rightarrow CIT_2 \downarrow$	NR	S	NR	S	support
$H_7 : CIT_1 > \frac{1}{2} CIT_2 \Rightarrow RET \downarrow$	NR	NR	R	R	reject
Scenario 1					**weakly support**
$H_5 : SPILL \uparrow$	NR	NR	S	R	inconclusive
$H_6 : CIT_1 \uparrow \Rightarrow CIT_2 \downarrow$	NR	S	NR	S	support
$H_8 : CIT_1 > CIT_2 \Rightarrow RET \downarrow$	NR	S	R	NR	inconclusive
Other					
$H_9 : FDI \downarrow$	R	R	R	NR	strongly reject
$H_{10} : RISK \uparrow$	R	R	R	R	strongly reject
$H_{11} : CLEG \downarrow$	R	R	R	R	strongly reject

Note: R stands for reject, NR for not reject, and S for support.
Fixed effects were computed without outliers, Blundell-Bond estimator using all obs.

it in both cases. Weighting all these results equally, we have to reject this hypothesis.[12] H_2 (provision of investment incentives is an increasing function of labor costs) is supported by all techniques—as the only one. Countries have to compensate foreign investors for high unit costs and low productivity. H_3 (if country's entrepreneurial environment is better than that of its rival, provision of investment incentives is an increasing function of the CIT rate) can be weakly rejected, since only the Blundell-Bond estimator rejects the hypothesis and other estimates are inconclusive. Conversely, H_4 (Provision of country's investment incentives is an increasing function of investment incentives provided by its rival) is weakly supported.

Combining all these results, we cannot entirely reject Scenario 4, but we cannot support it either. Two of the hypotheses are supported (strongly or weakly), the other two are rejected. Support for H_4 may indicate some level of regime competition, but it is not strong as only one of the estimators is significant.

Scenario 2 Let us continue with H_5 (provision of investment incentives is an increasing function of FDI spillovers)—cross-sectional methods cannot reject the hypothesis, whereas fixed effects estimator supports the hypothesis and Blundell-Bond estimator

---

[12]In most cases, the definition of weights does not matter a lot (and excluding basic OLS as least reliable would not affect the results at all); therefore, we will continue to weigh the methods equally, for simplicity.

rejects it. Taken altogether, the tests are inconclusive. H_6 (if the influence of country's own CIT rate is negative, the influence of its rival's CIT tends to be positive, and *vice versa*) is supported, since OLS and fixed effects are inconclusive and the other estimators are supportive. H_7 (if country's CIT rate exceeds at least one half of its rival country's CIT rate, then the provision of investment incentives is a decreasing function of the return on investments) is rejected because of both panel data models.

One hypothesis is rejected, one is supported, the other cannot be rejected; hence our evaluation of Scenario 2 will be similar to Scenario 4: the evidence is inconclusive.

Scenario 1   Concerning this scenario, H_5 and H_6 apply for it as well. The only difference between Scenario 1 and Scenario 2 is that instead of H_7 we now have H_8 (if country's CIT rate exceeds its rival country's CIT rate, then the provision of investment incentives is a decreasing function of the return on investments) which cannot be rejected by OLS and Blundell-Bond estimator, is supported by IRLS, and rejected by fixed effects; so the outcome is inconclusive.[13]

Taken altogether, Scenario 1 is weakly supported, as 2 hypotheses cannot be rejected and one is supported. Note, however, that the support for H_8 in IRLS was derived using very small number of degrees of freedom. Should we take into account only panel data estimates, the result would be inconclusive.

Control variables   Variables *FDI*, *RISK*, and *CLEG* were added to the model to improve the specification and increase explanatory power; nevertheless, we made some intuitive hypotheses about their influence on *INI*: H_9 (country saturated with FDI is less willing to provide incentives), H_{10} (the higher risk of relocation the government feels, the higher incentives it is willing to provide), and H_{11} (countries with poor legislation have to provide higher incentives). These intuitive expectations are obviously out of accord with our results; all three hypotheses are strongly rejected.

To sum it up, we cannot test for Scenario 3, there is no conclusive evidence for Scenario 4 (stronger competition) nor Scenario 2 (weaker competition), and only very little support for Scenario 1 (cooperation). Therefore, the evidence might suggest that governments' cooperation or supranational coordination could be—to some extent—effective. However, the present author would argue that it is much more probable for Scenario 5 to be valid, i.e., none of the models developed by Havránek (2008) is able to describe subsidy competition reasonably well. Thus, unfortunately, we cannot say anything specific about the strength of the competition.

---

[13]Moreover, as H_0 is theoretically a stronger case of H_7, a support for H_8 should also imply support for H_7. Since this is not the case, our findings are consistent with Scenario 5.

4.6 Conclusion

The purpose of this paper was to empirically verify/falsify models of subsidy competition and supply of investment incentives developed in Havránek (2007) and Havránek (2008) and critically evaluate similar attempts made by Havránek (2007). Whereas the last mentioned paper concludes that the optimal investment incentive model can reasonably explains subsidy competition, our results indicate that none of the models can be supported. The present author would argue that the contradiction arose mainly due to the following factors:[14]

1. Interpretation of results by Havránek (2007). He found CIT_1 to be insignificant and CIT_2 to be significant—but that finding, in general, does not support the model of optimal investment incentive.

