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Where to Find Positive Productivity Spillovers from FDI in China: Disaggregated Analysis

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Abstract

Using panel data from Chinese Industrial Surveys of Medium-sized and Large Firms for 2000-06, we show that while there is evidence of positive technological spillovers from FDI, such spillovers are very unevenly distributed. For some industries, there are positive spillovers from FDI presence in the same industry and province, but for others spillovers are negative. There are positive spillovers from FDI presence in upstream and downstream industries, but such spillovers mostly occur in private firms. There are more spillovers from foreign capital that comes from outside the greater China area.

Keywords: FDI, Spillovers, Forward-Backward Linkages, China

JEL Classification: L33, F23, O17

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1. Introduction

China has been the world leader among developing countries in attracting FDI over the past decade, during which period the Chinese economy has boomed. But to what extent have these FDI flows brought technologies, production techniques, and other management practices that have spilled over to indigenous Chinese firms either in the same industry (horizontal externalities) or in upstream or downstream industries (vertical externalities)?

The research on technological spillovers from FDI shows weak and inconclusive results.[1] A large body of the literature on technological spillovers from FDI *in China*, too large to be fully reviewed in this paper, mostly focuses on horizontal spillovers, even though vertical spillovers are likely to be important (Moran, 2007).[2] Hale and Long (2009) provide a critical survey of research on FDI spillovers in China, where potential econometric problems that arise in various studies are discussed in detail. Since that survey was written, numerous papers employed firm-level and industry specific analysis to address the question.[3] Nevertheless, the results remain inconclusive due to variation in the sample and the methodology, in addition to the fact that, as we find out from this paper, spillover effects are heterogeneous across industries, ownership types and sources.

In this paper, therefore, we try to reconcile some of these results by making use of the best available data, state of the art methodology, and disaggregated analysis that allows us to see where exactly spillover effects from FDI on TFP, if any, can be found.

One of the major difficulties in previous studies stems from the use of aggregate level data, which often include both foreign and domestic firms, and thus cannot distinguish the higher productivity of foreign firms from the positive spillover effects on domestic firms. Even when the two groups of firms can be separated, one cannot reject the possibility that the observed positive effects are due to the initially more productive domestic firms in the group attracting more foreign capital. Such reverse causality or omitted variable bias is present even if a cross-section of firm-level data are used, due to potential “cherry-picking” by foreign investors of firms that have higher potential which may not be observable by an econometrician. Moreover, if it takes time for positive FDI spillovers to take effect, cross-section analysis will miss them.

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1 See the literature reviews by Görg and Strobl (2001), Lipsey (2002), Saggi (2002), Görg and Greenaway (2004), and Javorcik (2008).

2 To the best of our knowledge, the only two published studies that have explored the vertical FDI spillovers for Chinese domestic firms is Hale and Long (2009), which did not detect any positive spillover effects based on a cross-sectional data set of private firms and SOEs, and Girma and Gong (2008), which also failed to find evidence of positive spillovers for SOEs.

3 While most published papers used industry-level data, Liu (2008) and Fu and Gong (2009) analyze firm-level data, with results that are conflicting due to different time period analyzed, different statistical methods used, and different definitions of TFP.

We employ *firm-level panel* data from the Chinese Industrial Surveys of Medium-sized and Large Firms (2000-2006). Using firm-level panel is essential for two reasons. First, firm fixed effects can be used, so that the effect of FDI presence is identified by within firm changes in productivity variables, thus ruling out the possibility of reverse causality or selection, to the extent that foreigners' investment decisions are based on initial firm conditions that do not vary over time. Second, seven years of data allow for the study of dynamic effects, which is crucial as various kinds of FDI spillovers all need time to materialize. Importantly, to avoid contamination from the firms that actually received foreign capital, we exclude from our regression sample all firms that had a non-zero share of foreign capital in any year during our sample period.

