Declaration of Authorship

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Prague, July 31, 2017

Signature
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Abstract

Assessment of the foreign direct investment (FDI) spillovers in the People’s Republic of China (PRC) has become a lively area of research in the past decades; nonetheless, the existing primary literature seems to be inconclusive. The present thesis revises the literature through a meta-analytical approach using Bayesian Model Averaging (BMA). Considering that the previous literature reviews are of either inferior quality or incomparable focus, our research is based on a collection of 1081 estimates from 14 primary studies published between 2007 and 2017 comprising data from 1995 to 2012. A variety of 85 characteristics of the observations is coded whilst we employ at least 30 of these within each BMA estimation. Through separate testing of individual spillover measures (horizontal, forward, and backward), an extensive evidence of publication bias is collected for horizontal spillovers in PRC—exaggerating the mean magnitude of the reported estimates. Finally, the thesis identifies that the spillover effect from FDI inflows originating from the area of Hong Kong, Macau, and Taiwan is systematically different from the others.

JEL Classification  O1, O3, O4

Keywords  FDI, spillover effect, China, PRC, meta-analysis, publication bias, BMA

Author’s e-mail  hermandominik@gmail.com
Supervisor’s e-mail  tomas.havranek@ies-prague.org
Abstrakt

Hodnocení spillover efektu přílivu přímých zahraničních investic do Čínské lidové republiky (ČLR) se v uplynulých letech stalo předmětem četných studií, avšak závěry primární literatury nejsou jednotné. Tato diplomová práce dostupnou literaturu reviduje a reinterpretove za použití meta-analytických metod a Bayesiánského modelu průměrování. Dosavadní souhrnné práce nejsou s daným výzkumem přímo porovnatelné s ohledem na své konkrétní zaměření. Výzkum je založen na 1081 odhadech sesbíraných z 14 primárních studií publikovaných mezi lety 2007 až 2017 využívajících v úhrnu data za období od roku 1995 do roku 2012. Ze souboru 85 různých charakteristik daných pozorování je vždy alespoň 30 z nich použito v rámci každého z BMA modelů. Skrze oddělené testování jednotlivých spillover efektů (tj. horizontálního a vpřed a zpětně vertikálního) je doložena přítomnost publikačního vlivu v případě horizontálního efektu v ČLR, kdy jsou průměrné hodnoty publikovaných odhadů nadhodnocovány. Z výsledků výzkumu je patrné, že spillover efekt přímých zahraničních investic pocházejících z regionu Hongkong, Macao a Tchaj-wan je systematicky odlišný od ostatních.

Klasifikace JEL O1, O3, O4

Klíčová slova přímé zahraniční investice, Čína, ČLR, meta-analyza, publikační vliv, BMA

E-mail autora hermandominik@gmail.com

E-mail vedoucího práce tomas.havranek@ies-prague.org

Počet znaků 97 894

Počet znaků bez mezer 83 103
# Contents

List of Tables viii  
List of Figures ix  
Acronyms x  
Thesis Proposal xi  

1 Introduction 1  

2 Foreign Direct Investment 4  
  2.1 FDI Spillovers . . . . . . . . . . . . . . . . . . . . . . . . . . . 6  
  2.2 FDI in PRC . . . . . . . . . . . . . . . . . . . . . . . . . . . 10  
  2.3 ODI in PRC . . . . . . . . . . . . . . . . . . . . . . . . . . . 13  
  2.4 FDI Spillovers in PRC . . . . . . . . . . . . . . . . . . . . . 15  

3 Methodology 20  
  3.1 Publication Bias . . . . . . . . . . . . . . . . . . . . . . . . . 21  
    3.1.1 Graphical Tools . . . . . . . . . . . . . . . . . . . . . . 22  
    3.1.2 Regression Tests . . . . . . . . . . . . . . . . . . . . . . 24  
  3.2 Bayesian Model Averaging . . . . . . . . . . . . . . . . . . . . 26  
  3.3 Criticism of the Meta-Analytical Approach . . . . . . . . . . 29  

4 Empirical Research 32  
  4.1 Data Description . . . . . . . . . . . . . . . . . . . . . . . . . 32  
  4.2 Summary Statistics . . . . . . . . . . . . . . . . . . . . . . . 34  
  4.3 Graphical Testing . . . . . . . . . . . . . . . . . . . . . . . . 39  
  4.4 Regression Testing . . . . . . . . . . . . . . . . . . . . . . . 42  
  4.5 Determinants of Heterogeneity . . . . . . . . . . . . . . . . . 44  

5 Conclusion 49
Bibliography

A Eliminated Studies

B Moderator Variables

C Auxiliary Results
List of Tables

4.1 List of primary literature .......................... 33
4.2 Description of datasets ............................. 34
4.3 Mean spillover effects ............................. 35
4.4 Mean t-statistics ................................. 39
4.5 Testing for publication bias ..................... 43

B.1 Description and summary statistics of collected variables . . . IX
List of Figures

3.1 Funnel plot with no, type I, and type II publication bias . . . 23
4.1 Horizontal estimates by authors . . . . . . . . . . . . . . . . . 36
4.2 Trend graphs of horizontal estimates . . . . . . . . . . . . . . . 36
4.3 Forward estimates by authors . . . . . . . . . . . . . . . . . . . 37
4.4 Trend graphs of forward estimates . . . . . . . . . . . . . . . . . 37
4.5 Backward estimates by authors . . . . . . . . . . . . . . . . . . 38
4.6 Trend graphs of backward estimates . . . . . . . . . . . . . . . . 38
4.7 Kernel density . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 40
4.8 Funnel and Galbraith plot (horizontal) . . . . . . . . . . . . . . 41
4.9 Funnel and Galbraith plot (forward) . . . . . . . . . . . . . . . . 41
4.10 Funnel and Galbraith plot (backward) . . . . . . . . . . . . . . . 42
4.11 Determinants (horizontal) . . . . . . . . . . . . . . . . . . . . . . 45
4.12 Determinants (forward) . . . . . . . . . . . . . . . . . . . . . . . 47
4.13 Determinants (backward) . . . . . . . . . . . . . . . . . . . . . . 48
C.1 Determinants (horizontal, published) . . . . . . . . . . . . . . XI
C.2 Determinants (forward, published) . . . . . . . . . . . . . . . . XII
C.3 Determinants (backward, published) . . . . . . . . . . . . . . . XIII
### Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>BMA</td>
<td>Bayesian Model Averaging</td>
</tr>
<tr>
<td>FDI</td>
<td>Foreign Direct Investment</td>
</tr>
<tr>
<td>FAT</td>
<td>Funnel Asymmetry Test</td>
</tr>
<tr>
<td>FE</td>
<td>Fixed-Effect</td>
</tr>
<tr>
<td>ME</td>
<td>Mixed-Effect</td>
</tr>
<tr>
<td>HMT</td>
<td>Hong Kong, Macau, and Taiwan</td>
</tr>
<tr>
<td>MNE</td>
<td>Multinational Enterprise</td>
</tr>
<tr>
<td>ODI</td>
<td>Outward Foreign Direct Investment</td>
</tr>
<tr>
<td>OLI</td>
<td>Ownership, Location, Internalization</td>
</tr>
<tr>
<td>OLS</td>
<td>Ordinary Least Squares</td>
</tr>
<tr>
<td>PET</td>
<td>Precision Effect Test</td>
</tr>
<tr>
<td>OPEC</td>
<td>Organization of Petroleum Exporting Countries</td>
</tr>
<tr>
<td>PRC</td>
<td>People’s Republic of China</td>
</tr>
<tr>
<td>SOE</td>
<td>State-Owned Enterprise</td>
</tr>
<tr>
<td>TFP</td>
<td>Total Factor Productivity</td>
</tr>
<tr>
<td>TNC</td>
<td>Transnational Corporation</td>
</tr>
<tr>
<td>UNCTAD</td>
<td>United Nations Conference on Trade and Development</td>
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Master’s Thesis Proposal

Author       Bc. Dominik Herman
Supervisor   doc. PhDr. Tomáš Havránek Ph.D.
Proposed topic  A Meta-Analysis of FDI Spillovers in China

Motivation   This diploma thesis will attempt to provide an accurate estimate of the effect of foreign direct investment (FDI) spillovers in China corrected from publication bias and other distorting and deflecting effects. This should be achieved through examination of a set of distinct studies concerning the effect of FDI spillovers in China.

In recent decades, global flows of FDI have risen. Many researchers have focused on the economic justification of FDI incentives while the main hypothesis usually examined is that domestic firms might indirectly benefit from FDI. Although it is broadly assumed that spillovers from FDI help domestic firms to increase their productivity, the reported estimates differ substantially. Both statistical significance and magnitude of the effect are not consistent across the primary literature. A quantitative method how to correct for the inconsistency is to collect the numerous estimates and examine them via so called meta-analysis. This comprehensive methodology has long been used in economics following the seminal contribution by Stanley and Jarrell (1989). One of the recent applications of meta-analysis in economics is methodologically closely related to topic of the diploma thesis; that is Irsova and Havranek (2013) on the determinants of horizontal spillovers from FDI. However, the diploma thesis is focused differently in terms of the regional concentration and particular phenomenon under investigation.

Three meta-analyses of spillovers of FDI in China have been already conducted (Gunby et al., 2015; Ljungwall and Tingvall, 2010; and Masoumy and Azarhoushang, 2015). Nevertheless, two of these analyses did not correct the estimates for publication bias. The publication selection can seriously bias the estimates of FDI spillovers as positive estimates are usually consistent with theory. The bias of the primary literature is suspected to be substantial. Finally, the
third meta-analysis conducted so far (Gunby et al., 2015) is directly focused on the economic growth instead of the effect of spillovers alone, i.e. its topic is only related, not identical or even sufficiently comparable.

Hypotheses

Hypothesis #1: The primary literature estimating FDI spillovers in China is affected by publication bias.

Hypothesis #2: The publication bias exaggerates the mean reported FDI spillovers.

Hypothesis #3: There is a structural difference between the spillovers estimated for FDI incoming from the HMT (Hong Kong, Macau, and Taiwan) regions and the rest of the foreign world.

Methodology  Meta-analysis is a tool designed for the empirical research results synthesis. It enables the researcher to make relevant and reliable conclusions and provides more systematic and unbiased analysis than the narrative reviews do. Meta-analysis helps to explain heterogeneity of the results and to estimate the real effect.

The first step of meta-analysis is to collect the primary studies. I will include all studies used by the three meta-analyses (Gunby et al., 2015; Ljungwall and Tingvall, 2010; and Masoumy and Azarhoushang, 2015). Additionally, I will search for any other relevant study available. At least 13 different online portals (13 online portals: Central Catalogue of the Charles University in Prague, Charles University E-resources Portal, EBSCOhost, EconLit - ProQuest, Google Scholar, JSTOR, RePEc EconPapers, RePEc IDEAS, ScienceDirect, Scopus, Springer, SSRN, and theses.cz) will serve as a source for the search. Preferably, I would like to include both English and Chinese language studies. In order to use all recent metanalytical methods and correct for publication bias, I have to collect the standard error of each estimate as well. If standard error not available, I will consider a possibility of computation of the standard error from either confidence intervals or means (Ramachandran and Tsokos, 2009; Ramachandran and Tsokos, 2015). If standard errors (or any other statistics from which standard errors could be computed) not reported, I will have to exclude such studies.

Publication bias occurs if a non-random sample of estimates is unpublished and unreported; or in other words, if the pool of research available is a biased representation of the population of estimates. (Stanley and Doucouliagos, 2007) In order to detect a publication bias, graphical tools and regression tests will be further introduced: funnel and Galbraith plots, simple meta-regression, Funnel Asymmetry
Test and Precision Effect Test (both based on the weighted least squares method), Fixed-Effect Model, and Mixed-Effect Multilevel Model. After the detection of publication bias, Heckman meta-regression will be employed in order to investigate the true effect of FDI spillovers. Furthermore, comprehensive Multivariate Meta-Regression Analysis will be employed to give the complete results on sources of heterogeneity of estimates reported in the primary literature.

Finally, I will employ the Bayesian model averaging (BMA) which provides a coherent mechanism for accounting for the model uncertainty in selection of its specification. Usually, certain model specification is selected from a class of models and then the selected specification is treated as generating the data. Such approach might lead to over-confident inferences and decisions more risky in reality than assumed. BMA involves averaging over all possible models (combinations of explanatory variables) when making inferences about quantities of interest.

**Expected Contribution** Via meta-analytical methodology, I will conduct a quantitative analysis of primary studies estimating the FDI spillovers in China. To the best of my knowledge, there are already three meta-analyses conducted on the stated or similar topic. Nevertheless, these are not sufficiently comprehensive as two of them (Ljungwall and Tingvall, 2010; Masoumy and Azarhoushang, 2015) lack to employ even some of the basic tools of meta-analysis such as the estimation of publication bias and the third one (Gunby et al., 2015) is focused on substantially different topic. In contrast, I will take the publication bias into consideration using the Mixed-Effect Multilevel Meta-Regression. Publication bias of the primary literature is suspected to be substantial. After correction for the publication bias, I expect to obtain estimates of the spillovers considerably smaller than the results of the previously published meta-analyses as well as the simple mean of all estimates in the sample of primary literature. The new corrected estimate might be directly used in argumentation over the rationale of FDI incentives; the new findings might revise part of the conventional reasoning. Additionally, it might be indirectly used in discussion over the economic growth of China.

**Outline**

1. Introduction: Introduction of the topic, methodology used and motivation stressing that there are meta-analyses, but they do not correct the estimates for publication bias.