2. Hypotheses tested by Havránek (2007). INI_1 is not monotonous in the size of the domestic market; it is better to use entrepreneurial environment instead. It is also important to test for the significance of RET and k and use *conditional* hypotheses where it is appropriate.

3. Definition of a rival government used by Havránek (2007). Neighboring country providing highest investment incentives does not have to be the rival; much more probably it would be a country with as close $PROD/WAGES$ as possible. Also, the definition of the proxy for spillovers used by Havránek (2007) is inappropriate.

4. Reliance on basic OLS by Havránek (2007). It is more suitable to check also results of panel data estimators for the whole available time span, robust estimators, and different specifications of the models. While Havránek (2007) runs only 3 basic OLS regressions, we try 48 different specifications and employ 5 alternative estimators.

However, we also made multiple simplifications throughout this paper. In the first place, we formulated our hypotheses as linear dependences, although in a few cases the theoretical relationship is rather complex. We used a very simple definition of entrepreneurial environment and in a similar way we derived a proxy for productivity spillovers.

It is also necessary to take into account the nature of the data on investment incentives we have at our disposal; i.e., we are dealing with the attractiveness of incentives and not with the provided amounts *per se*. Also, our definition of the variable RET might be seen as oversimplifying and problematic.[15] Another problem

---

[14]Of course, Havránek (2007) was testing an older form of the models; however, the basic relationships remain similar.

[15]Note the simplifying assumption of zero discount rate in Havránek (2008).

with this approach could be that tax holidays (which are considered in the underlying models) are not the only form of investment incentives appreciated by investors.

Possible caveats can be also raised to our research methodology; most notably, the discretion in defining weights for different specifications (see Table 4.6 and corresponding comments) or standard testing of hypotheses in the case of OLS when normality was previously rejected, though. In spite of that, the present author would argue that it is safe to say that—using the World Competitiveness Online Database— there is no significant empirical evidence supporting models presented in Havránek (2008). The only stronger claim that we can formulate based on the analysis of this data is the following: It seems that by means of FDI incentives *governments try to compensate MNCs for high labor costs and low productivity in their countries.*

Therefore, even if the models clearly distinguish cases of weak competition, cooperation, and fierce competition, all of which are empirically testable, we cannot make a strong conclusion about the nature of the competition with the data which we have at our disposal. There is some minor evidence for cooperation, but this result is rather unstable. Nevertheless, we suggest testing the models using different datasets and different methodologies.

References

ARELLANO, M. & S. BOND (1991): "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations." *Review of Economic Studies* **58(2)**: pp. 277–97.

ARELLANO, M. & O. BOVER (1995): "Another Look at the Instrumental Variable Estimation of Error-Components Models." *Journal of Econometrics* **68(1)**: pp. 29–51.

BALTAGI, B. H. (2005): *Econometric Analysis of Panel Data.* John Wiley & Sons, 3rd edition.

BLONIGEN, B. (2005): "A Review of the Empirical Literature on FDI Determinants." *Atlantic Economic Journal* **33(4)**: pp. 383–403.

BLUNDELL, R. & S. BOND (1998): "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models." *Journal of Econometrics* **87(1)**: pp. 115–143.

BRAMATI, M. C. & C. CROUX (2007): "Robust estimators for the fixed effects panel data model." *Econometrics Journal* **10(3)**: pp. 521–540.

DEVEREUX, M. P., B. LOCKWOOD, & M. REDOANO (2008): "Do countries compete over corporate tax rates?" *Journal of Public Economics* **92(5-6)**: pp. 1210–1235.

GHINAMO, M., P. M. PANTEGHINI, & F. REVELLI (2008): "FDI Determination and Corporate Tax Competition in a Volatile World." *Working Papers 0802*, University of Brescia, Department of Economics.

HAMILTON, L. C. (2006): *Statistics with STATA*. Duxbury Press.

HAVRÁNEK, T. (2007): "Nabídka pobídek pro zahraniční investory: Soutěž o FDI v podmínkách oligopolu." *Working Papers IES 2007/31*, Charles University Prague, Faculty of Social Sciences, Institute of Economic Studies.

HAVRÁNEK, T. (2008): "Determinants of Foreign Direct Investment Incentives: Subsidy Competition in an Oligopolistic Framework." *SSRN eLibrary*, Charles University Prague, Faculty of Social Sciences, Institute of Economic Studies.

HAVRÁNEK, T. & Z. IRŠOVÁ (2008): "Intra-Industry Spillovers from Inward FDI: A Meta-Regression Analysis." *Working Papers IES 2008/08*, Charles University Prague, Faculty of Social Sciences, Institute of Economic Studies.

HUBER, P. J. (1967): "The Behavior of Maximum Likelihood Estimates under Nonstandard Conditions." In "Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability," volume 1, p. 221–223. Berkeley, CA: University of California Press.

KOKKO, A. (1994): "Technology, Market Characteristics, and Spillovers." *Journal of Development Economics* **43(2)**: pp. 279–293.