Estimating total factor productivity (TFP) is not a straightforward task, although a number of approaches have been developed in the industrial organization literature. The main problems that need to be addressed are endogeneity of inputs and persistence of the variables. We use dynamic system GMM with firm fixed effects to estimate production functions by industry, the approach that seems to have become the state of the art in the literature. System GMM uses lagged values of right-hand-side variables as instruments and allows for the lagged dependent variable to be included among the regressors, thus addressing both problems–endogeneity and persistence.[4] Many recent papers that analyze the firm-level panel data also use this method, which allows for comparisons.[5]

We disaggregate our analysis in four dimensions. First, as we mentioned above, we do not limit our analysis to horizontal spillovers, but also analyze the effects of upstream and downstream presence of foreign firms, which we refer to as “vertical spillovers”. We note that measures of horizontal and vertical FDI presence are highly correlated even though we exclude “own industry” from vertical measures. Therefore, for the ease of interpretation we estimate separate regressions for vertical and spillover effects. Second, we analyze the effects of the presence of firms with capital from the Greater China Area separately from the firms with capital from other foreign countries, for two reasons: to account for the fact that some Greater China Area FDI is in fact round-tripping capital, and to acknowledge potentially different technological gaps between these two regions and mainland China. Third, we analyze separately domestic firms that are majority private and those that are majority state owned, because it is likely that private firms will be more susceptible to technological spillovers. Fourth, we estimate spillover effects, both vertical and horizontal, for each two-digit CIC industry separately and repeat our analysis for subsamples of private and state-owned firms.

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4 We attempted semi-parametric methods *à la* Olley and Pakes (1996) as well, but had to abandon that route due to data limitations.

5 In a recent contribution, Brandt, Van Biesebroeck and Zhang (2009) analyze the dynamics of TFP in China using a sample that is very similar to ours and very similar methodology. Main moments of our TFP estimates are very similar to theirs.

While in the full sample spillover effects are small and rarely statistically significant, we do find positive spillovers from FDI in China. Most positive effects are found in spillovers through backwards and forwards linkages of private firms. And most of these spillovers came from the presence of foreign capital from the outside of the greater China area. When conducting the analysis across industries, we find evidence of both positive and negative horizontal spillovers, which explain why on average no spillovers are found in a number of previous studies. We also uncover a number of interesting patterns by analyzing our results across industries.

We make several contributions to the literature on FDI spillovers in China and in general. First, we are able to use the best possible data set – a large panel of manufacturing firms – which allows us to control for firm and year fixed effects, ruling out main concerns related to endogeneity of FDI presence. Second, we study both horizontal and vertical FDI spillover effects. Third, we are able to distinguish between FDI from the greater China area and from other foreign sources. Fourth, we investigate separately the effects on private firms and on SOEs. And finally, we analyze FDI spillovers by industry, which uncovers interesting patterns and helps us understand why results in the literature may be inconclusive.

The paper is organized as follows. Part 2 presents the description of our data source and the variables we use in this study, as well as our empirical approach. Part 3 reports the results of our empirical analysis. Part 4 concludes.

2. Data and Empirical Approach

Our data come from the Chinese Industrial Surveys of Medium-sized and Large Firms for 2000-06. Commonly referred to as the National Bureau of Statistics (NBS) manufacturing census, this data set includes all state-owned companies and private firms that are above certain size thresholds. The full data set consists of about 1.5 million observations (0.5 million firms) and is an unbalanced panel with a lot more firms coming into the sample in 2004. Unfortunately, we are forced to drop many observations due to missing crucial variables, such as year, country or industry code; duplication (exact or approximate); negative values of assets or capital. For the purposes of our analysis we also have to drop from our sample firms that switch provinces during our sample period, because most of our analysis is that of spillovers within province-industry cells. We end up with a panel of 1,326,727 observations for 454,770 firms. Our regression analysis, however, includes only 371,368 observations for 170,691 firms for which we can estimate total factor productivity. The rest drop out due to missing values for capital, labor, intermediate inputs, or sales and their lags.

While we use an unbalanced panel of the firms, here we give the snapshot of the composition of the sample in 2006, for clarity. The initial 2006 sample consist of 301,961 firms, of which 28,761 had positive share of Hong Kong/Macao/Taiwan ownership (HMT) and 30,681 had positive share of other foreign ownership (FRN).[6] 238,872 firms are fully domestic, that is have no HMT or FRN share. Of these, 140,337 are majority private owned and 15,127 are majority state owned. The rest have either no majority or have majority collective, legal person, or other ownership.