2. FDI Spillovers: Broader introduction of the topic. (i) Description of the phenomenon under investigation. Answering the question: what does the FDI spillover mean? (ii) Description of the methodologies employed in the
3. Meta-Analysis Methodology: Broader introduction of the methodology used in the study. Detailed description of all meta-analytic tools used. In overall, second part of the literature review.

4. Empirical Research: Presentation of the main research of the study. (i) Description of the data used including all necessary disclaimers. (ii) Basic overview of the data. Provision of all obligatory summary statistics. (iii) Graphical analysis via funnel and Galbraith plots. (iv) Investigation of a possible publication bias and the true effect via FAT-PET tests and Heckman meta-regression. (v) Complex analysis of the heterogeneity of results via multivariate meta-regression analysis. (vi) Additional employment of BMA in order to find the most important determinants of the FDI spillovers in China. (vii) Discussion of results challenging the conclusions. The conclusions will be presented with all necessary disclaimers.

5. Conclusion: Summary of conclusions of the main research.

Core bibliography: Methodology


Core bibliography: Existing meta-analyses


Core bibliography: Primary literature


Chapter 1

Introduction

The People’s Republic of China (PRC) has evolved from the world leader among developing countries in attracting Foreign Direct Investment (FDI) into one of the world ultimate leaders in this respect over the past decades. Consequently, potential presence of FDI spillovers in PRC has lured researchers’ attention as the foreign investment is supposed to enrich the beneficiary country through enhanced productivity. Considerable effort of Chinese policymakers to attract FDI only makes the topic even more appealing. Nonetheless, findings of individual researchers have never become uniform—rather challenging and contradicting each other. This thesis examines the consistency of findings in the primary literature and verifies any fundamental shift in the impact of FDI on productivity spillovers in PRC over time. The research attempts to make the vast primary literature more transparent and prevent the academy to rely on obsolete findings. The individual studies of primary literature are based on entirely different datasets which makes it difficult for a reviewer to assess relevance of the findings by the means of narrative review. Assuming that there is a universal true effect to which the individual estimates randomly converge, controlling for both publication bias and study characteristics, meta-analytical approach is employed to acquire as much information as feasible.

The main hypotheses of the research are the following: (i) the primary literature estimating FDI spillovers in PRC is affected by publication bias, (ii) the publication bias exaggerates the mean reported FDI spillovers, and (iii) there is a structural difference between the spillovers estimated for FDI incoming from the regions of Hong Kong, Macau, and Taiwan (HMT). Based on our findings, the primary literature is spoiled by publication bias in the
case of horizontal spillovers whereas no similarly conclusive evidence is available for vertical spillovers. When detected, the publication bias is estimated to exaggerate the mean magnitude of the reported spillovers—attempting to comply with theoretical background of inefficient horizontal spillovers in PRC. Finally, FDI spillover estimates for HMT region are systematically different from the others in all three cases. We find the HMT estimates to be relatively smaller in comparison to the average.

Meta-analytical approach is employed within this thesis to shed some additional light on the ambiguous findings of the primary literature. Based on 1081 estimates collected from 14 different studies, we examine potential publication bias and heterogeneity of the results across the literature through the means of summary statistics, graphical methods, and regression tests. Bayesian Model Averaging (BMA) is used to resolve the resulting model uncertainty. To the best of our knowledge, there have been three meta-analyses conducted on a related topic; (Gunby et al. 2017; Ljungwall & Tingvall 2015; Masoumy & Azarhoushang 2015) none of these is, however, comparable to our research, especially with respect to particular focus, scope, and level of detail. This is the only research which focuses on productivity and differentiates between individual spillover channels—horizontal, forward, and backward. Moreover, none of the related studies is based on more than half of the number of regression results collected from the primary literature within this thesis. One of the studies is only preliminary while the concepts that it presents are rather basic. To conclude, the existing literature is either of inferior quality or not sufficiently comparable with our research.

The thesis is structured as follows: chapter 2 introduces the concept of foreign direct investment and its spillovers; specifically, it explores FDI both in general and in the particular case of PRC. Furthermore, chapter 3 reviews methodology: (i) the meta-analytical approach is described with focus on investigation of publication bias and heterogeneity, (ii) the concept of Bayesian Model Averaging is presented, and (iii) criticism of the meta-analytical approach is addressed providing an adequate defence. These two chapters represent a vast literature review of both theory and methodology. Moreover, chapter 4 presents and discusses the results of all summary statistics, graphical analyses, and regression analyses conducted. Finally, chapter 5 summarises findings and states conclusions. Appendix A contains the full list of studies from the primary literature which are excluded from the research. Appendix B describes in detail the moderator variables from conducted re-
gressions. Appendix C provides auxiliary results which are included as a robustness check.
Chapter 2

Foreign Direct Investment

Foreign Direct Investment is defined as an investment in which the investor acquires significant controlling interest in a firm based in a foreign country, or establishes a subsidiary in a foreign country. (Markusen et al. 1995) A firm which engages in direct foreign investment is usually called Multinational Enterprise (MNE) or Transnational Corporation (TNC). The operation of MNEs abroad substitutes export and licensing, i.e., other means of sales of the firm's products in a foreign country. In contrast to portfolio investments, any substantial movement of capital between home and beneficiary country occurs seldom under FDI as such investment is commonly financed from the local capital market. The establishment of MNEs is driven by business opportunities rather than difference in the general return to capital. Furthermore, MNEs face an inherent disadvantage in the foreign market. As long as the MNE does not possess any substantial advantage over the local firms, it cannot find it profitable to enter the foreign market. (Markusen et al. 1995) These kinds of advantage are later summarised under the Ownership, Location, Internalization (OLI) framework.

The difference between cost disadvantages and compensating advantages linked with international integration determines whether the MNE will enter the foreign market. The various disadvantages include the following: (i) additional transportation and communication cost, (ii) language and cultural differences, (iii) limited understanding of local market and business practices, or tax laws and other governmental regulations, (iv) risk of exchange rate volatility, expropriation, and other forms of policy discrimination, and (v) necessity of paying higher wages to employees living abroad. (Markusen et al. 1995) On the other hand, the major compensating advantages are comprised
under the OLI framework in which the abbreviation stands for ownership, location, and internalisation. (Dunning 1977) First, an *ownership advantage* might be linked to both tangible and intangible assets of the firm. It usually refers to a technological advantage, superior management scheme, or new products in a form of patent, blueprint, trade secret etc., but also to a trademark or reputation. One of the direct displays of economies to scale in this sense relates to the possibility of R&D performance taking place in a single location while spreading the results to different production locations. Second, a *location advantage* incorporates all reasons which might make it more profitable to integrate production in the foreign country than to continue to produce at home and export the goods. It consists of factor prices and availability, market size, transportation cost, consumer incomes, preferences and access (e. g., providing services), FDI governmental subsidies, and the trade barriers. Third, an *internalisation advantage* provides the investor with security of efficient utilisation and preservation of its intellectual property. It includes any argument against licensing the foreign firms. A production based on the sold blueprints might suffer from a lack of quality or disclosure of the firm’s know-how—making the transaction cost even higher than the one linked with FDI. (Markusen et al. 1995) The production integration might be either horizontal or vertical. The former one means producing homogeneous goods at different locations, i. e., *within-sector integration*. In contrast, the later one corresponds to production of goods at different stages of the overall production process within a single MNE, i. e., *between-sector integration*.

Although not very steadily, global flows of FDI have risen in the recent decades. The global FDI flows amounted to USD 1 730 billion\(^1\) reaching its highest level since the beginning of the financial crisis. Followed by 7% drop to USD 1 625 in 2016, development of the flows is still ascending in the long term. (OECD 2017) The global FDI flows have increased gradually since 2009 just as it had done so during the 2000s following the drop at the end of the preceding millennium. United Nations Conference on Trade and Development (UNCTAD) projects that the global FDI flows will further increase by around 10% over the year 2017. (UNCTAD 2017) The volume of global FDI flows reflects the degree of globalisation explaining all long-term growth, temporary slow-down or even decline following the recessions,

\(^{1}\)The figure corresponds to the average of inward and outward FDI. Although these should be equal by definition, there are some statistical discrepancies in practise.
and uncertain development linked with the current centripetal tendencies in politics. Consequently, wide range of researchers have examined the economic rationale of FDI incentives while the major hypotheses usually state that firms in the beneficiary country might indirectly benefit from FDI (Blomstrom & Kokko 2003; Chang et al. 2007) through so called knowledge spillovers or productivity spillovers.

2.1 FDI Spillovers

We insist to use the term productivity spillovers throughout the thesis as it better fits the broad understanding of any positive effects linked with FDI. The spillovers bound to the inflows of FDI might be further distinguished, similarly to the division of production integration. On one hand, the horizontal spillovers from FDI capture the effects of foreign investment on local firms in a single sector. A positive effect might arise from the labour turnover, demonstration effect, and competition effect, (Teece 1977) even though it might be suppressed or even exceeded by the negative crowding-out effect. (Aitken et al. 1997) Historically, the literature adopted mainly this point of view while the evidence for the impact had been mixed. Irsova & Havranek (2013) then conducted a large meta-analysis based on the existing primary literature finding that the horizontal spillovers are on average equal to zero, but that the sign and magnitude of individual estimates depend systematically on the features of the economy and MNEs. On the other hand, the vertical spillovers record the effects of foreign investment on local firms in the subsequent sectors of suppliers (backward vertical spillovers) and customers (forward vertical spillovers). The backward vertical spillovers are also sometimes called upstream whereas the forward spillovers might be labelled as downstream. The literature was refocused to this new point of view by an influential study of Javorcik in 2004 (Javorcik 2004) followed by a rapid emergence of the literature investigating vertical spillovers. In contrast to horizontal spillovers, the vertical spillovers are broadly assumed to be positive and significant over the studies. The lasting variation of the estimates magnitude was further explained by Havranek & Irsova (2011) who conclude that:

[...] model misspecifications reduce the reported estimates and journals select relatively large estimates for publication [...] the average spillover to suppliers is economically significant, whereas the spillover to buyers is sta-
statistically significant but small. Greater spillovers are received by countries that have underdeveloped financial systems and are open to international trade. Greater spillovers are generated by investors who come from distant countries and have only a slight technological edge over local firms.

The primary literature which examines the within-sector (horizontal) spillovers might be divided into two generations. The first one emerges in the 1970s and 1980s and consists of industry-level studies employing only cross-sectional data. (Blomstrom & Persson 1983; Caves 1974; Globerman 1979) Therefore, although the literature presents mostly positive correlation between FDI and industry productivity, reliability of the findings is only limited as the estimation techniques are not sufficiently sensitive. An identification problem present in the first generation primary literature is recognised as FDI is inclined toward more productive industries; therefore, the observed positive relationships are exaggerated. (Aitken & Harrison 1999) On the contrary, the second generation emerging mainly after the year 2000 relies on firm-level panel data through which one can better control for the investor’s selection bias. Nonetheless, the evidence presented over the second generation is rather mixed (Crespo & Fontoura 2007; Smeets 2008) with findings on all positive, (Aitken & Harrison 1999; Blake et al. 2009; Chang et al. 2007; Djankov & Hoekman 2000; Haddad & Harrison 1993; Javorcik 2004; Konings 2001; Mao & Yang 2016) insignificant or ambiguous, (Abraham et al. 2010; Agarwal & Milner 2011; Gorodnichenko et al. 2014; Kugler 2006; Lin et al. 2009; Liu 2008; Liu et al. 2009; Long et al. 2014) and negative spillovers. (Castellani & Zanfei 2003; Dries & Swinnen 2004; Girma et al. 2006; Girma & Gong 2008; Gorg & Strobl 2003; Haskel et al. 2007; Keller & Yeaple 2009; Tang 2008)

On the contrary, the recent findings on between-sector (vertical) spillovers are more favourable. The occurrence of only ambiguous horizontal, but rather positive vertical productivity spillovers are believed to correspond, among others, to MNEs incentives to prevent transfer of their intellectual property to competitors while the improvements of local suppliers production process are desired in order to obtain higher quality inputs. Nonetheless, similarly to the previous one, the overall findings are not completely uniform as also the vertical spillovers are concluded to be all positive, (Blalock & Gertler 2008; Javorcik 2004; Kugler 2006; Lin et al. 2009; Liu 2008; Liu et al. 2009; Long et al. 2014) mixed or insignificant, (Blake et al. 2009; Qiu et al. 2009; Wang & Wu 2016) and negative. (Girma & Gong 2008; Tang 2008) Furthermore,
the forward and backward linkages perform disunited productivity spillovers according to various studies. (Gorodnichenko et al. 2014; Long et al. 2014) In overall, any of the channels of higher productivity transfer is dependent on the absorptive capacity of individual regions, industries, and firms which varies according to the degree of R&D activities, training etc. (Fu 2008; Fu & Gong 2009) The findings on both horizontal and vertical productivity spillovers differ vastly also according to a detailed sorting of the firm’s characteristics (i.e., State-Owned Enterprise (SOE) vs. private firm, comparison of individual industrial sectors, degree of foreign ownership, short-term vs. long-term effect etc.).

Proxy variables which measure the foreign presence in all horizontal, forward, and backward sectors usually follow the same definitions over the entire primary literature. (Blalock & Gertler 2008; Javorcik 2004; Chang et al. 2007; Liang 2017; Lin et al. 2009; Tang 2008) Assuming that the research employs a panel data distinguishing between sectors and regions, the measure of horizontal foreign presence might be constructed in the following way:

$$\text{horiz}_jrt = \frac{\sum_{i \in jrt} y(\text{foreign})_{ijrt}}{\sum_{i \in jrt} y(\text{all})_{ijrt}},$$  
(2.1)

where subscript $j$ denotes sector (which sensitivity relies on the selection of standardised industrial sector digits), $r$ region (researchers usually employ the alternation of city-level and province-level), and $t$ time. The measure is, therefore, defined as the share of sector’s output ($y$) produced by foreign-owned firms. Nonetheless, the proxy is sometimes based on the level of employment or equity instead of output.