OECD (2003): "Checklist for Foreign Direct Investment Incentive Policies." *Technical report*, OECD.

PAPAGEORGIOU, C. (2002): "Technology Adoption, Human Capital, and Growth Theory." *Review of Development Economics* **6(3)**: pp. 351–68.

SJÖHOLM, F. (1999): "Technology Gap, Competition and Spillovers from Direct Foreign Investment: Evidence from Establishment Data." *Journal of Development Studies* **36**: pp. 53–73.

UNCTAD (2009): "Global Foreign Direct Investment now in decline—and estimated to have fallen during 2008." *Press release*, Geneva, 19 January 2009.

VÍŠEK, J. A. (1997): *Econometrics I*. Prague: Charles University.

WHITE, H. (1980): "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity." *Econometrica* **48(4)**: pp. 817–38.

4.A   Supplementary Tables

On the following pages, a few illustrative tables are provided.

Table 4.7: Acronyms of regression variables

Variable	Explanation
k	The relative price of labor adjusted for different productivity.
spilla	Spillover absorption capacity with $b = 0.25$.
spillb	Spillover absorption capacity with $b = 0.5$.
tgap	Spillover absorption capacity measured as technology gap.
ent	Relative quality of entrepreneurial environment.
cit1	Corporate income tax rate.
cit2	Corporate income tax rate in the rival country.
ret	Return on investment.
ini1	Attractiveness of investment incentives.
L.ini1	Lagged value of attractiveness of investment incentives.
ini2	Attractiveness of investment incentives in the rival country.
fdi	Stock of inward FDI divided by total GDP.
risk	Risk of relocation of production from the country.
cleg	Quality of competition legislation.

Table 4.8: Table of correlation coefficients

	k	spilla	ent	cit1	cit2	ret	ini2	fdi	risk	cleg
k	1									
spilla	0.2324	1								
ent	0.0076	-0.0340	1							
cit1	-0.0789	-0.0719	0.2586	1						
cit2	-0.0871	-0.0189	-0.1140	0.1641	1					
ret	-0.0568	-0.0223	0.0005	0.2660	0.2651	1				
ini2	-0.0834	-0.1292	0.1771	-0.0329	-0.347	0.0203	1			
fdi	0.2377	0.2676	-0.1968	-0.4652	-0.0150	-0.158	0.0808	1		
risk	-0.0623	0.0114	0.1071	0.0949	-0.134	-0.0753	0.2552	0.0183	1	
cleg	0.2018	0.3907	0.0280	0.0510	0.1266	-0.0209	-0.2474	0.2482	-0.0962	1

Table 4.9: Fixed effects estimator, 1997–2005, all observations

	Complete	Spillb	Tgap	Cond. 1	Cond. 2	Cond. 3	Best	Pure
k	0.345	0.416†	0.437*	0.0569	0.387†	0.907*	0.354†	0.406
	(1.62)	(1.95)	(2.06)	(0.16)	(1.74)	(2.18)	(1.68)	(1.60)
spilla	5.675*			11.58**	5.481*	0.474	5.583*	9.444**
	(2.31)			(2.76)	(2.15)	(0.11)	(2.33)	(3.27)
ent	0.162**	0.169**	0.167**	0.139*	0.165**	0.182	0.162**	0.266**
	(2.76)	(2.86)	(2.83)	(2.25)	(2.79)	(1.12)	(2.81)	(3.92)
cit1	-0.0190†	-0.0189†	-0.0168	0.0265	-0.0156	-0.0163	-0.0175†	-0.0133
	(-1.68)	(-1.65)	(-1.47)	(1.59)	(-1.30)	(-0.90)	(-1.76)	(-1.02)
cit2	-0.000245	-0.00247	-0.00350	0.0164	0.00181	-0.0335		-0.0127
	(-0.02)	(-0.23)	(-0.32)	(1.04)	(0.17)	(-1.36)		(-1.00)
ret	0.0260	0.0220	0.0170	0.150**	0.0365	0.0662		0.0115
	(1.02)	(0.85)	(0.65)	(3.73)	(1.39)	(1.46)		(0.39)
ini2	0.0174	0.0256	0.0291	0.117†	0.0301	0.0856		0.0126
	(0.37)	(0.54)	(0.61)	(1.73)	(0.63)	(1.03)		(0.22)
fdi	0.269	0.307	0.326	1.696†	0.707†	1.559†		
	(0.91)	(1.03)	(1.09)	(1.87)	(1.91)	(1.97)		
risk	-0.323**	-0.334**	-0.339**	-0.303**	-0.330**	-0.312**	-0.325**	
	(-7.25)	(-7.45)	(-7.62)	(-4.76)	(-7.32)	(-3.98)	(-7.40)	
cleg	0.513**	0.517**	0.510**	0.560**	0.523**	0.734**	0.498**	
	(7.14)	(7.13)	(7.02)	(4.90)	(7.03)	(6.50)	(7.13)	
spillb		2.336						
		(0.56)						
tgap			-0.931					
			(-0.92)					
Constant	0.867	1.093	1.520†	-2.876*	0.326	-0.509	1.172†	5.175**
	(1.07)	(1.35)	(1.66)	(-2.25)	(0.38)	(-0.34)	(1.94)	(6.85)
Observations	396	396	396	160	385	163	396	396
R^2	0.360	0.350	0.351	0.532	0.372	0.491	0.357	0.088

t statistics in parentheses
† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table 4.10: Blundell-Bond estimator, 1997–2005, "outliers" excluded

