On the difference in spillover effects between horizontal and vertical FDI[1)]

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Abstract: This paper uses a large firm-level panel data set to empirically investigate the spillover effects from foreign direct investment in China. In particular, the novelty of this paper is separation of spillover effects based on investment motives. The stated hypothesis is that multinational enterprises which are conducting horizontal FDI into China will create larger spillover effects compared with MNEs conducting vertical FDI. Examining economic theory I find conceptual support for the hypothesis, and the empirical tests substantiate the importance of differentiating between FDI motives when assessing potential for spillover effects.

Keywords: Foreign direct investment, China, spillovers, vertical FDI, horizontal FDI, firm-level panel-data

JEL Classification: F21, F23, H23, O12

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1. Introduction

Foreign direct investments are often actively attracted by governments in both developed and developing countries. Besides the direct effects on employment and tax-base, a main argument for attraction is the potential spillover effects expected in the host country. Since the social benefits will be larger than MNEs' private benefits, governments validate subsidies with counteraction of underinvestment in spillover-generating activities. Due to ambiguous findings from empirical research (Görg & Greenaway, 2004), this paper will attempt to add evidence on *actual* spillover outcomes. Following Feinberg and Keane's (2005) request for addressing *the nature of multinational corporation activity*, I will pursue an experimental methodology and investigate if the motivation behind FDI affects the succeeding spillover effects.

The hypothesis underlying this research is that horizontal FDI will yield higher knowledge spillovers. On the one hand, economic literature suggests that MNEs conduct horizontal FDI when they have a competitive advantage offsetting the negative effects from being foreign. Due to this, MNEs might often have a higher technological level than local firms, which again opens up for positive spillover effects. On the other hand, MNEs doing vertical FDI are not out to exploit competitive advantages, but they transfer part of their technology to the host country in order to *gain* a competitive advantage. One might argue that this process of exploiting relative abundance of factors in the host country will imply less technology transfer, and hence lower probability of spillover effects. My perspective on spillovers is relatively unexplored[1], and attempts to expand the part of the FDI literature related to *Investment motives* (Smeets, 2008) as presented in Figure 1.

[1] One major reason for the scarcity of conducted research in this area is the recent surge in vertical FDI (Protsenko, 2003).

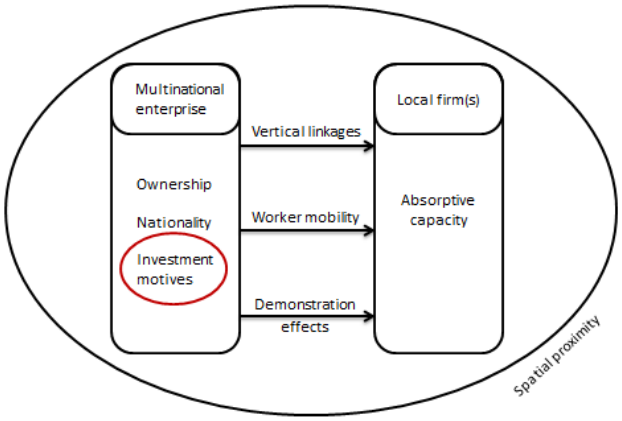


Figure 1 - FDI Knowledge Spillover Framework (Smeets, 2008)

2. Literature review

This section includes a discussion of papers dealing with the *Investment motives* part of the FDI spillover literature, and a brief comment on earlier spillover findings in transition economies.

Javorcik (2004) researches FDI spillovers by focusing on vertical and horizontal spillover effects. As a part of her work, she reports potentially higher spillovers to domestic firms in upstream sectors from market-oriented FDI. However, these results are not very robust (Javorcik & Spatareanu, 2005). Driffield and Love (2002; 2007) argue that technology-based FDI yields positive spillover effects while technology-sourcing FDI does not yield spillovers. Empirical testing using industry-level data produces strong evidence. The same hypothesis is supported by the findings of Girma (2005), who is using firm-level data from UK. There has also been conducted some work on the GDP growth effect of FDI (Beugelsdijk et al., 2008). The effects of US MNEs' investments are shown to be larger for horizontal than for vertical FDI. Moreover, the authors only find significant effects in developed countries.

More directly related to differentiation between vertical and horizontal FDI, Roording and de Vaal (2010) have developed a theoretical framework considering differences in spillover effects. They conclude that horizontal FDI might not always lead to higher spillover effects, and show the dependence

on the host country's technology level. The study most adjacent to my paper is Protsenko (2003). He studied spillover effects in the Czech Republic at sector-level, and found significantly negative results for horizontal FDI, while backward export oriented vertical FDI was positive and host country oriented vertical FDI had no significant effect. Görg and Strobl relate the ambiguous results on spillover effects to unobserved firm heterogeneity (2001). Taking this into account, the novelty of my paper is the utilization of firm-level data in combination with FDI motivation heterogeneity.

Li, Liu & Parker (2001), Wei & Liu (2001) and Liu (2002) found positive spillover effects using Chinese industry-level data, while Liu (2008) found ambiguous results using firm-level data. Görg & Greenway (2004) present an overview over intra-industry spillover findings for transition economies, and except for China the results are either negative or insignificant.