Under the same assumptions as stated above, the measure of backward vertical spillovers which captures the extent of linkages between domestic suppliers and MNEs as their customers might be defined as follows:

$$\text{back}_jrt = \sum_{k \neq j} \alpha_{jk} \text{horizontal}_{krt},$$  
(2.2)

where $\alpha_{jk}$ represents the proportion of sector $j$’s output which is supplied to sector $k$. The measure is based on input-output tables and selection of the standardised industrial sector digits while individual regions are typically not differentiated (note that $\alpha_{jk}$ lacks the regional subscript $r$) as the input-output tables provide information at only national level. $k$ is restricted to be different to $j$ as the effect is supposed to be separated from the horizontal
foreign presence (because this effect is already captured by $horiz_{jrt}$). Most of the recent primary literature follows Javorcik (2004) in the way that the proportion $\alpha_{jk}$ is calculated excluding the output for final consumption but including the imports of intermediate products. (Liang 2017)

Finally, the measure of forward vertical spillovers might be defined in the following way:

$$forw_{jrt} = \sum_{l \neq j} \gamma_{jl} \frac{y(foreign)_{ilrt} - export(foreign)_{ilrt}}{\sum_{i \in lrt} y(all)_{ilrt} - export(all)_{ilrt}},$$

(2.3)

as the weighted share of output in upstream sector produced by MNEs, where goods produced by MNEs for exports are excluded. (Javorcik 2004) Variable $\gamma_{jl}$ represents the share of inputs produced in sector $l$ and employed in sector $j$ while, similarly to the previous, inputs purchased within the same sector are excluded.

The response variable regressed by researchers in the primary literature is typically the measure of Total Factor Productivity (TFP) which is either estimated (Olley-Pakes method, Levinsohn-Petrin method etc.) or directly collected from available statistics. (Olley & Pakes 1996; Levinsohn & Petrin 2003) In some of the cases, TFP is substituted by output, value added, or labour productivity. Within our analysis, we control for any of the specifications introduced in this section. Based on all of the above mentioned, the general model in the primary literature on FDI spillovers might be illustrated on the following equation:

$$\ln(tfp_{ijrt}) = \beta_0 horiz_{jrt} + \beta_1 back_{jrt} + \beta_2 forw_{jrt} + \delta controls_{ijrt} + u_{ijrt},$$

(2.4)

where $tfp_{ijrt}$ represents the productivity measure (alternatively output, value added, or labour productivity). All control variables included in the regression (e. g., R&D spending, Herfindahl-Hirschman Index of sector competition etc.) are denoted by $controls_{ijrt}$. The estimates of coefficients $\beta_0$, $\beta_1$, and $\beta_2$ might be interpreted as semi-elasticities as the dependent variable is in the form of natural logarithm while the spillover variables on the right-hand side of the Equation 2.4 are levels. Thus, the level of spillover estimates implies the shifts in productivity of domestic firms based on a percentage-point change in foreign presence. For example, if $\beta_2$ is equal to
0.1, a 10-percentage-point increase in foreign presence implies a 1% increase in productivity of firms in downstream sectors.

### 2.2 FDI in PRC

Following tens of centuries of virtual closure of its boarders toward any substantial foreign influence, PRC experienced the first rupture of its excessive imperial self-esteem during the decades following the Republican Revolution in 1911. The rapid growth of coastal areas followed directly the sudden openness to international trade and FDI. As being later overlaid by the Japanese invasion, civil war, and establishment of the People’s Republic of China in 1949, the full potential of FDI inflows became to be exploited after the appointment of Deng Xiaoping in 1978. Deng, as the general architect of reform, accentuated the importance of economic reform and opening-up. The core strategy was to achieve significant effects through partial changes in fundamental factors (such as incentives, competition, mobility, and prices). Following the assumptions of the strategy, any minor inefficiencies should have been overcome by the essential improvements. The procedures were, nonetheless, further tested through so-called special economic zones in which, once more, especially the selected coastal areas enjoyed the benefits of the freeing- and opening-up. After a temporary slowdown, a remarkable increase in foreign trade and FDI inflows accelerated once again after Deng’s Southern Journey in 1992, trying to overshadow the bitterness of Tiananmen Incident of 1989 and replace it with augmented prosperity of the country. The inflows of FDI were further boosted by tough competition among the local officials over the volume of FDI inflows (among other economic indicators). Nevertheless, the general economic growth was bound to augmented limited-quality high-scale production rather than increasing productivity of the Chinese business. (Brandt & Rawski 2008; Lieberthal 2004; Qian 2000)

Due to the above mentioned open-door policy, PRC has been perceived as one of the largest recipients of FDI in the world over the past decades. Although this still holds as PRC is currently the second largest beneficiary of FDI inflows, the development is turning around. While the trend of FDI inflows amounted to USD 231 billion in 2016, if combined for both mainland China and Hong Kong, following the United States (USD 385 billion). If focused only on the mainland China, it is still ranked as the third largest beneficiary (USD 139 billion) following the United Kingdom (USD 179 billion), while Hong Kong itself is the fourth largest recipient of FDI. (UNCTAD 2017)
inflows is decreasing, the tendency of outflows is emerging. (Chang et al. 2007) In 2016, PRC faced a decline in FDI inflows for the third consecutive year (driven mainly by a decline in Hong Kong’s FDI), whereas it became a net outward direct investor for the first time. (OECD 2017) Historically, the determinants of Chinese FDI inflows were bound to a vast potential of a developing country’s economy. The inflows have been attracted especially by the following: (i) market size (environment of the most populated country in the world experiencing an enormous continues economic growth for several decades), (ii) cheap labour (high labour supply combined with low wages established a favourable conditions for an export-oriented FDI), (iii) governmental policies (provision of incentives targeted on foreign investors, e.g., tax concessions, and gradual elimination of trade barriers), and (iv) stable political regime (although PRC is not a democratic country, the political environment is broadly considered to be stable and trustworthy with respect to running a business based on a foreign direct investment). Therefore, the fundamental goal of the Chinese economic transformation initiated by Deng was, to a large extent, met. The open-door policy has contributed to the economic achievements based on the accent of changes in the core factors. Obviously, PRC has also capitalised on the comparative advantages of both developing economy and authoritarian regime. Chinese economic growth, as well as the FDI inflows themselves, has been fuelled by unexploited potential, massive infrastructure investment, misuse of intellectual property, heavy environmental footprint, or limitation of human rights. (Abraham et al. 2010; Brandt & Rawski 2008; KPMG 2015; 2016; Lieberthal 2004; Lin et al. 2009; Qian 2000)

The recent shift in FDI inflows volume and composition mirrors the changes of the Chinese economy. The existing fuel of the economic growth represented by the demand side (i.e., investment, export, and consumption)\(^3\) is being gradually replaced by the supply side. In particular, the voices calling for a supply-side structural reform are raising from both inside (local experts and Chinese administration itself) and outside (international experts) the country as a smooth transition to the new patterns of production and consumption are frequently challenged. The need for further restructure of industries, institutional and technological innovation, privatisation, or reduction of tax

\(^3\)In practice, the consumption is not a substantial driver of the Chinese economy. Therefore, it accounts for one of the major concerns about the current and future development of the economy.
burden encounters, nonetheless, a delicacy of political and social issues linked with a consequent increase of unemployment and instability. (CCTV 2016; KPMG 2016; UNCTAD 2017)

The recent drop in volumes of private investment and slowdown of economic growth emerge from the following factors: (i) manufacturing over-capacity (e. g., industries linked with the steel and coal; filled with zombie companies—mainly state-owned enterprises net-subsidised for more than three consecutive years), (ii) undercapacity of high-end products and gap between investment and consumption rates, (iii) vast amount of outstanding debt, (iv) increasing production cost, (v) overemployment, (iv) environmental degradation etc. In summary, a gradual exhaustion of different relatively short-term sources of economic growth and economic performance is observable in the recent years in PRC. (Brandt & Rawski 2008; CCTV 2016; KPMG 2016; Economist 2014) The ways how to deal with the present issues are, again, outlined by the experience of Chinese special economic zones within which the supply-side structural issues have been already addressed on the micro level. Not surprisingly, the given regions and cities (such as Guangdong and Fujian provinces, or cities of Shenzhen and Foshan) perform significantly better than the rest of the country. For example, Guangdong province has done significantly better than the nation-wide averages in 2016 in both GDP growth (7.4% in comparison to 6.7% nation-wide) and private fixed-capital investment growth (19.6% in contrast to only 2.8% nation-wide) despite a significantly higher saturation of the local economy. (Sheng, A. and Geng, X. 2016)

In accordance to the above mentioned, the character of Chinese FDI inflows has shifted over the recent years while further changes are about to come. The Chinese transformation from an investment-intensive and export-led economy to a consumption-oriented and innovation-driven system heavily influences the composition of FDI twofold: (i) inflows into the existing drivers of the economy in the form of general manufacture and traditional industries decline and (ii) FDI allocated into the sectors of services, high-tech manufacture, and consumer markets is on the upswing with a strong potential for further growth. (Economist 2014) Following the assumption of the shift toward quality, the eastern regions of PRC which are relatively more developed in comparison to the central and western regions of the country grew faster in absorbed FDI volumes recently. As emphasised in KPMG’s China’s outlook 2016, this happened "for the first time since 2010 when the government
began to actively promote westward growth initiatives." (KPMG 2016) The Chinese FDI inflows gain momentum in the sectors of services and high-end technology while the up-to-now sinks of FDI are getting clogged. Manufacturing and heavy industries are already highly saturated and both natural development and the party’s policies steer the economy to take different aims, that is to transform the swiftly reproducing economy to a highly innovative quality-based economy.

Accordingly, the Chinese investment in R&D as a percentage of GDP has increased nearly four times between 1996 and 2013 from 0.57% to 2.01% of the domestic output. With regard to the R&D investment, PRC has considerably approached Japan (3.47% in 2013) and the United States (2.81% in 2012) and even draw level of the European Union (2.02% in 2013). (Rodriguez-Pose & Wilkie 2016) The shift of the economy, and FDI composition consequently, toward quality-intensive production is, among others, traceable in the official Chinese strategic documents. Based on the 13th Five-Year Plan approved on 16 March 2016, two out of five underlying concepts of the Chinese development over the period 2016-2020 are innovation and green development. To demonstrate this on hard numbers, e. g., the R&D investment intensity is planned to increase by 0.4 percentage points from 2.1% of GDP in 2015 to 2.5% of GDP in 2020 while energy and carbon intensity and magnitude of particular major pollutants emission should drop by 10 to 18 percent over the period. Both of these key concepts are, therefore, highly quality-intensive. (State Council of the PRC 2016) One of the PRC’s individual short- and middle-term priorities announced within the last Five-Year Plan is the recognition of the need for foreign technology, know-how, and capital in the service sector which might generate further opportunities for FDI inflows in the areas of healthcare, e-commerce, consumer goods etc.

2.3 ODI in PRC

Another channel for accommodation of the additional productivity spillovers is also the Outward Foreign Direct Investment (ODI), i. e., FDI outflows. Di Minin et al. (2012) investigate technology exploration and exploitation intentions of Chinese firms (both private and SOEs) in Europe, taking advantage of highly skilled European labour. The authors consider such approach to be an alternative strategy to the one based on attracting foreign investments, although Hou & Mohnen (2013) show that the external technology
acquisitions are beneficial merely to a certain extent, especially because they increase the labour productivity only with a limited efficiency in the long term. With respect to the increasing volume of Chinese ODI (recall that PRC became a net outward direct investor for the first time in 2016), it is, nonetheless, worth to briefly sketch its composition and recent development, even though it is not the subject of our primary interest within this study.

PRC, being the second largest source of FDI worldwide following the United States, (OECD 2017) continuously further strengthens the share of the tertiary industry with respect to the total ODI. Although PRC is slightly augmenting its overseas investment into the infrastructure sectors of the secondary industry in the long term, it primarily focuses on ODI into healthcare, entertainment, and high-tech sectors. In addition, PRC has strangled its foreign investment into mining and construction in 2014 (i.e., last year of the detailed data available) for the first time since 2010 while, in contrast, it has boosted the investment into the tertiary industry in the same year. The structure of ODI is also shaped according to a particular destination of the investment, adjusting for the strategic character of the investments based on the target country. While there is more emphasis on the secondary industry in the case of investment into developing countries (e.g., infrastructure and manufacturing), the tertiary industry is prioritised when investing into developed countries (e.g., finance and different industries which feature a strong social influence). On one hand, Chinese ODI focuses on physical infrastructure in the areas with high economic potential (e.g., Africa or less developed areas in Asia) where it represents a key condition for future growth. On the other hand, it aims on services, media, and high-tech sectors in developed countries where PRC might increase its overall influence. (KPMG 2016; Economist 2014; 2017; Song & Golley 2013)

The United States, Luxembourg, Australia, Singapore, and the United Kingdom represented the top five beneficiaries of the Chinese ODI in 2014 with respect to both flows and stock. (KPMG 2016) Not surprisingly, all of these countries reaching the top five are either financial centres of their geographical areas or at least high-tech and quality-oriented economies. Such observation is in line with the Chinese strategy of strengthening its power among the world leading economies. Moreover, the assumptions about the targeting of Chinese ODI are further confirmed by the case study of Africa. In 2010, the Chinese ODI in Africa amounted to USD 2.11 billion (which accounted for 3.1% of the total ODI of PRC and 3.84% of the total FDI in
Africa) from which about one fifth streamed into South Africa, one of the most developed African countries. In overall, Chinese ODI in Africa has skyrocketed in the previous decade, performing the average annual growth of 46% in the period 2000-2009, while it has been focused on energy-rich African countries. (Tsao et al. 2015) This contradiction with the general perception of strictly resource-driven Chinese ODI to Africa is also confirmed by Carike et al. (2012) who conclude that "China invested in diversified, medium growth economies between 2003 and 2008. Although resource security is an important consideration for Chinese investors, Beijing’s approach to Africa does appear much wider than popularly believed."