	Complete	Spillb	Tgap	Cond. 1	Cond. 2	Cond. 3	Best	Pure
L.ini1	0.353**	0.344**	0.301**	0.467**	0.363**	0.357**	0.348**	0.562**
	(4.17)	(4.14)	(3.59)	(4.07)	(4.36)	(4.19)	(4.27)	(6.78)
k	0.0635	0.0988	0.0779	−0.0289	0.0767	1.102*		0.000289
	(0.20)	(0.32)	(0.25)	(−0.05)	(0.24)	(2.41)		(0.00)
spilla	−4.681*						−4.625*	
	(−2.10)						(−2.09)	
ent	−0.106	−0.0544	−0.0431	−0.00673	−0.0591	0.0316	−0.118†	−0.0753
	(−1.41)	(−0.75)	(−0.60)	(−0.07)	(−0.81)	(0.67)	(−1.93)	(−0.89)
cit1	−0.0302†	−0.0256	−0.0244	−0.0595*	−0.0251	−0.0716**	−0.0276†	−0.0160
	(−1.75)	(−1.49)	(−1.45)	(−2.11)	(−1.43)	(−3.01)	(−1.75)	(−0.86)
cit2	0.00675	0.00926	0.000311	0.0181	0.0108	−0.00773		−0.0108
	(0.45)	(0.63)	(0.02)	(0.60)	(0.73)	(−0.36)		(−0.67)
ret	0.0688†	0.0724*	0.117**	0.123†	0.0799*	0.0886	0.0670*	0.0971*
	(1.84)	(1.98)	(3.15)	(1.76)	(2.12)	(1.49)	(2.05)	(2.47)
imi2	0.188**	0.177**	0.169**	0.00508	0.182**	0.206**	0.183**	0.176**
	(3.17)	(3.01)	(2.94)	(0.05)	(3.05)	(2.83)	(3.26)	(2.66)
fdi	0.165	0.325	0.729	−0.353	0.428	1.511†		
	(0.32)	(0.63)	(1.38)	(−0.24)	(0.77)	(1.70)		
risk	−0.223**	−0.235**	−0.249**	−0.161†	−0.233**	−0.172*	−0.217**	
	(−4.10)	(−4.37)	(−4.67)	(−1.83)	(−4.28)	(−2.10)	(−4.13)	
cleg	0.175*	0.220**	0.247**	0.135	0.222**	0.238*	0.173*	
	(2.20)	(2.75)	(3.09)	(0.88)	(2.74)	(2.00)	(2.25)	
spillb		−14.85**		−4.196	−14.86**	−15.96**		−6.313
		(−3.39)		(−0.47)	(−3.34)	(−2.69)		(−1.34)
tgap			2.330**					
			(3.90)					
Constant	1.657	1.067	−0.235	2.665	0.822	1.805	2.032**	2.393*
	(1.38)	(0.90)	(−0.19)	(1.40)	(0.68)	(1.47)	(2.59)	(2.18)
Observations	336	336	336	142	333	140	336	336

t statistics in parentheses

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table 4.11: Arellano-Bond estimator, 1997–2005, all observations

	Complete	Spillb	Tgap	Cond. 1	Cond. 2	Cond. 3	Best	Pure
L.ini1	0.0433	0.0396	0.0389	0.239	0.0841	−0.0245	0.0417	0.333**
	(0.41)	(0.38)	(0.37)	(1.45)	(0.78)	(−0.20)	(0.40)	(2.80)
k	0.713*	0.694*	0.701*	0.147	0.614†	1.289**	0.708*	0.520
	(2.32)	(2.27)	(2.29)	(0.21)	(1.92)	(2.60)	(2.34)	(1.41)
spilla	−1.617			2.546	−1.756	−5.807		0.00875
	(−0.50)			(0.43)	(−0.54)	(−1.13)		(0.00)
ent	0.198†	0.189†	0.204†	0.108	0.170	−0.0404	0.204†	0.104
	(1.83)	(1.75)	(1.89)	(0.64)	(1.54)	(−0.18)	(1.91)	(0.81)
cit1	−0.0229	−0.0219	−0.0233	−0.0310	−0.0207	−0.0401	−0.0220	−0.0129
	(−1.49)	(−1.43)	(−1.52)	(−0.99)	(−1.30)	(−1.58)	(−1.51)	(−0.71)
cit2	0.00108	0.00188	0.00201	0.0474†	0.00509	−0.00891		−0.0124
	(0.07)	(0.13)	(0.14)	(1.67)	(0.33)	(−0.43)		(−0.71)
ret	0.0447	0.0429	0.0486	0.118†	0.0724*	0.0510	0.0497†	0.0696†
	(1.33)	(1.29)	(1.40)	(1.84)	(2.03)	(0.88)	(1.69)	(1.82)
imi2	0.144**	0.141**	0.146**	0.0430	0.162**	0.143†	0.146**	0.191**
	(2.62)	(2.59)	(2.67)	(0.45)	(2.83)	(1.86)	(2.74)	(2.90)
fdi	−0.0464	−0.0514	−0.0615	0.513	0.576	1.364		
	(−0.14)	(−0.15)	(−0.18)	(0.33)	(1.08)	(1.62)		
risk	−0.221**	−0.225**	−0.217**	−0.194*	−0.240**	−0.237**	−0.220**	
	(−4.53)	(−4.62)	(−4.48)	(−2.31)	(−4.68)	(−2.90)	(−4.56)	
cleg	0.397**	0.395**	0.395**	0.459**	0.397**	0.501**	0.396**	
	(5.31)	(5.30)	(5.27)	(2.68)	(5.01)	(4.14)	(5.39)	
spillb		−7.215						
		(−1.38)						
tgap			0.288					
			(0.23)					
Constant	1.182	1.260	0.952	−1.011	0.399	1.690	1.044	2.715*
	(1.05)	(1.14)	(0.75)	(−0.41)	(0.32)	(0.95)	(1.15)	(2.34)
Observations	308	308	308	124	299	126	308	308