In studying FDI spillovers, we exclude from the sample both HMT-invested firms and firms with investment from other foreign sources in any of the years in our sample. Thus, only firms with 100 percent domestic ownership are included in the regression analysis. To explore the effects of domestic firms' own ownership type on FDI spillovers, we single out two ownership types: private firms (defined as firms with majority private share) and state-owned enterprises SOEs (defined as firms with majority state share). While these two groups do not span all firms in our sample due to complicated ownership structure in China, they represent “extreme” categories in the sense of the degree of governmental control.

We make a number of adjustments to the raw data. In the end, in our FDI spillover regressions we have over 170,000 domestic firms, of which about 103,000 are private and almost 65,000 are non-private. In the full sample, we have over 370,000 observations.[7]

2.1 Productivity Measures

Most literature on technological spillovers from FDI focuses on total factor productivity (TFP). Similarly, we analyze the effects of FDI on TFP, which we define as the residuals generated from estimating a dynamic production function of the form:

$$y_{it} = \alpha_0 + \alpha_1 y_{i,t-1} + \alpha_2 l_{it} + \alpha_3 k_{it} + \alpha_4 m_{it} + \tau_t + \eta_i + \upsilon_{it} \quad (1)$$
$$\mathrm{E}[\eta_i] = \mathrm{E}[\upsilon_{it}] = \mathrm{E}[\eta_i \upsilon_{it}] = 0$$

where y_{it} is log of output by firm i at time t, k_{it} is log of capital, l_{it} is log of employment, m_{it} is log of intermediate inputs,[8] with time-specific fixed effects τ_t, firm-specific fixed effects η_i, and random error term υ_{it}.[9]

In designing estimation approach, the following characteristics of our data need to be taken into account. First, there is high autocorrelation in both left- and right-hand-side variables. Second, explanatory variables may be endogenously determined. Third, our panel is wide (large N) and short (small T).

6 These sets are not exclusive, because some firms have both HMT and FRN shares.

7 The main reason for dropped observations are missing data.

8 Output, capital and intermediate inputs are deflated to 2000 prices using Chinese national headline CPI.

9 Note that because we include lagged dependent variable on the right-hand side, the residual should be interpreted as an innovation to the TFP.

Moreover, firm fixed effects need to be included to account for unobserved time-invariant differences across firms. Though a variety of methods exist that can be implemented to estimate (1), data limitations constrain our choice of estimators. Ordinary least squares (OLS) and fixed effect (FE) estimators are not optimal in accommodating the first and the third data features above.[10] A large number of firms not reporting investment data limits our ability to implement the Olley and Pakes (1996) method. Thus, in order to estimate (1) and obtain residuals we have to rely on "internal" instruments that are based on lags of the instrumented variables using the system generalized method of moments (GMM) estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998), which is now becoming a mainstream method for estimating such models.

System GMM combines equations in the first-differences and in the levels. The former eliminates firm-specific fixed effects and uses the lagged levels of variables as valid instruments. The latter exploits additional moment conditions in the levels equations that enable the use of lagged differences of variables as valid instruments. The equations in levels address the problem of finite sample bias, which arises from the lagged levels of the variables providing weak instruments for first-differences (see Alonso-Borrego and Arellano, 1996). Exogeneity of instruments are tested using the Arellano-Bond (1991) test for autocorrelation and the Hansen (1982) J test of overidentifying restrictions.[11]

In conforming with established practices, we use the lags of levels and first-differences of covariates $y_{i,t-1}$, l_{it}, k_{it}, and m_{it} as GMM style instruments. We account for the endogeneity of $y_{i,t-1}$ by using instruments lagged $t-3$ and earlier for equations in first-differences and $\Delta y_{i,t-2}$ for the levels equations. This is done to avoid the violation of moment conditions $\mathrm{E}[y_{i,t-2}\Delta v_{it}] = 0$ and $\mathrm{E}[\Delta y_{i,t-1} v_{it}] = 0$. For the other three covariates l_{it}, k_{it}, and m_{it}, all possible lags in levels are used as instruments in the first-differenced equations and first-differences Δl_{it}, Δk_{it}, and Δm_{it} are used in the levels equations. We estimate production functions for each industry based on one-step system GMM with standard errors clustered on province-sector dyads.[12] There should be minimal first-order autocorrelation of v_{it} and the moment conditions pertaining to our specified instruments should hold, thus we expect to not reject either