The recent development of Chinese investment outflows, nevertheless, raises the concerns what should be an appropriate response from developed countries—making the future development uncertain. This is not a new phenomenon for the world economy as, e.g., the United States were facing the issue of undesirable inflows of FDI for several times during the 20th Century. During the World War I, the United States were dealing with an influx of FDI from Germany mainly into the chemical industry; throughout the 1970s, the Organization of Petroleum Exporting Countries (OPEC) invested in a large scale; and in the 1980s, the rise of Japanese foreign investments caused an anxiety among public as well. These events resulted in the commencement of new legislation which allows to block FDI, if there is a strong belief that it represents a threat to national security. (Song & Golley 2013; Zhang 2013) Obviously, if such restrictions are imposed in the future, it might freeze or even reverse the trend of growing foreign investment outflows.

### 2.4 FDI Spillovers in PRC

According to the primary literature, linkages between the overall economic growth of PRC and foreign investment inflows are not significantly traceable. (Gunby et al. 2017) Nonetheless, few characteristics and implications of FDI presence are identified. Based on the examination of variation of the firm’s characteristics linked with its foreign investment share, the foreign presence is associated with higher output and wages (Lin et al. 2009) and it also enhances Chinese manufacturing export. (Zhang 2006) Any effects of FDI are frequently differentiated according to the country of origin while a special case of HMT is widely investigated. The resulting FDI spillover effect is always a fusion of the geographical and cultural advantage (including the lack
of language barrier) of HMT investment on the one hand and the superior technology, level of global production chains, and broadly recognised brand names of non-HMT MNEs on the other. (Abraham et al. 2010; Lin et al. 2009; Long et al. 2014; Mao & Yang 2016) Although the findings are not uniform, the majority of identified negative spillovers linked with HMT investments (Girma & Gong 2008; Lin et al. 2009; Tang 2008) is in line with the basic theoretical background of domestic sourcing by foreign firms being inversely proportionate to the proximity of the beneficiary country. (Rodriguez-Clare 1996) On the other hand, detail research of a part of the primary literature describes some hidden nuances of the HMT influence. FDI from HMT tends to produce more positive horizontal spillovers for private firms and in technologically sophisticated industries in overall, (Long et al. 2014) but the export-driven investment increases competitive pressure making the export-oriented Chinese firms suffer from negative spillovers. (Abraham et al. 2010; Lin et al. 2009) Finally, no structural differences between HMT and non-HMT originated investments are found in a specific case of the hotel industry. (Mao & Yang 2016)

Similarly to the primary literature on FDI spillovers in general, the overall findings on both horizontal and vertical spillovers in PRC are inconclusive. Horizontal spillovers are concluded by the individual studies to be all positive, (Blake et al. 2009; Chang et al. 2007; Mao & Yang 2016) insignificant, (Long et al. 2014) ambiguous, (Abraham et al. 2010; Agarwal & Milner 2011; Lin et al. 2009; Liu 2008; Liu et al. 2009) and negative. (Girma & Gong 2008; Tang 2008) Analogously, vertical spillovers are also considered to be either positive, (Lin et al. 2009; Liu 2008; Liu et al. 2009; Long et al. 2014) insignificant or ambiguous, (Blake et al. 2009; Qiu et al. 2009; Wang & Wu 2016) and negative. (Girma & Gong 2008; Tang 2008) In addition, individual studies present a wide range of specific results which attempt to explain some of the variance.

For instance, differentiation of SOEs and private firms is one of the most lively areas of research on the FDI spillovers in PRC. Whereas Lin et al. (2009) find strong and robust vertical spillover effects on both SOEs and private firms, Chang et al. (2007) and Girma & Gong (2008) affirmatively conclude that their evidence in favour of any of these is not overwhelming, and the other researchers draw even different conclusions. In contrast to the former one, private firms are supposed to suffer from negative vertical linkages according to Liu et al. (2009) and Long et al. (2014). Moreover, findings on
the horizontal spillover effects on non-SOEs are further inconclusive—negative according to Liu et al. (2009), but positive by Long et al. (2014). Finally, although Liu et al. (2009), Long et al. (2014), and Tang (2008) find SOEs to experience negative horizontal spillovers, Blake et al. (2009) describe SOEs as more likely to benefit from them. Additional inconsistency is observable also in comparison of spillover effects for wholly foreign-owned firms and joint ventures. While Liang (2017) states that the positive effects are larger for wholly-owned subsidiaries, Abraham et al. (2010) conclude that joint ventures are more likely to have a positive impact on local productivity, and Tang (2008) finds that wholly foreign-owned firms account for a larger share of negative horizontal spillovers, compared to joint ventures.

On the other hand, primary literature is uniform in assessing the role of absorptive capacity and technological capabilities of individual firms or in specific industries. Limited absorptive capacity is concluded to be restricting whilst more technologically sophisticated industries are supposed to generate significant positive spillovers. (Girma & Gong 2008; Liu et al. 2009; Long et al. 2014) Similarly, advanced regions of special economic zones are identified as a favourable environment for production of positive spillovers (Abraham et al. 2010) and Mao & Yang (2016) who investigate a specific case of the hotel industry conclude that the horizontal spillovers are mostly associated with top-quality services in the selected regions. Finally, Liu (2008) distinguishes between short-term and long-term effects and conclude that an increase in FDI lowers the short-term productivity level, but raises the long-term rate of productivity growth in the same industry (i.e., horizontally). Liu further adds that the backward linkages seem to be statistically the most important channel through which positive spillovers occur.

As demonstrated throughout this section, most of the studies in the primary literature on the FDI spillover effects report various estimates—for different regions, different sectors, different types of firms (e.g., SOEs, export-oriented, joint ventures etc.), different methodology employed etc. To evade any arbitrary selection of the best practice, we include all reported estimates which are mutually comparable. Composition of such dataset assumes that there is a true effect of the FDI spillovers which differs across individual observations (which manifest through results of the primary research) due to various characteristics of the observations themselves. The vast meta-analysis conducted within this thesis is an attempt to control for the influential characteristics and capture the true effect.
To the best of our knowledge, there have been three meta-analyses conducted on a related topic. (Gunby et al. 2017; Ljungwall & Tingvall 2015; Masoumy & Azarhoushang 2015) First, Gunby et al. (2017) conclude that after controlling for publication bias and study and sample characteristics, the relationship between FDI and Chinese economic growth is much smaller than a simple aggregation of existing primary estimates would suggest. Actually, once the influential effects are accounted for, the estimated effect of FDI on the growth is reduced to statistical insignificance. Second, Ljungwall & Tingvall (2015) who examine a specific effect of R&D spending find that the growth-enhancing effect of R&D spending in China has been significantly weaker than that of other countries under investigation. Based on this, they assess it unlikely that R&D spending has been successful as a key contributing factor to economic growth in China. Third, Masoumy & Azarhoushang (2015) present only the hypotheses of their preliminary work; within these, they expect the primary estimates to be significantly affected by different types of FDI and various methodology characteristics of the research.

Although the presented literature reviews focus on related topics, they are either of inferior quality or not sufficiently comparable with our research. First, Gunby et al. (2017) base their dataset on a different kind of reported estimates. They rely on literature which investigates relationship between the aggregate domestic output and the presence of foreign investment. In comparison to our primary literature, such data provides less detailed information—focusing on a straightforward correlation between FDI and output instead of the impacts on productivity. Consequently, such data cannot distinguish between individual channels of FDI spillovers as the primary literature does not report the estimates of horizontal, forward, and backward spillover effects separately. Second, Ljungwall & Tingvall (2015) use an international dataset and only control for the effect through a Chinese dummy variable. Rationale of their research is, therefore, substantially different to ours—comparing the effect in PRC to other countries. Furthermore, they explore a distinct phenomenon of relationship between the R&D spending and economic growth. Finally, Masoumy & Azarhoushang (2015) present only a concept which they label as an “extremely preliminary.” The authors explicitly request not to cite their existing research; therefore, we mention the study only for the sake of acknowledgement of its existence. Although it is unnecessary to investigate the study in much detail due to its preliminary stage, it seems that the analysis is supposed to be based on a
much narrower dataset, not controlling for publication bias, nor employing advanced methodology of the heterogeneity investigation such as BMA.

In overall, none of the existing reviews is comparable to our research with respect to particular focus, scope, and level of detail. Our research is the only one which differentiates between individual spillover channels—horizontal, forward, and backward. Further, none of the related studies is based on more than a half of the number of regression results collected from the primary literature within this thesis. While we examine dataset which consists of 1081 individual estimates, Gunby et al. (2017) examine 280 reported coefficients, Ljungwall & Tingvall (2015) work with 538 observations (moreover, only a part of them is for PRC), and the preliminary paper of Masoumy & Azarhoushang (2015) presents the collection of only 132 primary regression results.
Chapter 3

Methodology

Primary literature focused on FDI spillovers in PRC is not uniform in its conclusions. Reported finding are mutually contradicting while the heterogeneity is not adequately explained. As there is no pattern of the heterogeneity occurrence identified, it is inappropriate to only insist on individual case studies and narrative literature reviews. An appropriate approach to solve this puzzle is the meta-analysis.

If the researchers present significantly different findings when investigating a seemingly identical phenomenon, the meta-analytical approach attempts to explain variation among the reported empirical results. The reasons for the heterogeneity might be miscellaneous. They may lie in the idiosyncratic choices of statistical methods, biases induced by model misspecification, or unique characters of individual datasets. (Stanley & Jarrell 1989) Similarly to any other statistical tool, the meta-analysis suffers from various peculiar weaknesses. Moreover, the approach might be misused when not applied properly. It differs, nonetheless, from traditional reviews substantially. The quantitative methods force the judgments to be made more explicit and to be subject to independent testing. "It moves literature reviews away from casual judgements about ‘good’ studies that deserve attention and ‘poor’ studies that should be set aside, and instead provides a replicable statistical framework for summarizing and interpreting the full range of evidence.” (Stanley 2001) Drawbacks of the meta-analytical approach are discussed in detail in section 3.3.

Several summary statistics and graphical methods are used to preliminarily identify potential publication bias and to provide a broader analysis of the estimated effects (see subsection 3.1.1). These basic complementary methods
serve only as a quick review and source of additional information. Both publication bias and heterogeneity of the reported primary estimates are further analysed in detail through regression tests (see subsection 3.1.2 and section 3.2). Moreover, BMA is employed to select the explanatory variables to be included in our modelling of heterogeneity–resolving the resulting model uncertainty (see section 3.2). To the best of our knowledge, there have been three different meta-analyses conducted on the topic of FDI in PRC. (Gunby et al. 2017; Ljungwall & Tingvall 2015; Masoumy & Azarhoushang 2015) Nevertheless, none of these is directly comparable to the presented research (for detailed information on the existing meta-analyses, see section 2.4).

3.1 Publication Bias

Besides the identification of how a particular choice of data, methods, and model’s specification affects reported results, the meta-analysis tests for presence of a publication bias. The publication bias represents a common issue of academic writing which results in a substantial distortion of the published pool of research. Both researchers and publishers might tend to treat the conventional and statistically significant results more favourably; in particular, the publication bias might arose from either of the following roots: (i) the findings consistent with the conventional views are preferentially accepted to be published by the reviewers and editors, (ii) the researchers tend to establish a model selection test on the conventional arrangements, (iii) the statistically significant results attract the attention of reviewers and editors more easily, (iv) the researchers adjust the data or model specification until the results meet their prior expectance. If any of these manifests in practice, the literature is then spoiled by distorted, broadly unreliable, findings consisting of a non-random sample of estimates. In contrast, if the reported estimates are randomly distributed around the true effect, the literature is free of publication bias. (Card & Krueger 1995; Stanley & Doucouliagos 2007)

The publication bias is further distinguished by its characteristics according to the various roots listed above. First, the bias is said to be of Type I, if the results consistent with the conventional theory are reported preferentially. Second, if the statistically significant results are favoured, the bias is called Type II. The former one is considered to be more essential as the consequences owing to under- or overestimation of the true effect might be
more serious. On the other hand, even though the later one makes the true effect seem to be larger than it actually is, the implications are mostly moderate. (Stanley 2005; 2013) The type II publication bias might occur in any research irrespective of its focus as it is a feature of human nature to seek for significant results; therefore, it is adequate to test for its presence. In addition, we suspect the literature on FDI spillovers in PRC to be biased by type I as well, since although the aggregate of individual findings is not uniform, nor sufficiently conclusive, the mean estimate of the entire literature might be still skewed by prevailing theoretical background. Especially, an attempt to confirm the national and provincial policy goals and open-door measures can underline and substantially influence the research of FDI spillover effects. The following subchapters introduce both graphical tools and regression tests to detect any publication bias.