3. Theory

3.1 Background

Vertical FDI is defined as investments where MNEs separate their production chain across borders (Helpman & Krugman, 1985), while horizontal FDI relates to MNEs' duplication of production processes in different countries (Markusen, 1995). Furthermore, closely related to my hypothesis, Hanson et al. (2003) classify FDI as being vertical if the investment is conducted to exploit factor price differences. I assume that this kind of exploitation will bring less advanced technology into the host country, as will be elaborated later. In order to empirically differentiate between the two forms of FDI, I will exploit another definition of vertical FDI given by Brainard (1993; 1997), which points out geographical sales distribution as a differentiator between the two forms of FDI. Consequently, I will see vertical FDI as geographical separation of production processes to exploit cheap factors in foreign countries while

exporting the bulk of production, and horizontal FDI as MNEs' duplication of production stages in order to access markets and exploit existing competitive advantages.

In the spirit of Javorcik (2004) I will define knowledge spillovers as knowledge brought by an MNE which is utilized by a domestic firm, and where the MNE is *not fully compensated*. In the following section I will present theory and intuition to support the stated belief that horizontal FDI will create larger positive spillovers than vertical FDI. To structure my discussion I will deal with the three main channels of knowledge spillovers, namely *demonstration effects*, *worker mobility* and *inter-industry linkages* in addition to *competition* (Saggi, 2006; Castellani & Zanfei, 2006).

3.1.1 Demonstration effects

Demonstration effects may arise for two reasons. First, MNEs can demonstrate the feasibility of a given technology in the host country (Jenkins, 1990). Second, through reverse engineering or informal contact, local firms can imitate the MNEs' technology (Mansfield & Romeo, 1980).

I expect higher spillover effects from horizontal FDI through the demonstration channel explained by both mentioned reasons. In terms of the feasibility argument, I expect horizontal FDI to bring in more path-breaking technology to overcome the disadvantages from being foreign (Beugelsdijk et al., 2008). Exploiting cheap labor or abundance of resources can be expected to be more labor intensive and less technologically advanced. Second, using the imitation argument it is important to notice that it is likely easier to reverse engineer a product if one can observe the whole value chain, including marketing and sales.

However, it might be easier to imitate vertical FDI if vertical projects conduct less technologically advanced activities (Driffield & Love, 2007), and the absorptive capacity is a constraint in the host

country (Girma et al., 2001; Roording & de Vaal, 2010). This effect is undermined by horizontal entities' ability to lower their technology level to flee spillovers and still possess a competitive advantage given large technological distance. For the case of vertical affiliates, this will reduce their competitiveness on the home (or world) market which have greater consequences.

3.1.2 Worker mobility

The argument underlying the worker mobility channel is that workers who move from an MNE to a domestic firm will be able to extract valuable knowledge from their past work experience (Aitken et al., 1997). I assume this spillover channel will be similar for both vertical and horizontal FDI, and hence not central for research trying to differentiate between the two[2].

3.1.3 Inter-industry linkages

For an MNE searching cheap factors, one might expect less interaction with the local economy. For horizontal FDI, given its product market participation and complete value-chain, I expect more networking in the host country and hence more efficient spillover channels. Also, I assess the probability of engaging in a joint venture, which automatically will yield more linkages, as being larger for horizontal FDI since *vertical projects* seem less lucrative for domestic players. This can be related to several arguments, such as lower technology intensity for learning purposes, higher likelihood of production in an *enclave* focused on export to the home country etc., which makes potential synergies for local corporations rather small for *vertical projects*. Standalone, I believe more interaction will yield more opportunities for spillovers.

[2] This conclusion holds for worker mobility seen as a separated channel. Please note that e.g. demonstration effects might work through worker mobility. If imitation is easier in horizontal MNE affiliates, ex horizontal affiliate workers will bring more knowledge to domestic firms if they switch employer.

One might notice an issue reducing the efficiency of linkage channels from MNEs conducting horizontal FDI. Horizontal MNE affiliates are likely more cautious regarding transfer of knowledge because potential recipients include competitors. This will make spillover effects to suppliers of intermediate goods more likely than intra-industry spillovers (Saggi, 2002), which directly will be left out by my research methodology[3]. However, I might pick up indirect productivity effects since domestic firms can get access to cheaper and better inputs from improved suppliers. Also, it should be noted that many transfers will be fully compensated by the domestic firm, since transfer of knowledge to increase the efficiency of local players often will be rather explicit. Although, it is expected to observe spillovers through (i) information transfer, (ii) technical assistance and (iii) financial, management and procurement assistance which go without full compensation (Castellani & Zanfei, 2006).

Even though there are some factors accentuating vertical FDI, I believe that horizontal FDI will have more efficient linkage channels on aggregate. This is validated by the more enclaved vertical firms which often receive most inputs from and ship most outputs to their parent firms.

3.1.4 Competition[4]

On the one hand, competition has positive effects on domestic firms' efficiency. Given the presence of a superior MNE, domestic firms have an incentive to keep up with the foreign player and may hence initiate efficiency increasing actions. This argument is in particularly relevant for horizontal FDI, and holds even though domestic firms are unable to imitate the MNEs' technology (Protsenko, 2003). Also, horizontal FDI yielding more competition upstream might provide cheaper inputs to downstream industries, which again will raise demand upstream etc[3]. On the other hand, competition might have negative effects. Firstly, due to competition foreign firms are more likely to guard their trade secrets

[3] Notice that my empirical model does only directly account for intra-industry spillover effects.
[4] It is open for discussion if competition is a true spillover effect, since its effect comes through the effect on prices (Saggi, 2002). Nevertheless, I will include a passage on competition, since this effect is likely to contribute to the productivity response (Protsenko, 2003).

closely, decreasing the potential spillover effects (Protsenko, 2003). Secondly, entry from an MNE will cause reduced market shares for incumbent domestic firms. This will in turn decrease economies of scale, and hence reduce productivity (Harrison, 1996). In the extreme, domestic firms might be forced so far down their average cost function that production will lead to a loss, and hence exit (Aitken & Harrison, 1999). Even though this *creative destruction* might be desired from an efficiency point of view, governments might want to decrease the rate of exits by domestic firms (Castellani & Zanfei, 2006). These two effects are especially relevant for horizontal FDI, since vertical FDI focus on exporting back to their home countries.