t statistics in parentheses

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Appendix A

Alternative Specifications of Meta-Regressions

Table A.1: Standard meta-regression, old studies

	OLS, including outliers				OLS, excluding outliers			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ldf	0.790	0.831			0.137	0.0156		
	(1.40)	(1.61)			(0.63)	(0.08)		
avgyr	−0.0277	−0.00783			0.0265	−0.0434		
	(−0.27)	(−0.15)			(0.69)	(−1.55)		
devg	−3.265	−2.196			0.804	−0.348		
	(−0.91)	(−0.94)			(1.00)	(−0.45)		
trans	1.328	1.416		2.511	3.018^{**}	1.343		2.602^{*}
	(0.36)	(0.71)		(1.10)	(2.84)	(1.26)		(2.65)
cs	7.859^{*}	7.750^{**}		7.527^{*}	$1.382^{\dagger}$	3.237^{**}		1.585^{*}
	(2.27)	(3.33)		(2.19)	(1.95)	(2.84)		(2.18)
growth	0.742		0.581		0.527		0.980	
	(0.41)		(0.30)		(0.93)		(1.41)	
industry	0.951		0.754	−2.367	3.057^{**}		2.648^{**}	2.252^{*}
	(0.29)		(0.52)	(−0.66)	(3.29)		(4.10)	(2.68)
secdum	−0.0926		−3.162		0.191		0.0712	
	(−0.05)		(−1.06)		(0.16)		(0.06)	
empl	−0.266		2.350	−0.328	2.397^{*}		1.563^{*}	1.752^{**}
	(−0.09)		(1.18)	(−0.15)	(2.30)		(2.03)	(3.01)
assets	2.840		3.447		0.225		−0.0358	
	(1.18)		(0.91)		(0.21)		(−0.03)	
output	2.450		$5.512^{\dagger}$	1.013	4.433^{**}		3.503^{**}	3.704^{**}
	(0.62)		(1.96)	(0.25)	(3.67)		(3.30)	(3.40)
Constant	46.98	8.351	−1.118	−2.349	−57.65	85.13	-1.762^{*}	-2.849^{**}
	(0.23)	(0.08)	(−0.52)	(−1.07)	(−0.75)	(1.53)	(−2.08)	(−3.50)
Observations	46	46	46	46	42	42	42	42
R^2	0.403	0.351	0.113	0.289	0.626	0.384	0.482	0.586

Note: heteroscedasticity robust (Huber–White sandwich est.) t statistics in parentheses

response variable: t statistic

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table A.2: Robust meta-regression, old studies

	IRLS				Median regression			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ldf	0.163	0.0891			$0.379^{\dagger}$	0.385		
	(0.76)	(0.48)			(1.82)	(1.56)		
avgyr	0.0185	−0.0371			−0.0291	−0.0322		
	(0.42)	(−0.78)			(−0.63)	(−0.52)		
devg	0.654	−0.352			−0.547	−1.248		
	(0.69)	(−0.39)			(−0.63)	(−1.08)		
trans	2.931^{*}	$2.051^{\dagger}$		2.608^{**}	3.444^{**}	1.299		3.390^{**}
	(2.60)	(1.81)		(3.08)	(3.49)	(0.88)		(2.77)
cs	1.326	3.967^{**}		$1.460^{\dagger}$	2.167^{*}	5.262^{**}		1.500
	(1.42)	(4.36)		(1.85)	(2.44)	(4.22)		(1.36)
growth	0.434		0.649		−0.0435		$1.147^{\dagger}$	
	(0.60)		(0.90)		(−0.07)		(1.74)	
industry	3.168^{*}		2.700^{**}	2.417^{**}	3.580^{**}		2.157^{**}	
	(2.54)		(3.38)	(2.89)	(3.08)		(2.92)	
secdum	0.506		0.748		0.787		−1.418	
	(0.47)		(0.71)		(0.84)		(−1.58)	
empl	2.308^{*}		1.470	1.786^{*}	$1.650^{\dagger}$		2.190^{*}	
	(2.04)		(1.56)	(2.44)	(1.71)		(2.66)	
assets	0.288		−0.0869		0.0177		2.098^{*}	
	(0.29)		(−0.09)		(0.02)		(2.29)	
output	4.383^{**}		3.447^{**}	3.914^{**}	4.559^{**}		3.780^{**}	
	(3.46)		(3.41)	(4.20)	(3.78)		(4.09)	
Constant	−41.82	71.56	-1.666^{*}	-2.880^{**}	51.75	60.07	-1.927^{*}	-3.600^{**}
	(−0.48)	(0.76)	(−2.08)	(−4.33)	(0.56)	(0.49)	(−2.59)	(−3.82)
Observations	46	46	46	46	46	46	46	46
R^2	0.549	0.362	0.418	0.534	0.288	0.207	0.179	0.238