3.1.1 Graphical Tools

When dealing with a potential publication bias, two simple graphical methods of examination are at disposal—funnel and Galbraith plot. Although none of these graphical tools is an ultimate test for publication bias, both are quick and auxiliary instruments how to assess it. Drawing the plots represents the first and necessary step of the analysis of publication bias.

A funnel plot is the simplest and most frequently used method of an informal examination to detect publication bias. (Sutton et al. 2000) This scatter diagram is composed of precision on vertical axis and non-standardized effect (i.e., estimate or partial correlation coefficient) on horizontal axis. The precision can be measured in different ways; nonetheless, “the most common and precise of which is the inverse of the standard error (1/SE).” (Stanley 2005) Further, the sample size, or its square root, might serve as a measure of precision. Finally, the number of degrees of freedom used in the primary estimation might be considered as applied in Babecky & Havranek (2014).

If no publication bias is present, estimates should vary randomly and symmetrically around the true effect regardless of its magnitude. The expected shape of the plot—i.e., inverted funnel—corresponds to a predictable heteroscedasticity. The fabricated funnel is more dispersed at the bottom because small-sample studies with usually larger standard errors—corresponding to less precision—are located at the bottom of the plot. An asymmetrical funnel plot suggests the type I publication bias. In contrast, a
hollow and wide funnel plot indicates the type II publication bias, i.e., publication selection favouring results with higher statistical significance. (Stanley 2005) The type II publication bias is further investigated also via Galbraith plot.

For a better illustration, simulation of three different states of affairs is depicted in the following diagrams, Figure 3.1. These three alternatives depicted are the following: (i) no publication bias, (ii) type I publication bias, and (iii) type II publication bias.

**Figure 3.1:** Funnel plot with no, type I, and type II publication bias

As already mentioned, the graphical tools have their limits in assessing publication bias. First, the funnel plots implicitly assume presence of a single underlying true effect. Alternatively, variation of the true effect is assumed to be random—i.e., symmetric—in the case of absence of a single value for the true effect common to all studies. Nevertheless, publication bias is not the only potential source of asymmetry in reality. (Stanley 2005) Second, heterogeneity of the true effect may, by contrast, incur asymmetry into the funnel plots even if no publication bias is present. (Stanley 2005) cautions against such confounding of publication bias with heterogeneity and describes it as the *funnel graphs’ greatest threat to validity* in econometric economic applications. Nonetheless, we use this graphical tool only as an auxiliary indicator and further employ a regression analysis to analyse the heterogeneity explicitly, as explained in section 3.2.

The type II publication bias can be identified by the Galbraith plot. Galbraith plot is a scatter diagram of standardized effect and precision, (Galbraith 1988) where the standardized effect is a t-statistic computed in the following way:

\[
adjt_i = \frac{\text{spillover}_i - \text{true}}{se_i}, \quad (3.1)
\]

where *true* represents the true effect. The true effect can be estimated
3. Methodology

by Precision Effect Test, or preferably by Heckman meta-regression. Both methods are introduced in the following sections. \( \text{spillover}_i \) is an estimate of the FDI spillover effect and \( se_i \) stands for the standard error.

Through a Galbraith plot, we can appraise an excessive likelihood of reporting the significant results. Galbraith plot corresponds to a funnel plot which is rotated 90 degrees and adjusted to eliminate heteroscedasticity. If there is no genuine effect present, the individual points should be randomly distributed around zero with no systematic relation to precision. In addition, the computed t-statistic should not abandon the interval \([-1.96, 1.96]\) in more than 5% of cases. (Stanley 2005)

3.1.2 Regression Tests

A simple meta-regression of an estimated FDI spillover effect (\( \text{spillover}_i \)) on the standard error (\( se_i \)) is the starting point for modelling publication bias. If there is no publication bias, the estimate should vary randomly and independently of the standard error around the true FDI spillover effect (\( \beta_0 \)). The model might be defined in the following way:

\[
\text{spillover}_i = \beta_0 + \beta_1 se_i + u_i \quad u_i | SE_i \sim N(0, \delta^2).
\] (3.2)

With increased information, standard error decreases and consequently approaches zero with the sample size going to infinity. Therefore, larger samples might be expected to exhibit a minor level of publication bias since their reported estimates have a better predisposition to approach the true effect and their reported publication biases (\( \beta_1 \)) approach zero with the error variance. Following this rationale, a quick remedy for areas of research which contain vast number of studies is to average the findings from only the largest studies. (Stanley 2005) suggests to take only the top 10% into consideration.

Nonetheless, since studies in the primary literature employ various data sets, sample sizes, and explanatory variables (the variation in approaches is described in detail in section 2.1 and section 2.4), the random estimation errors \( u_i \) are presumed to suffer from heteroscedasticity. Fortunately, weighted least squares method offers an efficient correction through dividing Equation 3.2 by the standard error of \( \text{spillover}_i \). This procedure improves also the comparability of individual estimates. A t-statistic which becomes the new dependent variable (i. e., the estimated effect divided by its standard error) has no dimensionality and is perceived as "a standardized measure of
the critical parameter of interest.” (Stanley & Jarrell 1989) The model specification then comprises the Funnel Asymmetry Test (FAT) and the Precision Effect Test (PET) and corresponds to the following:

\[
\frac{\text{spillover}_i}{\text{se}_i} = t_{stat}_i = \frac{1}{\text{se}_i} + \beta_1 + v_i \quad v_i|SE_i \sim N(0, \delta^2),
\]

(3.3)

Within this arrangement, we can test for a potential publication bias; the null hypothesis is \(H_0 : \beta_1 = 0\). (FAT) If we are able to reject the hypothesis, we detect a publication bias. In addition, we can test for the significance of the FDI spillover effect; the hypothesis is \(H_1 : \beta_0 = 0\) (PET) If we are not able to reject the hypothesis, no significant effect is present. Nonetheless, such weighting scheme gives more weight to these primary estimates which yield superior level of precision. In other words, if a primary study underestimates the standard error, weighting by precision might generate an additional bias. Therefore, all of the presented weighted model’s specifications should be treated with caution as the estimation of standard errors themselves is one of the fundamental features of modelling in economics. Primarily, the model defined as Equation 3.3 might be estimated by Ordinary Least Squares (OLS). Nonetheless, potential of a structural dependency over (i) the estimates reported within a single study or (ii) the estimates reported as the results of the same methodology, data etc. calls for a robustness check.

First, study-level clusters are employed within the estimations. Second, the Fixed-Effect (FE) model is introduced to overcome the dependency of estimates reported within the same study. The model is specified in the following way:

\[
t_{stat}_{ij} = \beta_0 \frac{1}{\text{se}_{ij}} + \beta_1 + \xi_{ij} \quad \xi_{ij}|SE_{ij} \sim N(0, \delta^2),
\]

(3.4)

where the subscript \(i\) specifies an individual estimate as previously, but \(j\) further denotes a particular study. Third, we address a between-study heterogeneity generated by the variation in methodology, data, model specification etc. by using the Mixed-Effect (ME) multilevel model which follows:

\[
t_{stat}_{ij} = \beta_0 \frac{1}{\text{se}_{ij}} + \beta_1 + \zeta_j + e_{ij} \\
\zeta_j|\text{se}_j \sim N(0, \psi); \quad e_{ij}|\text{se}_{ij}, \zeta_j \sim N(0, \theta)
\]

(3.5)
where the error term is further divided into (i) study-level random effects $\zeta_j$ and (ii) estimate-level disturbances $e_{ij}$. Under this kind of random-effects meta-analysis, we assume that the true FDI spillover effect is randomly distributed over the primary literature complying with the variation across methods employed. The newly introduced components of the error term are assumed to be independent. The overall error variance might be computed as $\text{Var}(\xi_{ij}) = \psi + \theta$. Nevertheless, reliability of the ME model is very sensitive on any substantial violation of exogeneity assumptions. With respect to this, the robustness check of cross verification of results obtained through OLS, FE, and ME is fundamental.

Apart from the estimation of publication bias, we desire to estimate the true FDI spillover effect as precisely as possible to incorporate it indirectly into the Galbraith plot. We obtain the estimate which is further used to compute the adjusted t-statistic as described in Equation 3.1 by estimation of the following model:

$$t\text{stat}_{ij} = \beta_0 \frac{1}{se_{ij}} + \beta_1 + \beta_2 se_{ij} + \zeta_j + e_{ij}, \quad (3.6)$$

where $\beta_0$ is the estimated coefficient of the true FDI spillover effect. The presented model is the ME specification of Heckman meta-regression (ME is used as an example as it is the most comprehensive of the employed specifications) which is based on a non-linear relationship between the estimates and standard errors. The relationship between publication bias and standard errors is assumed to be quadratic.

### 3.2 Bayesian Model Averaging

Study of heterogeneity across the FDI spillover effect’s estimates reported in the primary literature is accompanied by an obligatory uncertainty in specification of the final model. The uncertainty is underlined by the amount of collected attributes of data, methodology, and other characteristics of the studies; in overall, we collected 85 characteristics while more than 30 of them are employed within each of the individual models of heterogeneity. To find the most important determinants, we employ BMA approach. Whereas some of the economic factors which might influence the productivity spillovers (such as specification of the FDI source’s region or type of the firm’s ownership) are traceable in the theory, it is ambiguous which features of the study
design are relevant. BMA provides an inclusion of all method and economic variables which is essential as an omission of the significant control variables might make our estimates to be biased; by these means, BMA generalises the fundamental robustness check of estimating different regressions with various sets of explanatory variables. In practice, we let BMA to gradually reestimate our meta-regression; the model which examines the heterogeneity might be denoted in the following way:

\[
spillover_{ij} = \beta_0 + \sum_{k=1}^{K} \alpha_k Z_{k,ij} + \epsilon_{ij}, \tag{3.7}
\]

where \( Z_k \) is the set of explanatory variables and \( K \) corresponds to their total amount. Based on an individual specification, (i) the whole Equation 3.7 might be weighted by precision \((1/\text{se}_{ij})\) or by the number of estimates reported per study; or (ii) the error term \( \epsilon_{ij} \) might consist of two components \( \zeta_j \) and \( e_{ij} \) as both introduced in the previous section. For the sake of clarity, rationale of the BMA method is explained on the example described by Equation 3.7. Since we lack knowledge of the true set of explanatory variables, we initially face a total of \( 2^K \) potential model specifications. BMA resolves the uncertainty in the following way:

\[
p(\alpha|\text{spillover}, A) = \sum_{m=1}^{2^K} p(\alpha|\text{spillover}, A_m)p(A_m|\text{spillover}, A) \tag{3.8}
\]

represents the posterior of a vector (denoted as \( \alpha \)) of all \( K \) effects \( \alpha_k \) associated with explanatory variables \( Z_k \). The set of all potential combinations of regressors \( Z_k \) which might be included in the model is labelled \( A \equiv [A_1, A_2, ..., A_{2^K}] \). \( p(\alpha|\text{spillover}, A_m) \) is acquired by estimation of model \( A_m \) on the set of primary estimates spillover. A posterior model probability (denoted as \( p(A_m|\text{spillover}, A) \)) is related to combination \( A_m \) which might be computed as follows:

\[
p(A_m|\text{spillover}, A) = \frac{p(A_m|A)p(\text{spillover}|A_m)}{\sum_{m=1}^{2^K} p(A_m|A)p(\text{spillover}|A_m)}, \tag{3.9}
\]

where \( p(A_m|A) \) and \( p(\text{spillover}|A_m) \) correspond to prior probability of model \( A_m \) and its marginal likelihood, respectively. The marginal likelihood further follows:
\[ p(\text{spillover}|\alpha, A_m) = \int p(\text{spillover}|\alpha, A_m)p(\alpha|A_m)d\alpha, \quad (3.10) \]

where \( p(\alpha|A_m) \) is prior density of parameter vector and \( p(\text{spillover}|\alpha, A_m) \) is the likelihood. When reestimating the meta-regression, each estimated model generates a forecast density providing us with \( 2^K \) forecasts \( f_1, f_2, \ldots, f_{2^K} \). In theory, we would identify the true model and employ its single density. In practice, BMA weights for us each of the individual forecasts by posterior probability of the model and generates the final point prediction expressed in the following way:

\[ f = \sum_{m=1}^{2^K} p(A_m|\text{spillover}) f_m, \quad (3.11) \]

To summarise the present methodology, BMA computes a weighted average over the estimated models, where the weights are the posterior model probabilities. These might be perceived in a similar way as the adjusted R-squared or information criteria in the common methodologies as they represent a measure of the fit of the model. Consequently, the highest posterior model probabilities are assigned to the models which fit the data most accurately. Furthermore, BMA provides us also with a measure of likelihood that a variable should appear in the true model—it is called the posterior inclusion probability and it consists of the sum of the posterior model probabilities of the full set of models which include the variable. Finally, we can also extract the statistics which are analogous to the estimated coefficients and their standard errors; the posterior mean (which is similar to the estimate) and the posterior standard deviation (analogous to the standard error) might be deduced from the posterior coefficient distribution. In practice, we employ the \textit{bms} package in R (Feldkircher & Zeugner 2015) which uses the Metropolis-Hastings algorithm to go through the most influential models (i.e., models with the highest posterior model probabilities) via Markov chain Monte Carlo methods. By running the estimation with 2 million iterations, we overcome the issue of assessing \( 2^K \) models, where \( K > 30 \), and ensure an adequate degree of convergence. For more detailed introduction to the BMA approach in general, see Koop \textit{et al.} (2007), Hoeting \textit{et al.} (1999), or Wasserman (2000). Furthermore, an overview of Moral-Benito (2015) provides summary of the existing BMA applications in economics and Feldkircher
& Zeugner (2015) can shed some valuable light on BMA’s technical application in R.