3.2 Research question

Even though spillovers from horizontal FDI are halted by the competition effect, the underlying theory seems to indicate higher potential for spillover effects through horizontal FDI. Also, most evidence available from similar research hypothesis indicates the same effect. The horizontal branch of direct investments usually implies higher technology intensity, more linkages and positive effects to downstream industries, and due to this intuition which seems to be solidly backed up by theoretical evidence I state the following research question for empirical testing:

Intra-industry spillover effects from horizontal FDI are larger than the effects from vertical FDI

4. Empirical test

4.1 Data

The data set used includes information on manufacturing firms in China from 1995 to 2004. The data is unbalanced, and includes on average around 22,000 firms per year. The source is China's National Bureau of Statistics, which yearly conducts a Survey of Large and Medium Size Enterprises. The data set

indicates rising importance of foreign firms and capital in China throughout the time period. Furthermore, one can observe a clear trend in the share of vertical FDI stock relative to horizontal. A visual image of related key statistics is presented in Figure 2.

Figure 2

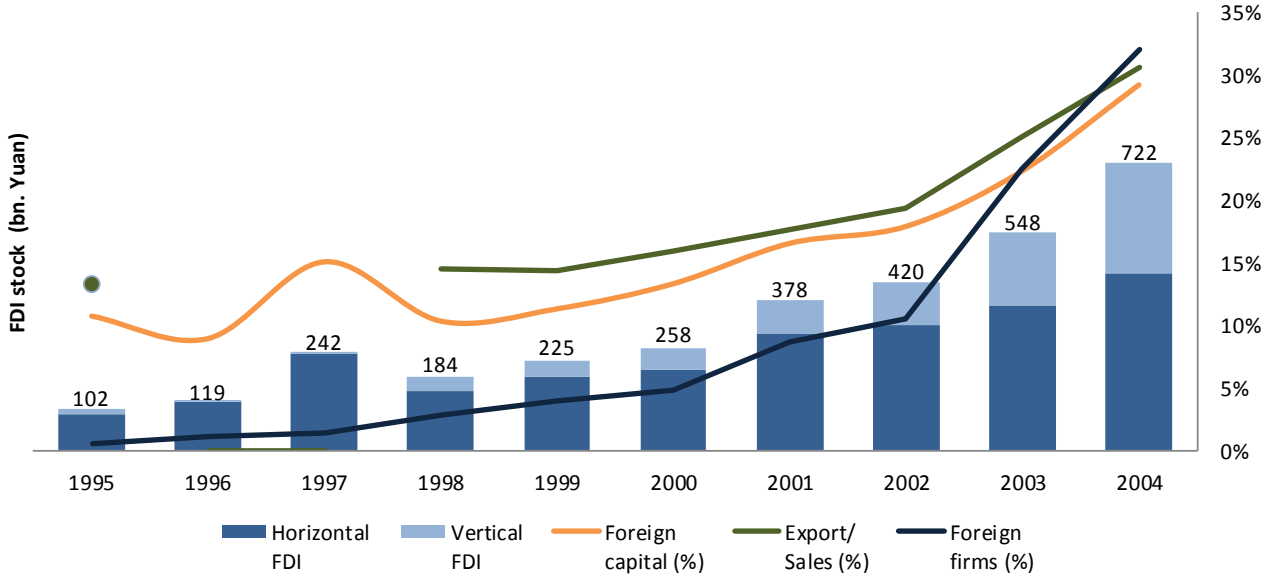


Table 1 gives a more detailed presentation of the data set. One might observe that foreign firms and JVs contribute with 48% of value added, but only 29.2% of firms' capital[5]. This indicates higher efficiency, which substantiate my hypothesis where foreign firms enter with a higher technological level. Another key factor for my empirical results is the presence of vertical FDI given the rather strict requirement for high export/sales ratio documented in section 0. The high and increasing ratio will makes statistical inference more valid. To further elaborate on this development Figure 4 in the appendix presents an industry-level overview from 1995 to 2004[6]. We can observe a particularly large growth towards being highly "vertical industries" in technology intensive industries such as *Electric machinery* and *Computer and telecom*. Also, *Education related products*, *Leather* and *Furniture* protrude as export oriented.

[5] This effect is further magnified by the fact that some foreign capital will be left out when assessing the value added effect from foreign firms and joint ventures.
[6] 2-digit Chinese SIC codes will determine industry throughout this paper; see Table 7 – Industry overview.