Note: t statistics in parentheses

response variable: t statistic

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table A.3: Panel meta-regression, old studies

	Random effects, including outliers				Random effects, excluding outliers			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ldf	0.494	0.743			0.137	0.0137		
	(0.85)	(1.26)			(0.63)	(0.07)		
avgyr	0.0778	0.0900			0.0265	−0.0376		
	(0.58)	(1.01)			(0.69)	(−1.32)		
devg	−3.559	−3.346			0.804	−0.491		
	(−0.97)	(−1.26)			(1.00)	(−0.63)		
trans	0.0926	−0.0608		2.176	3.018^{**}	1.193		2.602^{**}
	(0.02)	(−0.03)		(0.85)	(2.84)	(1.08)		(2.65)
cs	9.299^{*}	8.654^{**}		8.276^{*}	$1.382^{\dagger}$	3.345^{**}		1.585^{*}
	(2.41)	(3.14)		(2.14)	(1.95)	(2.88)		(2.18)
growth	−0.222		−0.212		0.527		0.980	
	(−0.12)		(−0.10)		(0.93)		(1.41)	
industry	−1.591		0.522	−3.295	3.057^{**}		2.648^{**}	2.252^{**}
	(−0.40)		(0.30)	(−0.79)	(3.29)		(4.10)	(2.68)
secdum	−0.765		−2.762		0.191		0.0712	
	(−0.41)		(−0.99)		(0.16)		(0.06)	
empl	1.756		2.680	−0.0109	2.397^{*}		1.563^{*}	1.752^{**}
	(0.75)		(1.16)	(−0.01)	(2.30)		(2.03)	(3.01)
assets	3.812		3.821		0.225		−0.0358	
	(1.51)		(0.94)		(0.21)		(−0.03)	
output	1.644		4.419	−0.164	4.433^{**}		3.503^{**}	3.704^{**}
	(0.38)		(1.41)	(−0.04)	(3.67)		(3.30)	(3.40)
Constant	−160.5	−185.0	−0.817	−2.124	−57.65	73.73	$−1.762^{*}$	$−2.849^{**}$
	(−0.59)	(−1.03)	(−0.32)	(−0.88)	(−0.75)	(1.30)	(−2.08)	(−3.50)
Observations	46	46	46	46	42	42	42	42
R^2	0.350	0.327	0.102	0.282	0.626	0.383	0.482	0.586

Note: heteroscedasticity robust (Huber-White sandwich est.) t statistics in parentheses

response variable: t statistic

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table A.4: Probability meta-regression, old studies

	Probit—positiveness, all observations				Probit—significance, all observations			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ldf	-0.121	-0.0647		-0.118	0.497*	0.171		
	(-0.90)	(-0.55)		(-0.91)	(2.34)	(1.56)		
avgyr	-0.0285	-0.0329			-0.0811†	-0.0485†		
	(-0.51)	(-0.71)			(-1.65)	(-1.82)		
devg	-0.0816	-0.224			2.097*	0.982*		1.667***
	(-0.09)	(-0.36)			(2.28)	(1.99)		(2.75)
trans	0.984	0.456		0.841	1.797†	0.840		1.071
	(1.18)	(0.73)		(1.28)	(1.73)	(1.38)		(1.53)
cs	1.810**	1.908**		1.976**	0.495	0.529		0.152
	(2.93)	(3.45)		(3.31)	(0.73)	(1.04)		(0.27)
growth	-0.161		-0.389		0.923		0.628	
	(-0.27)		(-0.87)		(1.60)		(1.41)	
secdum	-0.763		-1.190†		-0.982		-0.527	-0.997
	(-0.93)		(-1.83)		(-1.27)		(-0.85)	(-1.51)
empl	0.701		0.867	0.651	0.642		0.288	0.781
	(0.80)		(1.56)	(0.90)	(0.74)		(0.52)	(1.30)
assets	1.183		0.902	0.872	-0.282		0.158	
	(1.60)		(1.48)	(1.28)	(-0.43)		(0.27)	
output	1.718†		1.519*	1.645†	-0.849		0.446	0.126
	(1.66)		(2.17)	(1.67)	(-0.76)		(0.74)	(0.19)
industry					1.737†		0.554	-0.0654
					(1.72)		(1.17)	(-0.11)
Constant	56.18	65.38	-0.0612	-0.649	155.9	94.58†	-0.433	-1.109†
	(0.51)	(0.71)	(-0.13)	(-0.61)	(1.62)	(1.79)	(-0.90)	(-1.76)
Observations	46	46	46	46	46	46	46	46
Pseudo R^2	0.419	0.340	0.178	0.391	0.359	0.203	0.068	0.183