3.3 Criticism of the Meta-Analytical Approach

Meta-analytical approach is sometimes perceived with a certain amount of scepticism. Such attitude arises, nonetheless, especially from a lack of depth of knowledge and prudence of the criticizers. As the challenge and defence of the research represent the corner stone of science, some frequently raised doubts are addressed in this Section. For further assessment of the possible drawbacks of the approach, see Havranek & Irsova (2017), Sharpe (1997), and Stanley (2001; 2005; 2013). An additional dispute over any of the below-mentioned, or omitted, points is certainly welcome any later.

The meta-analytical research needs to be conducted with the same thoroughness and caution as any other research. The main aim of the meta-analysis is to provide us with more detailed information about the phenomenon under study through the investigation of particular case studies. Essentially, although we lack the depth of understanding of the phenomenon held by the primary researchers, we are still able—under the assumption of a common true effect and random distribution of deviations—to extract the most robust findings. Here, the role of robustness checks is irreplaceable. Only if our model is robust and stable enough, we can draw any reliable conclusions.

Heterogeneity of the studies which constitute the dataset examined by meta-analysis is one of two major issues of the approach that is discussed. This is being usually referred to as comparing apples with oranges. The individual estimates are extracted from different data and by various methods; therefore, it is crucial to control with caution for any substantial differences in the primary studies’ design. The issue of availability and selection of relevant factors (i.e., explanatory variables in the meta-analytical model) is consequently frequently highlighted. With respect to this, one should publish only such results which are based on an appropriately robust dataset. We collect 85 characteristics of data, methodology, and background of the studies which might cause heterogeneity in estimates reported in the primary literature. More than 30 of these (35, 33, and 36 in particular) are employed within the BMA estimation of heterogeneity for horizontal, forward, and backward spillovers, respectively. In comparison to the existing literature which
uses meta-analysis, such pool of variables is considerably robust as Nelson & Kennedy (2009) summarise that a median meta-analysis uses 12 explanatory variables.\footnote{The review is based on 140 individual meta-analyses, while the largest one employs 41 explanatory variables.} Moreover, a group of studies which do not present results directly comparable with the others is excluded from the analysis in order to secure the dataset to be as homogenous as possible (for detailed information on the eliminated studies, see Appendix A). BMA is further employed to select the explanatory variables to be included. The approach resolves the resulting model uncertainty (for detailed information on this, see section 3.2).

Inclusion of unpublished, or "poor-quality", studies represents the second frequently challenged issue. Irrespective of questionable reliability of a publication as the ultimate criterion of quality, the garbage in, garbage out query is necessary to be addressed when defending the approach. As it is of the utmost difficulty to draw the line between good and bad, we prefer to rely on inclusion of as large part of the primary literature as possible while vary the weights to individual characteristics of the primary studies based on our further explained selection. Nonetheless, we still control for the impact factor of the publication outlet and the amount of citations. All of the key estimations are also altered using a restricted data for estimates collected from only published papers as a robustness check (the alternative results are reported in Appendix C).

Potential issue of dependency of individual estimates is addressed by the means of clustering the standard errors of the estimations at study-level and employment of fixed- and mixed-effect models as the robustness checks as described in subsection 3.1.2. The regression results reported in the primary literature are not independent, but neither are the observations in most of the economic datasets. Further, possibility of a distortion of the examined dataset by inappropriate coding is restricted by its long-term compilation and continuous checking for mistakes. Moreover, the base of the dataset consists of data previously employed by other researchers: Gunby et al. (2017), Havranek & Irsova (2011), and Irsova & Havranek (2013)—augmenting the soundness of the data. Although some mistakes in data coding might be considered as inevitable, we do our best to limit their number as much as possible. Speaking about the omitted studies, most of the relevant primary literature is included in the final dataset (for detailed information on eliminated studies, see Appendix A). Omission of some of these should not spoil
the results as long as their estimates do not differ systematically from the included ones. Still, with 1081 estimates collected, the present thesis is one of the largest meta-analyses conducted in economics. (Nelson & Kennedy 2009; Doucouliagos & Stanley 2013)
Chapter 4

Empirical Research

This chapter finally describes data under investigation in detail, presents individual results of both graphical and regression analyses, and discusses the findings. Our research of FDI spillovers in PRC is uncovered in the following order. Initially, the process of data collection is defined and used primary literature is enumerated in section 4.1. The following section 4.2 further summarises the fundamental characteristics of the data—an information is provided on the simple and weighted means of primary estimates, their general distribution and distribution by individual authors, time trends, and corresponding t-statistics. A potential publication bias is tested first by graphical tools in section 4.3 and second by regression tests in section 4.4. At the final stage of the analysis, BMA model is introduced and the heterogeneity’s determinants are estimated; findings drawn from the results are also directly discussed in section 4.5. Throughout the whole analysis, the research is conducted threefold—differentiating for separate measure of (i) horizontal spillovers, (ii) forward vertical spillovers, and (iii) backward vertical spillovers.

4.1 Data Description

The primary literature was collected in two independent and one complementary rounds. The first round was realised in July 2016, the second one in February 2017, and the complementary one in May 2017. Initially, a set of 11 different online academic libraries was used for the search and further extended by inspection of the analogous Chinese online portals accessible with a willing help of our native colleague. First two rounds were executed
separately generating in union the base set of our primary literature. The complementary search was aimed at identified, but uncollected studies (especially these in Chinese).

The full set of the employed academic libraries includes the following portals: (i) Central Catalogue of the Charles University in Prague, (ii) Charles University E-resources Portal, (iii) EBSCOhost, (iv) EconLit - ProQuest, (v) Google Scholar, (vi) JSTOR, (vii) RePEc EconPapers, (viii) RePEc IDEAS, (ix) ScienceDirect, (x) Scopus, and (xi) Springer. The search was terminated on May 21, 2017. In total, 78 primary studies have been taken into consideration, although only 14 of them are finally integrated into the analysis (see Table 4.1). An excessive amount of literature, based on wide criteria, was initially collected to make the dataset as robust as possible; nonetheless, most of the literature has a different—incomparable—focus or does not conduct as detailed research as demanded (for more detailed information on eliminated studies, see Appendix A). The ultimate final criterion for an inclusion of the estimate to our dataset is the provision of a separately defined estimate of either horizontal, forward, or vertical spillover effect of FDI incoming to PRC. Still, total number of 1081 individual estimates (402 of horizontal, 280 of forward, and 399 of backward spillovers) is included. Moreover, a variety of 85 different characteristics of data, methodology, and background of the studies is coded. More than 30 of these (35, 33, and 36 in particular) are examined in practice within the individual models.

Table 4.1: List of primary literature

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Blake et al. (2009)</td>
<td>Long et al. (2014)</td>
</tr>
<tr>
<td>Girma &amp; Gong (2008)</td>
<td>Qiu et al. (2009)</td>
</tr>
</tbody>
</table>

Notes: Both published and unpublished studies are included. For detailed information on eliminated studies, see Appendix A. The search for primary studies was terminated on May 21, 2017.

Three individual datasets are examined separately within this research. We test for publication bias and attempt to explain heterogeneity independently for (i) horizontal spillovers, (ii) forward vertical spillovers, and (iii)
backward vertical spillovers. The datasets are defined in Table 4.2. As methodology of their estimation varies and the individual effects might rely on different rationale, we believe that a sensitive investigation should be conducted on separate to capture the key determinants (for more detail on computation and theory of individual spillover effects, see section 2.1). Further, we prefer to include all comparable estimates collected from the primary literature while we control for particular characteristics of individual estimates. Among others, we also control for an impact factor of the publication outlet and the amount of citations. Furthermore, we report the results on restricted data which covers only estimates collected from the published papers as a robustness check in Appendix A. The response variable regressed by researchers in the primary literature is mostly the measure of TFP and the estimates of spillover coefficients are reported as semi-elasticities; therefore, the level of spillover estimates implies the shifts in productivity of domestic firms based on a percentage-point change in foreign presence as explained in section 2.1.

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Description</th>
<th>No. of estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>horiz</td>
<td>estimates of spillovers in the same sector.</td>
<td>402</td>
</tr>
<tr>
<td>forw</td>
<td>estimates of spillovers in the sector of customers.</td>
<td>280</td>
</tr>
<tr>
<td>back</td>
<td>estimates of spillovers in the sector of suppliers.</td>
<td>399</td>
</tr>
</tbody>
</table>

Notes: The table presents number of estimates included in individual datasets under examination.

4.2 Summary Statistics

The magnitude and significance of the FDI spillover effects are summarised in this section. Table 4.3 distinguishes between simple and weighted means of primary estimates; the left-hand side of the table comprises averages of unweighted estimates whilst the right hand side displays means of estimates weighted by the inverse of the amount of estimates reported in individual study. The weights balance the importance of individual studies.
Table 4.3: Mean spillover effects

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Obs.</th>
<th>Unweighted</th>
<th>Weighted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SE</td>
</tr>
<tr>
<td>horiz</td>
<td>402</td>
<td>0.149</td>
<td>0.214</td>
</tr>
<tr>
<td>forw</td>
<td>280</td>
<td>0.740</td>
<td>0.092</td>
</tr>
<tr>
<td>back</td>
<td>399</td>
<td>0.161</td>
<td>0.051</td>
</tr>
</tbody>
</table>

Notes: The table presents mean estimates of the FDI spillover effects in PRC for different datasets under examination. On the right-hand side, estimates are weighted by the inverse of the amount of estimates reported in individual study.

Based on the summary provided by Table 4.3, the mean estimates of all three spillover effects are drag down by some influential studies—the weighted means are always larger. While only positive coefficients are inside the 95% confidence interval for both vertical spillovers, a zero coefficient is contained in the case of horizontal spillover. Nonetheless, the relevance and reliability of the literature’s averages depends on potential presence of publication bias; the averages might under- or overvalue the true effect. The individual estimates of spillovers are not homogeneous and vary both across and within primary studies; this holds especially for forward estimates as presented by Figure 4.3. Speaking about time trends, we differentiate between development according to the year of publication of the primary study and the average year of time span of data used. Although it seems that there are no strong evolution patterns in general, Figure 4.2 uncovers that an ascending tendency is partially observable in reported horizontal spillovers. If this should mirror a real shift in horizontal spillover effect, it might suggest that the FDI inflows have been reallocated into less satiated sectors with higher potential of productivity spillovers among competing firms.

Having a look at Epanechnikov kernel density of the estimates depicted in Figure 4.7, it is apparent that the distributions of individual spillover effects are far from the normal distribution as all of them exhibit a substantially excessive kurtosis—being more peaked—and especially both vertical spillovers possess a long tail to right, meaning an excessive skewness. In such case, one might be preliminarily suspicious of a potential publication bias. Similar to the summary of estimates, Table 4.4 documents that some influential primary studies (in the meaning of reporting larger amount of primary estimates) decrease the simple mean t-statistic. It might correspond to a different approach of researchers among who some of them prefer to report only
4. Empirical Research

Figure 4.1: Horizontal estimates by authors

Notes: The figure depicts a box plot of the estimates of horizontal FDI spillover effect in PRC reported in individual studies. The dotted line corresponds to a simple mean of the estimates and the dashed one to the weighted average of the estimates weighted by the inverse of the amount of estimates reported in individual study. One outlier observation collected from Mao & Yang (2016) is excluded from the figure.

Figure 4.2: Trend graphs of horizontal estimates

Notes: The figure depicts time trend of the estimates of horizontal FDI spillover effect in PRC reported in individual studies. On the left-hand side, the horizontal axis measures the year of publication of the primary study; on the right-hand side, it measures the average year of time span of the data. The dashed line shows the time trend. One outlier observation collected from Mao & Yang (2016) is excluded from the figure.
Figure 4.3: Forward estimates by authors

Notes: The figure depicts a box plot of the estimates of forward vertical FDI spillover effect in PRC reported in individual studies. The dotted line corresponds to a simple mean of the estimates and the dashed one to the weighted average of the estimates weighted by the inverse of the amount of estimates reported in individual study.

Figure 4.4: Trend graphs of forward estimates

Notes: The figure depicts time trend of the estimates of forward vertical FDI spillover effect in PRC reported in individual studies. On the left-hand side, the horizontal axis measures the year of publication of the primary study; on the right-hand side, it measures the average year of time span of the data. The dashed line shows the time trend.
4. Empirical Research

Figure 4.5: Backward estimates by authors

Notes: The figure depicts a box plot of the estimates of backward vertical FDI spillover effect in PRC reported in individual studies. The dotted line corresponds to a simple mean of the estimates and the dashed one to the weighted average of the estimates weighted by the inverse of the amount of estimates reported in individual study.

Figure 4.6: Trend graphs of backward estimates

Notes: The figure depicts time trend of the estimates of backward vertical FDI spillover effect in PRC reported in individual studies. On the left-hand side, the horizontal axis measures the year of publication of the primary study; on the right-hand side, it measures the average year of time span of the data. The dashed line shows the time trend.
their preferred results with a high statistical significance, whereas the others provide a wider set of auxiliary estimates. In any case, according to the 95% confidence intervals which comprise only large values of t-statistics (with an exception of the unweighted mean of backward spillovers), vast majority of reported estimates are of a high statistical significance.