Table 1[7]

Summary statistics

Year	# firms	Foreign capital	Foreign capital (%)	Vertical FDI	Horizontal FDI	VA (mean)	VA (% from foreign/JV)	Export/ Sales (%)	Domestic firms	Foreign /JV	Foreign firms (%)
1995	14637	101 513 410	10,7 %	13 279 696	88 233 714	40 006	14,7 %	13,3 %	89,2 %	10,8 %	0,5 %
1996	16673	119 238 341	8,9 %	37 638	119 200 703	42 881	16,5 %	0,0 %	87,2 %	12,8 %	1,1 %
1997	17844	242 377 947	15,1 %	142 589	242 235 358	44 137	17,5 %	0,0 %	86,3 %	13,7 %	1,4 %
1998	17355	184 327 413	10,3 %	34 563 455	149 763 958	45 857	20,7 %	14,4 %	84,4 %	15,6 %	2,7 %
1999	17387	225 337 846	11,3 %	43 198 172	182 139 674	52 031	22,9 %	14,3 %	81,7 %	18,3 %	3,9 %
2000	16742	257 899 351	13,3 %	54 012 635	203 886 716	58 974	24,5 %	15,9 %	79,8 %	20,2 %	4,8 %
2001	17515	378 422 745	16,5 %	85 690 854	292 731 891	69 850	29,7 %	17,6 %	73,6 %	26,4 %	8,7 %
2002	16893	420 275 150	17,9 %	104 895 874	315 379 276	83 954	31,1 %	19,3 %	70,9 %	29,1 %	10,5 %
2003	13828	547 600 653	22,3 %	182 425 698	365 174 955	134 615	39,5 %	25,0 %	53,6 %	46,4 %	22,5 %
2004	14401	722 482 164	29,2 %	279 810 754	442 671 410	151 479	48,1 %	30,6 %	40,8 %	59,2 %	32,0 %

*Please note the data quality in 1996 and 1997, which might affect my results as these outliers are probably data weaknesses.

Finally, from Table 2 we can observe that foreign firms are more efficient than domestic firms, even though the differences level out over time. Surprisingly, vertical firms tend to get larger FDI injections than horizontal firms. This also holds if I control for sales magnitude.

Table 2[6]

Summary statistics (2)

	Domestic firms		Foreign firms/Joint ventures		Horizontal firms		Vertical firms	
Year	Value added/ employee	Sales/ employee	Value added/ employee	Sales/ employee	FDI size	FDI/sales	FDI size	FDI/sales
1995	24	83	72	258	6 518	4,5 %	12 072	11,7 %
1996	26	87	76	274	7 158	4,9 %	1 792	N/A
1997	28	95	81	294	13 617	8,9 %	2 593	N/A
1998	31	103	85	315	9 483	5,9 %	22 128	16,8 %
1999	36	121	98	361	11 523	6,4 %	27 341	18,1 %
2000	44	153	106	406	13 532	6,4 %	32 246	17,8 %
2001	53	180	119	460	18 961	7,5 %	41 277	19,5 %
2002	63	212	133	492	21 451	7,3 %	47 876	18,7 %
2003	88	297	108	429	34 369	6,6 %	56 955	15,2 %
2004	116	388	114	476	44 161	7,1 %	63 928	14,7 %

[7] All figures are in 1000 Yuan at present year prices.

4.2 Estimation strategy

To empirically examine the hypothesized relation I will use the standard approach taken by the literature. I will regress $\frac{\text{value added}}{\text{labor}}$ on capital intensity and the industry stock of FDI, all in logs:

$$\ln\left(\frac{Y}{L}\right)_{ijt} = \beta_0 + \beta_1 \ln\left(\frac{K}{L}\right)_{ijt} + \beta_2 \ln HFDI_{j,t-1} + \beta_2 \ln VFDI_{j,t-1} + \varepsilon_{ijt}$$

Y is value added, L is the number of employees and K is a proxy for capital employed. The methodology to estimate FDI stock per sector is as follows. Assuming the sample is large enough to proxy for the whole population of relevant firms, I sum the total foreign capital per industry employed by foreign firms and joint ventures to get total FDI stock. To define a respective FDI stock as vertical or horizontal, I first need to classify foreign firms/JVs. Following Brainard's definition (1993; 1997) and Protsenko's thought set (2003); a firm is classified as vertical if it exports over 70% of its sales. The definition of vertical FDI follows as the FDI stock in *vertical receivers*[8]. Under the basic specification I will add FDI using a lagged variable to take into account the fact that efficiency improvements might not tail FDI injections instantaneously.

Following the literature consensus, I estimate my equation using OLS fixed effects (Castellani & Zanfei, 2006). Lipsey and Sjöholm (2005) conclude that heterogeneity in host-country factors are the most likely source of the inconclusiveness of empirical research. Including firm and industry fixed effects let me control for the fact that the best firms or industries might attract a gross share of FDI (Bosco, 2001)[9] and tends to be larger and use more inputs (Castellani & Zanfei, 2006). It will also to some extend deal with

[8] It is very important to take notice of the methodology used to separate FDI types. There are problems resulting from the fact that some vertical firms act as export platforms (Ekholm et al., 2003). In lieu of a better estimate, I will proceed using the one stated and interpret the results as being from pure vertical FDI. However, I would urge future research to utilize detailed information about how much is exported back to HQ when available.

[9] This seems to be indicated by the summary statistics.

the fact that productivity and inputs are simultaneously determined. I will also include time dummies, to control for changes in the economic environment, government policies etc.