Note: t statistics in parentheses

response variable: dummy = 1 if t stat is positive (columns 1–4); dummy = 1 if t stat is significant (columns 5–8)

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table A.5: Standard meta-regression, new studies

	OLS, including outliers				OLS, excluding outliers			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ldf	0.458	−0.317		0.281	0.183	−0.109		0.199†
	(1.16)	(−1.41)		(0.92)	(1.15)	(−0.67)		(1.79)
avgyr	0.0142	0.224		0.0969	−0.150	−0.0201		−0.146†
	(0.05)	(1.24)		(0.41)	(−1.26)	(−0.25)		(−2.00)
devg	2.570	−3.909†			−0.0703	−1.562		
	(0.62)	(−1.94)			(−0.04)	(−1.27)		
trans	6.214	−1.998		3.975	1.092	−1.481		1.107
	(0.98)	(−0.86)		(1.24)	(0.56)	(−1.34)		(0.91)
cs	5.151*	1.902		4.978*	2.687*	1.697		2.674**
	(2.22)	(1.15)		(2.33)	(2.72)	(1.42)		(2.80)
growth	1.857		1.504	1.817	1.153		0.689	1.004
	(0.95)		(0.82)	(1.24)	(1.21)		(0.91)	(1.40)
industry	5.451†		3.947†	5.055*	3.438*		1.748	3.358*
	(1.86)		(1.88)	(2.19)	(2.27)		(1.25)	(2.63)
secdum	3.816†		3.597†	3.228*	0.936		0.272	0.893
	(1.83)		(1.81)	(2.35)	(0.84)		(0.34)	(0.93)
empl	7.267		3.017	6.368	2.046		1.119	1.816†
	(1.08)		(0.79)	(1.56)	(1.66)		(1.37)	(1.70)
assets	0.892		0.830	0.949	0.651		0.500	0.345
	(0.23)		(0.25)	(0.55)	(0.62)		(0.49)	(0.35)
output	−0.305		−0.583		0.396		−0.143	
	(−0.09)		(−0.20)		(0.33)		(−0.16)	
Constant	−41.41	−441.3	−2.847	−202.4	295.9	42.39	−0.866	286.3†
	(−0.08)	(−1.23)	(−0.71)	(−0.43)	(1.26)	(0.26)	(−0.79)	(1.98)
Observations	51	51	51	51	45	45	45	45
R^2	0.255	0.059	0.150	0.245	0.314	0.141	0.148	0.312

Note: heteroscedasticity robust (Huber-White sandwich est.) t statistics in parentheses

response variable: t statistic

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table A.6: Robust meta-regression, new studies

	IRLS				Median regression			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ldf	0.248	−0.0681		0.181	0.351	0.00683		0.381†
	(1.20)	(−0.42)		(1.13)	(0.83)	(0.04)		(1.91)
avgyr	−0.256*	−0.0333		−0.213*	−0.277	−0.0322		−0.188†
	(−2.17)	(−0.34)		(−2.29)	(−0.92)	(−0.30)		(−1.72)
devg	0.900	−1.081			1.874	−1.944		
	(0.61)	(−0.93)			(0.46)	(−1.57)		
trans	1.881	−1.326			3.141	−2.310†		
	(1.12)	(−1.21)			(0.69)	(−1.94)		
cs	3.213*	1.967†		2.758*	2.988	1.624		1.993
	(2.68)	(1.87)		(2.62)	(1.07)	(1.40)		(1.46)
growth	1.615†		0.601	1.184†	1.187		0.950	1.443
	(1.77)		(0.65)	(1.70)	(0.46)		(0.52)	(1.45)
industry	4.595**		1.612	3.800**	5.020		1.360	4.339*
	(3.10)		(1.30)	(3.01)	(1.37)		(0.53)	(2.61)
secdum	1.579		0.239	1.143	2.856		1.230	1.966
	(1.60)		(0.28)	(1.42)	(1.05)		(0.73)	(1.63)
empl	2.299		1.121		3.765		2.543	
	(1.54)		(0.97)		(0.87)		(1.07)	
assets	1.118		1.054		1.537		2.343	
	(0.79)		(0.75)		(0.37)		(0.87)	
output	1.057		−0.0835		0.768		0.273	
	(0.79)		(−0.06)		(0.20)		(0.10)	
Constant	503.2*	68.18	−0.771	421.8*	544.2	66.42	−2.503	370.0†
	(2.16)	(0.35)	(−0.51)	(2.28)	(0.91)	(0.31)	(−0.85)	(1.70)
Observations	51	51	51	51	51	51	51	51
R^2	0.348	0.136	0.115	0.304	0.099	0.044	0.033	0.064

Note: t statistics in parentheses

response variable: t statistic

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table A.7: Panel meta-regression, new studies