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Obs</th>
<th>Unweighted</th>
<th></th>
<th></th>
<th>Weighted</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SE</td>
<td>95% conf. int.</td>
<td>Mean</td>
<td>SE</td>
<td>95% conf. int.</td>
<td></td>
</tr>
<tr>
<td>horiz</td>
<td>402</td>
<td>2.224</td>
<td>0.106</td>
<td>2.015</td>
<td>2.433</td>
<td>0.124</td>
<td>2.229</td>
</tr>
<tr>
<td>forw</td>
<td>280</td>
<td>2.382</td>
<td>0.195</td>
<td>2.000</td>
<td>2.766</td>
<td>0.242</td>
<td>2.374</td>
</tr>
<tr>
<td>back</td>
<td>399</td>
<td>1.793</td>
<td>0.113</td>
<td>1.572</td>
<td>2.014</td>
<td>0.132</td>
<td>2.057</td>
</tr>
</tbody>
</table>

Notes: The table presents mean t-statistics of the FDI spillover effects in PRC for different datasets under examination. On the right-hand side, values are weighted by the inverse of the amount of estimates reported in individual study.

### 4.3 Graphical Testing

Based on our suspicion from the fundamental analysis, we further investigate the publication bias by the means of graphical methods (funnel and Galbraith plots) in this section and test for it by regression (unweighted and weighted FAT-PET) in the following section 4.4.

Publication bias of both type I and type II is indicated in Figure 4.8 for horizontal spillovers. The corresponding funnel plot is obviously asymmetrical which suggests a preference of zero or negative estimates. Moreover, the reference interval \([-1.96, 1.96]\) certainly does not contain 95% of the observations which might be considered as an evidence of a tendency to report preferably the statistically significant results; nonetheless, this is not supported by appearance of the funnel plot which should be rather hollow in such case.

Although the evidence is not equally strong, similar might be observed in Figure 4.9 and Figure 4.10 for both vertical spillovers. The funnel plots are not sufficiently symmetrical and the Galbraith’s reference intervals do not comprise enough of the observations. Therefore, one should be also suspicious of potential publication bias in either of its forms, although the funnel plots are still not hollow which should accompany the type II publication bias.
Figure 4.7: Kernel density

Notes: The figure depicts Epanechnikov kernel density of the estimates of FDI spillover effects in PRC. The dashed lines denote the normal distribution density. One outlier observation collected from Mao & Yang (2016) is excluded from the figure for horizontal spillovers.
4. Empirical Research

Figure 4.8: Funnel and Galbraith plot (horizontal)

Notes: On the left-hand side, the figure depicts a funnel plot. The virtual funnel should occur symmetrically around the most precise estimates of the FDI spillover effect in PRC. The dotted line corresponds to a simple mean of the estimates and the dashed one to the weighted average of the estimates weighted by the inverse of the amount of estimates reported in individual study. On the right-hand side, Galbraith plot is depicted. The horizontal dashed lines define $[-1.96, 1.96]$ interval which should not be surpassed in more than 95% if no publication bias is present. Outlier observations are eliminated from both of the plots for the sake of clarity (underlying conditions of inclusion: $Spillover < 20$ and $Precision < 200$) but included in all following regression tests.

Figure 4.9: Funnel and Galbraith plot (forward)

Notes: On the left-hand side, the figure depicts a funnel plot. The virtual funnel should occur symmetrically around the most precise estimates of the FDI spillover effect in PRC. The dotted line corresponds to a simple mean of the estimates and the dashed one to the weighted average of the estimates weighted by the inverse of the amount of estimates reported in individual study. On the right-hand side, Galbraith plot is depicted. The horizontal dashed lines define $[-1.96, 1.96]$ interval which should not be surpassed in more than 95% if no publication bias is present. Outlier observations are eliminated from both of the plots for the sake of clarity (underlying conditions of inclusion: $Spillover < 4$ and $Precision < 30$) but included in all following regression tests.
Figure 4.10: Funnel and Galbraith plot (backward)

Notes: On the left-hand side, the figure depicts a funnel plot. The virtual funnel should occur symmetrically around the most precise estimates of the FDI spillover effect in PRC. The dotted line corresponds to a simple mean of the estimates and the dashed one to the weighted average of the estimates weighted by the inverse of the amount of estimates reported in individual study. On the right-hand side, Galbraith plot is depicted. The horizontal dashed lines define $[-1.96, 1.96]$ interval which should not be surpassed in more than 95% if no publication bias is present. Outlier observations are eliminated from both of the plots for the sake of clarity (underlying condition of inclusion: Precision < 50) but included in all following regression tests.

4.4 Regression Testing

Results of five different model specifications of FAT-PET regressions (three unweighted: OLS, FE, and ME, and two weighted: weighted by the inverse of precision and by the number of estimates reported per study) are presented to test for publication bias under a robustness check.

Table 4.5 comprises the results of regression tests for all three types of FDI spillovers. Merely the set of estimates which corresponds to publication bias in horizontal spillovers is conclusive as desired. The potential of presence of publication bias is statistically significant at 1% level in all specifications—confirming the indication obtained though preceding graphical analyses. We are able to reject the hypothesis $H_0 : \beta_1 = 0$. (see Equation 3.2) of no publication bias as the corresponding p-values do not exceed value 0.001. Further, four out of five estimates of the true effect beyond bias propose a negative statistically significant horizontal spillover effect in PRC. Although this is only an auxiliary measure, it indicates that even though there is a publication bias present in the primary literature, the true effect is still negative as reported by majority of the studies. On the contrary, no conclusive findings might be drawn from the publication bias tests on vertical spillovers. Even
### Table 4.5: Testing for publication bias

<table>
<thead>
<tr>
<th>Dependent variable: horizontal</th>
<th>OLS</th>
<th>FE</th>
<th>ME</th>
<th>Precision</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE (publication bias)</td>
<td>1.810***</td>
<td>1.815***</td>
<td>1.814***</td>
<td>2.284***</td>
<td>1.811***</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.330***</td>
<td>-0.330***</td>
<td>-0.205**</td>
<td>-0.015</td>
<td>-0.196**</td>
</tr>
<tr>
<td>Observations</td>
<td>402</td>
<td>402</td>
<td>402</td>
<td>402</td>
<td>402</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dependent variable: forward</th>
<th>OLS</th>
<th>FE</th>
<th>ME</th>
<th>Precision</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE (publication bias)</td>
<td>0.417</td>
<td>0.149</td>
<td>0.162</td>
<td>1.475*</td>
<td>1.138*</td>
</tr>
<tr>
<td>Constant</td>
<td>0.544*</td>
<td>0.670***</td>
<td>0.828*</td>
<td>0.047*</td>
<td>0.473</td>
</tr>
<tr>
<td>Observations</td>
<td>280</td>
<td>280</td>
<td>280</td>
<td>280</td>
<td>280</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dependent variable: backward</th>
<th>OLS</th>
<th>FE</th>
<th>ME</th>
<th>Precision</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE (publication bias)</td>
<td>-0.025</td>
<td>0.256</td>
<td>0.250**</td>
<td>1.696***</td>
<td>1.46</td>
</tr>
<tr>
<td>Constant</td>
<td>0.173</td>
<td>0.040</td>
<td>0.257</td>
<td>0.009</td>
<td>-0.004</td>
</tr>
<tr>
<td>Observations</td>
<td>399</td>
<td>399</td>
<td>399</td>
<td>399</td>
<td>399</td>
</tr>
</tbody>
</table>

**Notes:** Response variable is the estimate of FDI spillover effect in PRC. The standard errors of the regression parameters clustered at the study level are reported in parentheses. OLS = ordinary least squares. FE = fixed effects. ME = mixed effects. Precision = the inverse of the primary estimate’s standard error is used as weight. Study = the inverse of the amount of estimates reported in individual study is used as weight. Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level.
though the graphical analysis suggests a presence of bias, we are not able to uniformly reject the hypothesis of no publication bias as the results vary according to a particular method of estimation. Recall that the evidence based on graphical tools is neither entirely conclusive about the type II publication bias—actually, it is possible that the suspicious displays of Galbraith plots are influenced by the value of true effect potentially not significantly distinguishable from zero.

4.5 Determinants of Heterogeneity

Determinants of heterogeneity are estimated by BMA whilst a graphical representation of the results is supplied. The individual models for horizontal, forward, and backward spillover effects correspond to columns in Figure 4.11, Figure 4.12, and Figure 4.13, respectively. Width of the columns is proportional to the value of posterior model probability, where the higher the probability, the better the fit of the model. If a moderator variable (enumerated on the vertical axis) is employed in the model, corresponding cell is coloured according to the sign of the estimated regression coefficient (blue colour, darker in grayscale, means a positive coefficient; red colour, lighter in grayscale, means a negative one). Further, the variables are listed in descending order by the value of posterior inclusion probability and no colour denotes exclusion of the variable from the model. The full list and description of moderator variables is attached in Appendix B.

HMT The key moderate variable under investigation turns out to be significantly negative in estimations for all three types of FDI spillovers—meaning that the true effect of FDI spillovers from countries Hong Kong, Macau, and Taiwan is relatively smaller in comparison to an average estimate. It seems that the effect corresponds to the basic theoretical background of domestic sourcing by foreign firms being inversely proportionate to the proximity of the beneficiary country. (Rodriguez-Clar 1996) In other words, the resulting FDI spillover effect favours the advantage of superior technology, level of global production chains, and broadly recognised brand names of the non-HMT’s MNEs over the HMT’s privileges of geographical, cultural, and language proximity.

Time trend The estimates of horizontal and forward vertical spillover effects seem to be positively correlated with time (through manifestation of variables controlling for average year of the primary datasets and the pub-
Figure 4.11: Determinants (horizontal)

Notes: Response variable: the estimate of the horizontal spillover effect. Individual models are denoted by columns; the horizontal axis indicates the cumulative posterior model probabilities. Moderate variables listed on the vertical axis are sorted by posterior inclusion probability in descending order. Blue colour (darker in grayscale) = estimated sign is positive. Red colour (lighter in grayscale) = estimated sign is negative. No colour (white) = the variable is excluded from the model.
lication date)—following an ascending time trend. Such observation might be linked with the shifts in the Chinese economy and FDI inflows composition when the foreign investment streams more into less satiated sectors with higher potential of positive spillovers.

Data characteristics Level of detail of the primary data employed bends all three types of spillover estimates. In particular, explanatory variable which controls for a less detailed level of data for productivity (a dummy variable denoting an industry-level data instead of base firm-level data) is significantly positive. Under assumption of better estimation based on more detailed data, it seems that a lack of detail in data exaggerates the mean estimates. Likewise, moderator variables controlling for balanced panel data employed and investigation of a specific industry (i.e., both of a higher level of detail) are estimated to be significantly negative in the case of horizontal spillovers.

FDI characteristics, Methods, and Specification Subsequent controlling variables which should capture the patterns following different characteristics of dataset and estimation do not induce any coherent findings. For example, firm’s features perform differently for individual spillovers: SOE are linked with smaller horizontal spillover effects while with larger forward vertical effects etc. In overall, apart from HMT, no real factors can explain the variation in estimates of backward vertical spillovers; therefore, estimates of this type of spillovers seem to rely mostly on methods and specifications used in the primary research. Further, no significant effect of the measures of response in the academy (i.e., the impact factor or number of citations) is detected in any of the individual spillover’s channels. No systemic difference between more and less influential studies is recognised.

The analogous BMA estimations are further reported in Appendix C for restricted dataset of primary estimates collected from only published studies. The reduction of observations increase an occurrence of multicollinearity—meaning that the number of included moderator variables has to be lowered. Therefore, the auxiliary results are not entirely supportive, especially in the case of horizontal spillovers. Nonetheless, the results on the factor of our primary interest (i.e., HMT) are affirmative.
Notes: Response variable: the estimate of the forward vertical spillover effect. Individual models are denoted by columns; the horizontal axis indicates the cumulative posterior model probabilities. Moderate variables listed on the vertical axis are sorted by posterior inclusion probability in descending order. Blue colour (darker in grayscale) = estimated sign is positive. Red colour (lighter in grayscale) = estimated sign is negative. No colour (white) = the variable is excluded from the model.
Figure 4.13: Determinants (backward)

Notes: Response variable: the estimate of the backward vertical spillover effect. Individual models are denoted by columns; the horizontal axis indicates the cumulative posterior model probabilities. Moderate variables listed on the vertical axis are sorted by posterior inclusion probability in descending order. Blue colour (darker in grayscale) = estimated sigh is positive. Red colour (lighter in grayscale) = estimated sigh is negative. No colour (white) = the variable is excluded from the model.
Chapter 5

Conclusion

The present thesis revises the primary literature on the FDI spillovers in PRC. Based on a collection of 1081 estimates from 14 primary studies, the research examines separately the individual measures of (i) horizontal, (ii) forward vertical, and (iii) backward vertical spillovers. A robust meta-analysis is conducted using graphical tools, regression tests, and BMA approach to resolve the model uncertainty of the heterogeneity’s determinants estimation. The main objectives of the research are to test for a presence of publication bias, potentially assess its impacts, and investigate performance of the estimates of spillover effect from FDI inflows which originate from the area of HMT in detail. In comparison with the existing literature reviews, the present thesis is unique with respect to particular focus, scope, and level of detail. Our research is the only one which differentiates between individual spillover channels—horizontal, forward, and backward. Moreover, all of the related studies (Gunby et al. 2017; Ljungwall & Tingvall 2015; Masoumy & Azarhoushang 2015) are based on less than half of the number of regression results collected from the primary literature within this thesis.