4.3 Results

The regression results from my basic setup are presented in Table 3. This study focuses on the existence of spillover effects, and will hence not include control variables suitable for studies trying to elaborate on magnitudes. Using normal OLS we see that spillover effects from vertical FDI are in fact higher[10]. Since the literature has expressed skepticism towards not controlling for firm, sector and time heterogeneity (see e.g. Lipsey & Sjöholm (2005)), I will swiftly proceed to a fixed effects model. In [3] and [4], controlling for sector fixed effects, the hypothesized result holds. Controlling for capital intensity, horizontal FDI yields higher spillover effects significant at 1% level. This might indicate that the premier sectors receive the gross share of FDI (Bosco, 2001). Further controlling for firm and time effects we see that the results are robust towards unobserved firm heterogeneity and shifts in the environment or policies. In column [8], controlling for sector, firm and year effects and capital intensity; vertical FDI is insignificant while horizontal FDI is highly significant. The magnitude of the spillover effect is vastly reduced, which indicates large effects from unobserved heterogeneity issues[11]. In sum, fixed effects analysis strongly supports my hypothesis.

[10] For all specification the differences are tested using t-tests. Results are not reported, and are to be implied by the reader if not states otherwise.

[11] This is the normal explanation for why cross-sectional studies tend to find more significant spillover results than micro studies.

Table 3
Empirical results

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Estimation methodology	OLS	OLS	Fixed effects: Sector	Fixed effects: Sector	Fixed effects: Sector, firm	Fixed effects: Sector, firm	Fixed effects: Sector, firm, year	Fixed effects: Sector, firm, year
Constant	2.514595***	0.5795882***	-0.4692925***	-1.602657***	1.983734***	1.299348***	3.569944***	2.534999***
	(0.0411178)	(0.0375326)	(0.0662968)	(0.0600228)	(0.0871249)	(0.0862314)	(0.0928265)	(0.0934397)
Vertical FDI (Sector level)	0.0364779***	0.0292933***	0.0402075***	0.0294721***	0.014028***	0.0113288***	-0.0023378**	-0.0017597
(1 period lag)	(0.0006317)	(0.000556)	(0.0006195)	(0.0005609)	(0.0003793)	(0.0003748)	(0.0011164)	(0.0010992)
Horizontal FDI (Sector level)	0.0230676***	-0.0041282*	0.2250753***	0.1505307***	0.0786356***	0.0544339***	0.0110311***	0.0093452***
(1 period lag)	(0.0027304)	(0.0024019)	(0.0042496)	(0.0038487)	(0.0026067)	(0.0025891)	(0.003048)	0(.003001)
Capital intensity	—	0.5999679***	—	0.548513***	—	0.265255***	—	0.2423741***
		(0.003179)		(0.0032635)		(0.0044745)		(0.0045602)
Sector fixed effects	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	No	No	Yes	Yes	Yes	Yes
Year fixed effects	No	No	No	No	No	No	Yes	Yes
N. Obs	119 946	119 946	119 946	119 946	119 946	119 946	119 946	119 946
R^2	0.0323	0.2539	0.1380	0.3023	0.0489	0.2490	0.1213	0.2918

Standard deviations are reporten in parenthesis. Significance at 1% / 5% / 10% level is indicated with *** / ** / *.

4.4 Robustness checks

In this section the following robustness issues will be handled or discussed; biased standard errors, causality issues, selection bias and endogeneity problems not handled by fixed effects.

4.4.1 Underestimated standard errors

As problematized in Moulton's article *An illustration of a pitfall in estimating the effects of aggregate variables on micro units* (1990), the inclusion of industry-level variables in a micro study will result in underestimated standard errors. To correct for this I will conduct the analysis over groups with the same firms over time, or in other terms cluster by firm id (Bosco, 2001; Moulton, 1990). This will control for heteroskedasticity, and allow for correlation within observation groups (Bosco, 2001). The results are presented in Table 4, and the virtually unchanged estimates indicate robustness[12].

[12] Note that we observe the expected change in standard deviations.

Table 4

Empirical results (Robust standard errors)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Estimation methodology	OLS	OLS	Fixed effects: Sector	Fixed effects: Sector	Fixed effects: Sector, firm	Fixed effects: Sector, firm	Fixed effects: Sector, firm, year	Fixed effects: Sector, firm, year
Constant	2.514595***	0.5795882***	-0.4692925***	-1.602657***	1.983734***	1.299348***	3.569944***	2.534999***
	(0.1352641)	(0.0874119)	(.1284178)	(0.0954888)	(0.1210691)	(0.1098765)	(0.1177227)	(0.1139434)
Vertical FDI (Sector level)	0.0364779***	0.0292933***	0.0402075***	0.0294721***	0.014028***	0.0113288***	-0.0023378**	-0.0017597
(1 period lag)	(0.0006488)	(0.0005975)	(0.000646)	(..0005806)	(0.0004346)	(0.0004283)	(0.0011099)	(0.0010923)
Horizontal FDI (Sector level)	0.0230676***	-0.0041282	0.2250753***	0.1505307***	0.0786356***	0.0544339***	0.0110311***	0.0093452***
(1 period lag)	(0.0085768)	(0.0059011)	(0.0082151)	(0.0061415)	(0.0036524)	(0.0031782)	(0.0027631)	(0.0026704)
Capital intensity	—	0.5999679***	—	0.548513***	—	0.265255***	—	0.2423741***
		(0.0065593)		(.0063731)		(0.0089392)		(0.0092181)
Sector fixed effects	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	No	No	Yes	Yes	Yes	Yes
Year fixed effects	No	No	No	No	No	No	Yes	Yes
N. Obs	119 946	119 946	119 946	119 946	119 946	119 946	119 946	119 946
R^2	0.0324	0.2539	0.1382	0.3023	0.0489	0.2490	0.1213	0.2918

Standard deviations are reporten in parenthesis. Significance at 1% / 5% / 10% level is indicated with *** / ** / *.