	Random effects, including outliers				Random effects, excluding outliers			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ldf	$0.563^{\dagger}$	-0.317		0.104	0.132	-0.0738		0.130
	(1.78)	(-1.41)		(0.38)	(0.79)	(-0.50)		(0.99)
avgyr	0.188	0.224		0.141	-0.119	-0.00447		$-0.109^{\dagger}$
	(0.59)	(1.24)		(0.61)	(-1.07)	(-0.05)		(-1.66)
devg	3.279	$-3.909^{\dagger}$			-0.356	-1.554		
	(0.82)	(-1.94)			(-0.23)	(-1.32)		
trans	9.272	-1.998			0.751	-1.462		
	(1.37)	(-0.86)			(0.39)	(-1.14)		
cs	6.405^{*}	1.902		$3.101^{\dagger}$	2.249^{*}	1.472		1.811^{*}
	(2.05)	(1.15)		(1.93)	(2.25)	(1.26)		(2.21)
growth	-2.186		-3.186		0.818		0.396	
	(-0.97)		(-1.48)		(0.91)		(0.54)	
industry	$8.366^{\dagger}$		$6.942^{\dagger}$	$3.091^{\dagger}$	3.199^{*}		1.803	2.503^{*}
	(1.90)		(1.89)	(1.70)	(2.11)		(1.31)	(2.21)
secdum	2.045		2.590	3.729^{*}	1.002		0.606	1.114
	(1.46)		(1.54)	(2.26)	(0.97)		(0.72)	(1.25)
empl	4.035		0.604	4.198	2.108		1.445	$1.208^{\dagger}$
	(0.61)		(0.09)	(1.47)	(1.28)		(1.00)	(1.76)
assets	-12.32^{**}		-10.93^{*}		0.757		0.742	
	(-3.20)		(-2.50)		(0.49)		(0.47)	
output	-7.194		-5.250		0.687		0.148	
	(-1.64)		(-1.05)		(0.39)		(0.10)	
Constant	-382.0	-441.3	4.863	-284.7	234.6	11.10	-0.906	$214.6^{\dagger}$
	(-0.61)	(-1.23)	(0.87)	(-0.62)	(1.07)	(0.07)	(-0.58)	(1.65)
Observations	51	51	51	51	45	45	45	45
R^2	0.131	0.059	0.051	0.163	0.302	0.139	0.136	0.233

Note: heteroscedasticity robust (Huber-White sandwich est.) t statistics in parentheses

response variable: t statistic

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table A.8: Probability meta-regression, new studies

	Probit—positiveness, all observations				Probit—significance, all observations			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ldf	-0.00712	-0.0484		-0.0254	0.141	0.107		0.167
	(-0.06)	(-0.49)		(-0.22)	(1.04)	(1.01)		(1.36)
avgyr	0.0000351	-0.000206			-0.0269	0.0159		-0.0233
	(0.00)	(-0.00)			(-0.38)	(0.27)		(-0.34)
trans	0.234	-0.821		0.390	-1.103	-1.027		-0.880
	(0.37)	(-1.23)		(0.64)	(-1.12)	(-1.64)		(-1.34)
cs	0.931	0.394		0.658	1.116	1.246†		1.348*
	(1.04)	(0.57)		(0.80)	(1.51)	(1.93)		(1.97)
growth	0.160		0.0311		0.320		0.279	
	(0.26)		(0.05)		(0.56)		(0.53)	
industry	0.656		0.652	0.313	0.567		-0.0505	0.946
	(0.66)		(0.83)	(0.36)	(0.60)		(-0.08)	(1.07)
secdum	0.675		0.556		0.491		0.259	0.464
	(1.15)		(1.08)		(0.84)		(0.56)	(0.84)
empl	2.283*		1.959**	1.976*	-0.0286		0.802	
	(2.50)		(2.65)	(2.43)	(-0.03)		(1.26)	
assets	1.400		1.306	1.128	0.905		1.300†	
	(1.49)		(1.51)	(1.54)	(1.06)		(1.65)	
output	0.794		0.639	0.553	-0.0822		0.106	
	(0.97)		(0.85)	(0.89)	(-0.10)		(0.14)	
devg		-0.199			-1.177	-1.190†		-1.063
		(-0.28)			(-1.28)	(-1.76)		(-1.48)
Constant	-1.516	1.668	-1.018	-0.630	52.05	-32.32	-1.302	44.95
	(-0.01)	(0.01)	(-1.08)	(-0.50)	(0.37)	(-0.28)	(-1.54)	(0.33)
Observations	51	51	51	51	51	51	51	51
Pseudo R^2	0.208	0.074	0.184	0.185	0.205	0.134	0.086	0.156

Note: t statistics in parentheses

response variable: dummy $= 1$ if t stat is positive (columns 1–4); dummy $= 1$ if t stat is significant (columns 5–8)

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Appendix B

Content of Enclosed DVD

There is a DVD enclosed to this thesis which contains used empirical data, Stata and LaTeX source codes, and simulations of models' sensitivity in Excel. All this content can also be found on the thesis website: www.tomashavranek.cz/research/master-thesis.

- Folder 1: Empirical data

- Folder 2: Source codes

- Folder 3: Sensitivity simulations