Concerning the main hypotheses of the research, first, an extensive evidence of publication bias is collected for horizontal spillovers in PRC. Second, the research finds that the bias exaggerates the mean magnitude of the reported horizontal estimates. Third, the thesis identifies that the spillover effect from FDI inflows originating from the area of HMT is systematically different from the others—amounting to relatively smaller values in comparison to the average. Apart from these hypotheses that we are primarily testing for, several additional conclusions might be drawn based on the results.

Any lack of detail in primary data employed seems to be linked with
overestimation of the mean estimates. For instance, larger spillover effects (all horizontal, forward, and backward) are reported if an industry-level data for productivity are used instead of firm-level data. Moreover, some positive time trend is traceable in the case of horizontal and forward spillover effects. Such development might follow the shifts in Chinese economy and FDI inflows composition: if the foreign investment streams more into less satiated sectors with higher potential, the spillover effect might strengthen. This particular conjecture, however, calls for further investigation.

The world economy’s globalisation has gradually boosted the volumes of FDI while PRC has emerged as one of the largest beneficiaries and sources of foreign investment flows. Since the great economic transformation, beginning in 1978 by the appointment of Deng Xiaoping, the Chinese open-door policy attracts many foreign investors making the country the second largest beneficiary of FDI in the world. Currently, significant shifts in the composition of both Chinese economy and FDI are observable. Since a secured transition from the demand-side-oriented economy by the means of a supply-side structural reform is accented by both domestic and international experts and Chinese administration, it is desirable to verify whether the existing literature on FDI spillovers in PRC is still relevant or should be replaced by an updated research. Although there is a wide range of primary literature (total amount of 78 primary studies which either investigate the FDI spillovers in detail, or examine the impact of FDI on Chinese economy in the broader terms, are collected within this thesis), it inspects the economy under conditions which are, to certain extent, no longer valid and will change even further in the future. The present thesis contributes to the clarification of the phenomenon’s assessment by identification of publication bias and explanation of selected factors, but further extensions should follow. Researchers ought to study continuously the individual spillover channels with respect to shifts in the FDI’s composition and volume. Additionally, the study of spillover effects in PRC might refocus more considerably to the role of Chinese ODI.
Bibliography


China: A panel data study for 1992-2004.” In: Conference of WTO,
China and Asian Economies, University of International Business and
Appendix A

Eliminated Studies

The full list of eliminated studies from the primary literature is presented in this Appendix. Based on the list, any following researcher may further check for correctness of our findings or widen the research. A vast literature is initially included in our investigation to avoid omission of any relevant study. Actually, most of the initially considered studies are not utilised. The largest cluster of eliminated studies is excluded based on their different focus—making them incompatible with our final primary literature. First, the largest portion of eliminated literature examines only a basic relationship between economic growth and FDI; therefore, it cannot distinguish between individual channels of FDI spillovers. In other words, it does not report the estimates of horizontal, forward, and backward spillover effects separately. Second, several studies report estimates of spillover effects with respect to level of innovation or R&D spendings. (Ha & Giroud 2015; Huang et al 2012; Wang & Wu 2016) Finally, one of the studies cannot be included as it presents the results of estimation by log-log regression without reporting the sample means necessary for computation of desired measure of semi-elasticity. We have not succeeded to collect the additional information from the authors on time. (Agarwal & Milner 2011)

The full list of eliminated literature


Ho, O. C. (2004): "Determinants of foreign direct investment in China: a sectoral analysis.” Department of Economics, University of Western Australia.


Appendix B

Moderator Variables

Table B.1 summarizes mean values and standard deviations of the moderator variables collected for the regression analyses. Only a final list of variables considered in conduction of BMA is presented, although a set of 85 different characteristics of data, methodology, and background of the studies which might cause heterogeneity in estimates is collected from the primary literature. The total number of 85 variables is reduced for the purposes of analyses as the full set consists partially from alternative measures of the same factors (e.g., the values of impact factor according to different databases or the dummy variables including the base one). Any additional information on the data and source codes are available upon request.
### B. Moderator Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study ID</td>
<td>ID of the study from which the estimate is extracted.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Publication date</td>
<td>date of publication. (=(year+(month*2-1)/24)-2000)</td>
<td>10.38</td>
<td>3.00</td>
</tr>
<tr>
<td>No. of obs.</td>
<td>number of observations.</td>
<td>165</td>
<td>259</td>
</tr>
<tr>
<td>Average year</td>
<td>average year of data sample. (=(start+end)/2-2000)</td>
<td>1.01</td>
<td>1.75</td>
</tr>
<tr>
<td>Time span</td>
<td>time span of data sample used for estimation.</td>
<td>5.31</td>
<td>2.13</td>
</tr>
<tr>
<td>No. of firms</td>
<td>nat. log. of the number of firms used for estimation.</td>
<td>9.14</td>
<td>2.15</td>
</tr>
<tr>
<td>Estimate</td>
<td>semi-elasticity of productivity with respect to foreign presence.</td>
<td>0.31</td>
<td>2.81</td>
</tr>
<tr>
<td>SE</td>
<td>standard error of the semi-elasticity of productivity with respect to foreign presence.</td>
<td>0.39</td>
<td>1.49</td>
</tr>
<tr>
<td>1/SE</td>
<td>coefficient of precision. (=1/se)</td>
<td>21.70</td>
<td>63.76</td>
</tr>
<tr>
<td>SOEs</td>
<td>1 if only SOEs are investigated.</td>
<td>0.14</td>
<td>0.35</td>
</tr>
<tr>
<td>Private</td>
<td>1 if only private firms are investigated.</td>
<td>0.09</td>
<td>0.29</td>
</tr>
<tr>
<td>Specific</td>
<td>1 if the estimate is for services sectors.</td>
<td>0.04</td>
<td>0.18</td>
</tr>
<tr>
<td>Cross-sectional</td>
<td>1 if cross-sectional data are used for the estimation.</td>
<td>0.03</td>
<td>0.16</td>
</tr>
<tr>
<td>Panel</td>
<td>1 if panel data are used for the estimation of spillovers.</td>
<td>0.97</td>
<td>0.16</td>
</tr>
<tr>
<td>Log-log</td>
<td>1 if the estimate is extracted from a log-log regression.</td>
<td>0.02</td>
<td>0.14</td>
</tr>
<tr>
<td>Differences</td>
<td>1 if the estimate is extracted from a regression estimated in differences.</td>
<td>0.35</td>
<td>0.48</td>
</tr>
<tr>
<td>Aggregated-level</td>
<td>1 if industry-level data for productivity is used.</td>
<td>0.07</td>
<td>0.25</td>
</tr>
<tr>
<td>Backward &amp; Forward</td>
<td>1 if backward and forward spillovers are estimated together in the same regression.</td>
<td>0.52</td>
<td>0.50</td>
</tr>
<tr>
<td>Vertical &amp; Horizontal</td>
<td>1 if vertical and horizontal spillovers are estimated together in the same regression.</td>
<td>0.78</td>
<td>0.42</td>
</tr>
<tr>
<td>Competition</td>
<td>1 if specification controls for sectoral competition.</td>
<td>0.29</td>
<td>0.45</td>
</tr>
<tr>
<td>Lagged</td>
<td>1 if the estimate is for lagged foreign presence or is a combination that contains lagged foreign presence.</td>
<td>0.19</td>
<td>0.39</td>
</tr>
<tr>
<td>More</td>
<td>1 if it is not the sole estimate for horizontal/backward spillovers extracted from the same regression.</td>
<td>0.65</td>
<td>0.48</td>
</tr>
<tr>
<td>Balanced</td>
<td>1 if a balanced data set is used.</td>
<td>0.03</td>
<td>0.18</td>
</tr>
<tr>
<td>Year-fixed</td>
<td>1 if year fixed effects are included.</td>
<td>0.89</td>
<td>0.32</td>
</tr>
<tr>
<td>Sector-fixed</td>
<td>1 if sectoral fixed effects are included.</td>
<td>0.63</td>
<td>0.48</td>
</tr>
<tr>
<td>Region-fixed</td>
<td>1 if regional fixed effects are included.</td>
<td>0.70</td>
<td>0.46</td>
</tr>
<tr>
<td>Absorption cap.</td>
<td>1 if specification controls for absorption capacity.</td>
<td>0.06</td>
<td>0.24</td>
</tr>
<tr>
<td>Fully-owned</td>
<td>1 if only fully foreign MNEs are considered.</td>
<td>0.09</td>
<td>0.29</td>
</tr>
<tr>
<td>Joint ventures</td>
<td>1 if only joint ventures MNEs are considered.</td>
<td>0.09</td>
<td>0.29</td>
</tr>
<tr>
<td>HMT</td>
<td>1 if nationality of the investor is HMT.</td>
<td>0.15</td>
<td>0.36</td>
</tr>
<tr>
<td>Employment (FP)</td>
<td>1 if proxy for foreign presence is employment.</td>
<td>0.23</td>
<td>0.42</td>
</tr>
<tr>
<td>Equity (FP)</td>
<td>1 if proxy for foreign presence is equity.</td>
<td>0.07</td>
<td>0.26</td>
</tr>
<tr>
<td>Translog</td>
<td>1 if translog production function is used.</td>
<td>0.18</td>
<td>0.38</td>
</tr>
<tr>
<td>One-step</td>
<td>1 if response variable is output, value added, or labor productivity.</td>
<td>0.18</td>
<td>0.39</td>
</tr>
<tr>
<td>Pooled OLS</td>
<td>1 if pooled OLS are used for the estimation.</td>
<td>0.01</td>
<td>0.10</td>
</tr>
<tr>
<td>Random effects</td>
<td>1 if firm random effects are used for the estimation.</td>
<td>0.05</td>
<td>0.21</td>
</tr>
<tr>
<td>GMM</td>
<td>1 if system GMM estimator is used for the estimation.</td>
<td>0.15</td>
<td>0.36</td>
</tr>
<tr>
<td>OLS</td>
<td>1 if OLS or other methods are used in the first phase of TFP estimation.</td>
<td>0.27</td>
<td>0.44</td>
</tr>
<tr>
<td>Olley-Pakes</td>
<td>1 if Olley-Pakes method is used in the first phase of TFP estimation.</td>
<td>0.23</td>
<td>0.42</td>
</tr>
<tr>
<td>Levinsohn-Petrin</td>
<td>1 if Levinsohn-Petrin method is used in the first phase of TFP estimation.</td>
<td>0.30</td>
<td>0.46</td>
</tr>
<tr>
<td>Regional (FP)</td>
<td>1 if for vertical spillovers, foreign presence is expressed as a ratio of foreign firms in a wider sector in a certain region excluding the firm's narrower sector.</td>
<td>0.02</td>
<td>0.13</td>
</tr>
<tr>
<td>TR impact</td>
<td>journal impact factor (Thompson Reuters, 2016), collected in May 2017.</td>
<td>1.28</td>
<td>2.00</td>
</tr>
<tr>
<td>SY TR impact</td>
<td>5-year journal impact factor (Thompson Reuters, 2016), collected in May 2017.</td>
<td>1.72</td>
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<tr>
<td>TR eigen</td>
<td>journal eigen factor score (Thompson Reuters, 2016), collected in May 2017.</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Scopus impact</td>
<td>journal impact factor (Scopus, 2016), collected in May 2017.</td>
<td>1.33</td>
<td>1.85</td>
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<tr>
<td>RePsC impact</td>
<td>outlet impact factor (RePsC), collected in May 2017.</td>
<td>0.33</td>
<td>0.53</td>
</tr>
<tr>
<td>Study citations</td>
<td>nat. log. of yearly study citations (Google Scholar), collected in May 2017.</td>
<td>1.56</td>
<td>1.01</td>
</tr>
<tr>
<td>Published</td>
<td>1 if the study was published in a peer-reviewed journal.</td>
<td>0.65</td>
<td>0.48</td>
</tr>
<tr>
<td>Native co-author</td>
<td>1 if at least one co-author is a Chinese native.</td>
<td>0.95</td>
<td>0.22</td>
</tr>
<tr>
<td>US-based</td>
<td>1 if at least one co-author is affiliated with a US-based institution.</td>
<td>0.58</td>
<td>0.49</td>
</tr>
</tbody>
</table>

**Notes:** SD = standard deviation. Statistics comprise the whole dataset including estimates for all horizontal, forward, and backward spillovers.
Appendix C

Auxiliary Results

Any additional information on the results and source codes are available upon request.
Notes: Response variable: the estimate of the horizontal spillover effect. Data from only published studies is used. Individual models are denoted by columns; the horizontal axis indicates the cumulative posterior model probabilities. Moderate variables listed on the vertical axis are sorted by posterior inclusion probability in descending order. Blue colour (darker in grayscale) = estimated sigh is positive. Red colour (lighter in grayscale) = estimated sigh is negative. No colour (white) = the variable is excluded from the model.
C. Auxiliary Results

Figure C.2: Determinants (forward, published)

Notes: Response variable: the estimate of the forward spillover effect. Data from only published studies is used. Individual models are denoted by columns; the horizontal axis indicates the cumulative posterior model probabilities. Moderate variables listed on the vertical axis are sorted by posterior inclusion probability in descending order. Blue colour (darker in grayscale) = estimated sign is positive. Red colour (lighter in grayscale) = estimated sign is negative. No colour (white) = the variable is excluded from the model.
Figure C.3: Determinants (backward, published)

Notes: Response variable: the estimate of the backward spillover effect. Data from only published studies is used. Individual models are denoted by columns; the horizontal axis indicates the cumulative posterior model probabilities. Moderate variables listed on the vertical axis are sorted by posterior inclusion probability in descending order. Blue colour (darker in grayscale) = estimated sigh is positive. Red colour (lighter in grayscale) = estimated sigh is negative. No colour (white) = the variable is excluded from the model.