4.4.2 Causality

One might argue that the presented results give no proof for causality. It might be the case that even after controlling for fixed effects, the effect reflected in the FDI coefficients are due to the fact that more productive firms receive more FDI and not vice versa. To control for this I will include a three year moving average lag of FDI stock. This deeper lag will increase the validity of my argument since it is less likely that a firm received FDI four years ago because it is productive today. Moreover, it will also handle direct endogeneity issues resulting from correlation between productivity shocks and FDI magnitude. The results using the lagged moving average are presented in Table 5. We observe little change in the results, supporting the predicted causality.

Table 5

Empirical results - Three year moving average (Robust standard errors)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Estimation methodology	OLS	OLS	Fixed effects: Sector	Fixed effects: Sector	Fixed effects: Sector, firm	Fixed effects: Sector, firm	Fixed effects: Sector, firm, year	Fixed effects: Sector, firm, year
Constant	2.726046***	0.7114997***	-1.14021***	-2.032217***	1.426064***	0.9234935***	2.778729***	1.866232***
	(0.142322)	(0.0930234)	(0.1524224)	(0.1145364)	(0.1364946)	(0.1217814)	(0.1298339)	(0.1241226)
Vertical FDI (Sector level)	0.0453394***	0.0413416***	0.0502921***	0.0410517***	0.0221536***	0.0200623***	-0.0017659	-0.0009512
(3 year moving average)	(0.0009941)	(0.0008854)	(0.0010328)	(0.0009028)	(0.0006959)	(0.000678)	(0.0013446)	(0.0013143)
Horizontal FDI (Sector level)	0.0032143	-.02217***	0.2628441***	0.1720835***	0.1086947***	0.0734958***	0.0207012***	0.0165463***
(3 year moving average)	(0.0092283)	(0.0063905)	(0.0100163)	(0.0076409)	(0.0057083)	(0.0050807)	(0.0048432)	(0.0046632)
Capital intensity	—	0.6024467***	—	0.5440524***	—	0.2604033***	—	0.2427686***
		(0.0064756)		(0.0063631)		(0.0088366)		(0.0091278)
Sector fixed effects	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	No	No	Yes	Yes	Yes	Yes
Year fixed effects	No	No	No	No	No	No	Yes	Yes
N. Obs	124 790	124 790	124 790	124 790	124 790	124 790	124 790	124 790
R^2	0.0293	0.2485	0.1406	0.2993	0.0356	0.2298	0.1192	0.2848

Standard deviations are reporten in parenthesis. Significance at 1% / 5% / 10% level is indicated with *** / ** / *.

4.4.3 Selection bias

Other researchers utilizing the same Chinese data set have emphasized its unbalanced nature (Deng & Jefferson, 2009), with around 22% of firms dropping out of each year. If these exits are due to lower productivity, we will be left with more productive firms. Again, this will bias the estimated coefficients. I will deal with this issue using two techniques. First, I will limit my data set, and secondly I will utilize Heckman's two-step methodology.

4.4.3.1 Data set limitation

First, I will reduce the number of observations with the intention to remedy the selection bias problem. I will remove all firms where I do not have the full ten-year history of observations. This will decrease the problem outlined in Deng & Jefferson (2009) with regards to exiting firms[13]. Also, Djankov & Hoekman (1999) argue that the most successful firms are more likely to become "foreign"/JVs. As a compromise to resolve this problem I will run the regressions only over firms which stay domestic throughout the 10

[13] Remark that I might end up with the most efficient domestic firms in my sample. This can cast doubt on the generality, if one believes that absorptive capacity influences the productivity effects from FDI.

years (Protsenko, 2003; Smarzynska, 2002). The results are presented in Table 6, and preserve the fact that horizontal FDI yields more positive spillover effects[14].

Table 6

Empirical results -Only local firms with complete history (Robust standard errors)

	[1]	[2]	[3]	[4]
Estimation methodology	Fixed effects: Sector, firm, year	Fixed effects: Sector, firm, year	Fixed effects: Sector, firm, year	Fixed effects: Sector, firm, year
Constant	3.965932***	2.963014***	4.053289***	3.106488***
	(0.2341554)	(0.2650875)	(0.2530201)	(0.2768227)
Vertical FDI (Sector level) (1 year lag)	-0.0074209***	-0.0068514***	-	-
	(0.0021022)	(0.0020649)		
Horizontal FDI (Sector level) (1 year lag)	0.0159364***	0.0131838***	-	-
	(0.0040264)	(0.0038733)		
Vertical FDI (Sector level) (3 year moving average)	-	-	-0.0204624***	-0.0202735***
			(0.0037517)	(0.003648)
Horizontal FDI (Sector level) (3 year moving average)	-	-	0.0220633***	0.0164058**
			(0.0067872)	(0.0065067)
Capital intensity	-	0.2364422	-	0.2358503***
		(0.0323638)		(0.0326049)
Sector fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
N. Obs	14 590	14 590	14 590	14 590
R^2	0.0365	0.1349	0.0373	0.1385

Standard deviations are reporten in parenthesis.
Significance at 1% / 5% / 10% level is indicated with *** / ** / *.

4.4.3.2 Heckman's two-step technique

Also, several authors deal with the selection bias issue using Heckman's two-step technique (Deng & Jefferson, 2009; Damijan et al., 2003). This procedure will first estimate a probit model to deal with the determinants of firm exits. Due to software availability, I am only able to run the simple non-panel Heckman model. Running different specifications I always end up with insignificant spillover effects for

[14] Please remark that my dataset is reduced to 14590 observations using this technique.

both FDI types[15]. It would be interesting to implement the panel data Heckman approach to address the selection bias problem taking into effect endogeneity issues known to disturb results.

4.4.4 Further endogeneity issues

There are several endogeneity issues which might not be dealt with using fixed effects. First, we have endogeneity problems due to possible correlation between the error term (e.g. productivity shocks) and adjustments in input factors. Second, productivity shocks might be correlated with the FDI terms. Such correlation might be due to favorable industry environment or management capability. These issues are typically dealt with using Generalized Method of Moments with Instrumental Variables[16]. These problems will not be further pursued in this paper, but are an area for improvement in coming papers. The same decision is made regarding the fact that different industries might have different production functions[17].

5. Conclusion

This paper contributes to the ambiguous literature on spillover effects from FDI. I find strong evidence that horizontal FDI yields higher spillover effects than vertical FDI using a large data set of Chinese enterprises, shifting attention to the heterogeneity of FDI motivation. Moreover, the hypothesis seems to be supported by theoretical evidence on spillover channels and various spillover catalysts' relation to differences in FDI motivations. From a policy perspective, these results will add as an important element. When governments are focusing their attraction strategies towards multinational enterprises, this paper emphasize the importance of MNE motivation for the realized externality potential for

[15] The results from the Heckman procedure are not reported, due to the weak procedure specification.
[16] For a widely used methodology see Arellano & Bond (1991). Also, other well-known approaches are outlined in Olley & Pakes (1996) and Levinsohon & Petrin (2003).
[17] See for example Castellani & Zanfei (2006).

domestic firms. Significant resources are used to attract foreign capital, but my paper indicates that public funds might be better employed in the *horizontal portion* of these cases.

Going forward, it would be beneficial to further elaborate on the differentiated effects with respect to country heterogeneity. Recent theoretical work by Roording & de Vaal (2010) indicates that the technology difference between the domestic firms and the MNEs will be a key determinant for which type of capital a country should attract[18]. This and other country differences should be tested empirically before making grand, general conclusions. Also, further development of the classification of motivation would be beneficial. Firm level data including bilateral flows would increase the validity of this literature branch substantially.

[18] An example potentially highlighting the theoretical results of Roording & de Vaal (2010) is the opposite findings between my paper and the sector-level results from the Czech Republic (Protsenko, 2003).

6. Appendix

Table 7 – Industry overview

SIC2	Industry
13	Agricultural-related food processing
14	Food
15	Beverage
16	Tobacco
17	Textile
18	Clothing
19	Leather
20	Wood processing
21	Furniture
22	Paper
23	Printing
24	Education-related products manufacturing
25	Oil
26	Chemical
27	Pharmaceutical
28	Chemical fiber
29	Rubber
30	Plastic
31	Non-metal minerals
32	Ferrous metal processing
33	Non-ferrous metal processing
34	Metal products
35	General equipment
36	Special equipment
37	Transportation equipment
38	N/A
39	Electric machinery
40	Computer and telecom
41	Instruments and office products
42	Art and crafts manufacturing
43	Recycling

Figure 3 - FDI stocks per industry for 2004

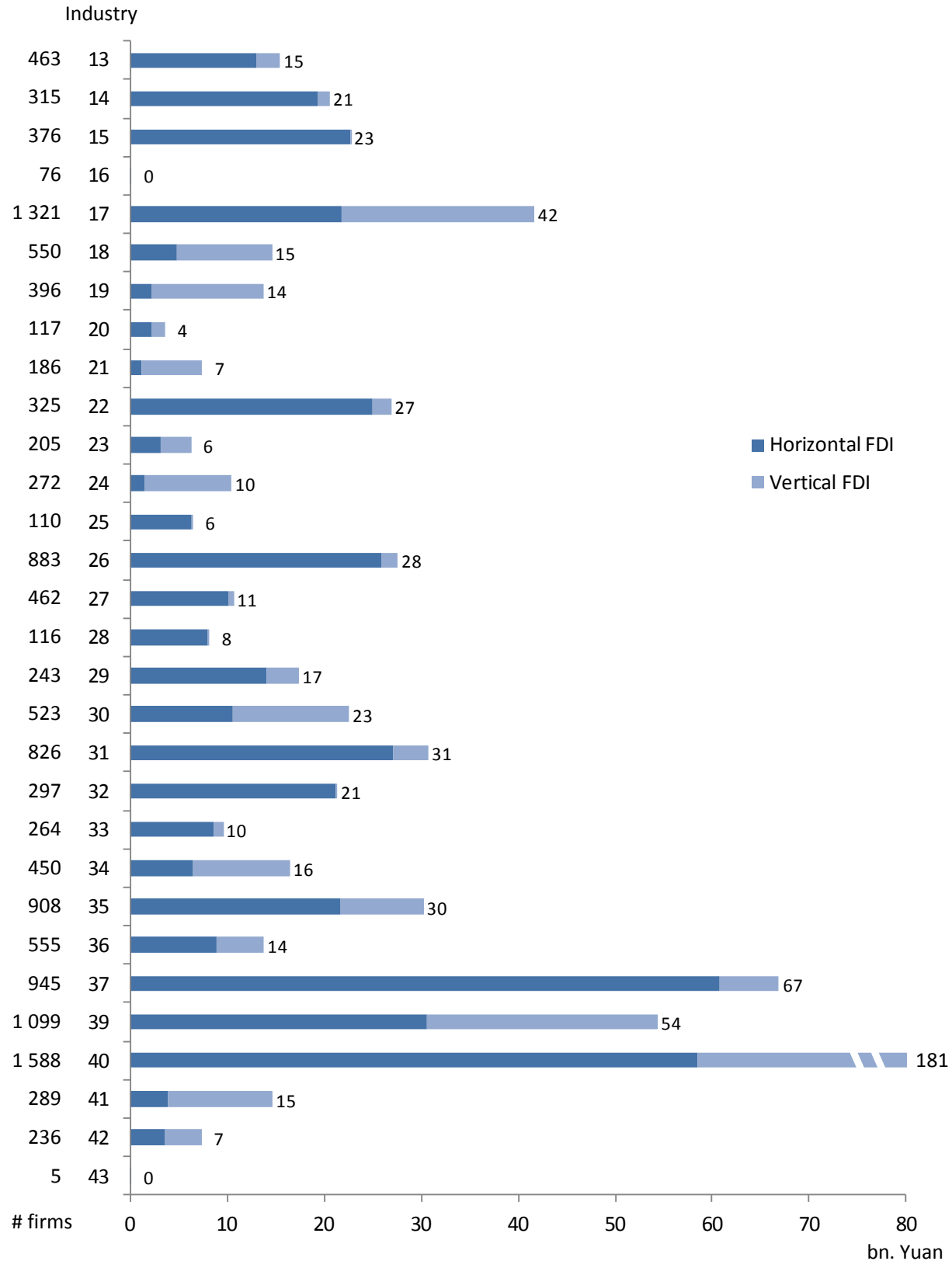
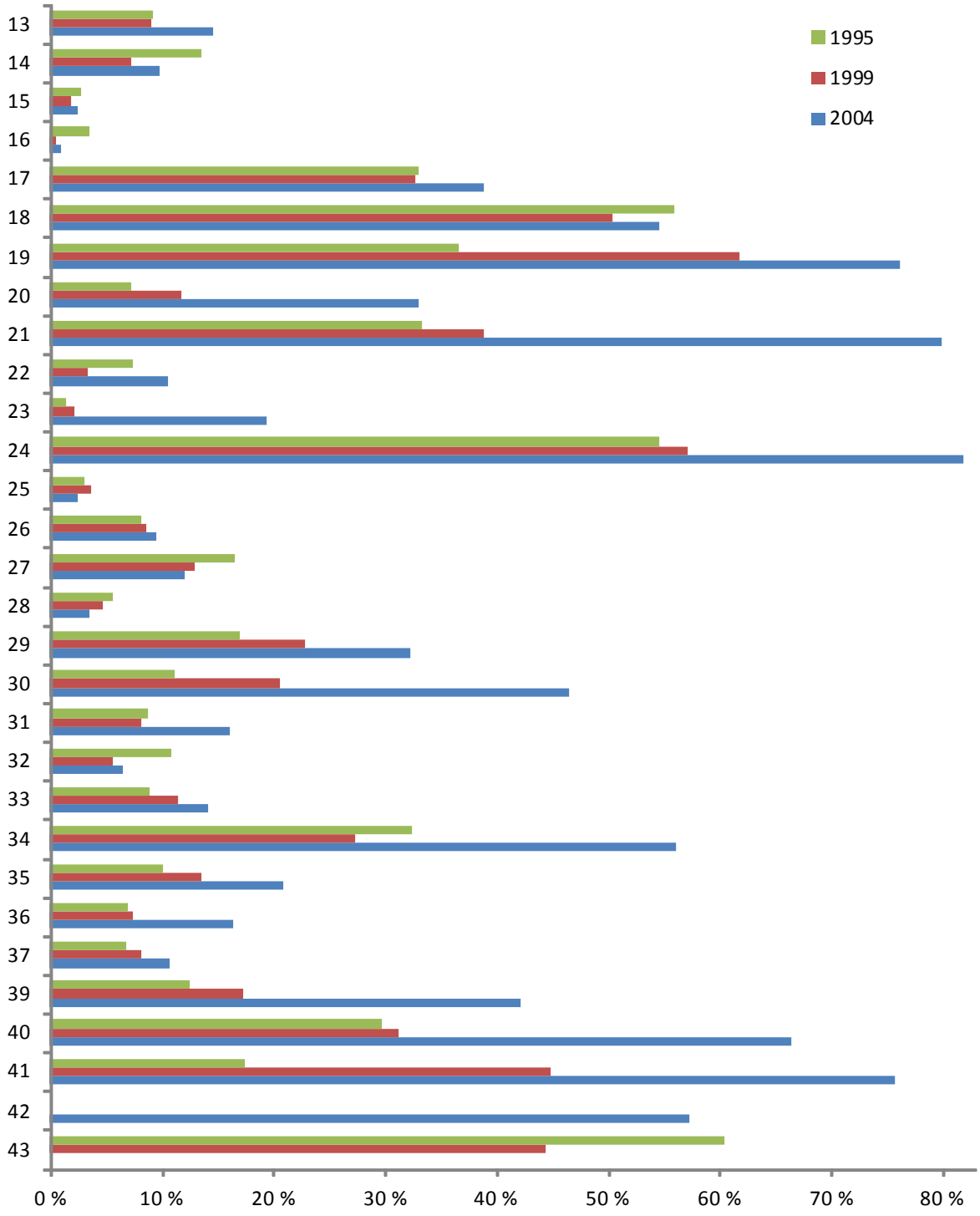


Figure 4 - Export/sales per industry



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