10 The asymptotic properties of OLS and FE estimators can be modified to take into account the inclusion of the lagged dependent variable on the right hand side [Greene, 2008, sec. 4.9.6], however, the consistency of the estimators depend on $T \rightarrow \infty$ [Greene, 2008, sec. 15.6.5].

11 The Arellano-Bond (1991) test for autocorrelation tests the null of zero pth-order autocorrelation in the first-differenced error term (Δv_{it}). In general, AR(p) in first-differences must be checked in order to assess AR($p-1$) in levels, and thus the test statistic of main concern is AR(2). The Hansen (1982) J test, which is an extension of the Sargan (1958; 1959) test, is used to test the null that the instruments as a group are exogenous. The test is robust to heteroskedasticity and autocorrelation.

12 We assume production functions vary across industries. For industries with two-digit CIC equal to 16 (Tobacco Processing), 17 (Textile), and 30 (Plastic Products), we drop outliers in the top and bottom one percent. In addition, we separate the Plastic Products industry into two sub-sectors based on three-digit CIC: Industrial Plastics (301-305) and Consumer Plastics (306-309).

the Arellano-Bond test for AR(2) or the J test. We also do not expect to reject the Wald test of constant returns to scale hypothesis: $\alpha_2 + \alpha_3 + \alpha_4 = 1$.

Estimation results are fairly consistent with our expectations. For all industries, we fail to reject the Arellano-Bond test for AR(2) and the J test at the 5% level. Autocorrelation of the random error term in the levels equations has been removed and our specified instruments are valid. Only for a few industries can we reject constant returns to scale at the 5% level, which suggest potentially inefficient scale of production. These industries all have a high share of SOEs.[13] Lastly, for each firm, TFP is set equal to υ_{it}.

In a recent paper Brandt, Van Biesebroeck, and Zhang (2009) provide a very careful estimation of TFP using the same data set as we do, with fewer restrictions on the sample. Encouragingly, the descriptive statistics of our TFP measures are very close to theirs.

2.2 Measures of FDI Presence

To measure the presence of FDI, we construct the weighted average foreign share of all firms located in the same province and in the same two-digit CIC sector, with each firm's employment as the weight. To distinguish the potentially different effects of investment from different foreign origins, we compute the FDI presence measure separately for investment from Hong Kong-Macao-Taiwan (HMT) and that from other foreign sources (FRN).

To study vertical FDI spillovers, we use China's Input-output Table of 2002 (122-sectors) to compute the *upstream* FDI presence and *downstream* FDI presence for industry j. Based on the within industry FDI presence of all other two-digit CIC industries that serve as suppliers to industry j, as computed above, we construct the *upstream* FDI for industry j. In particular, it is the sum of FDI presence in all these industries (excluding the industry to which firm j belongs) in the same province weighted by the *input* coefficients of these industries corresponding to firm j's industry. The *downstream* FDI presence, on the other hand, is computed as the sum of FDI presence in all the client industries of j, weighted by the *output* coefficients of industry j to these other industries.

Specifically, we construct the complete output coefficient matrix (containing a coefficient for each pair of industries), $\mathbf{B}$, as

13 These industries are: Tobacco Processing (16), Printing and Record Medium Reproduction (23), Cultural, Educational and Sports Goods (24), Petroleum Processing, Coking and Nuclear Fuel Processing (25), Industrial Plastics (301-305), and Consumer Plastics (306-309).

$$\mathbf{B} = (\mathbf{I} - \mathbf{A})^{-1} - \mathbf{I}$$

where $\mathbf{I}$ is the identity matrix and $\mathbf{A}$ is the direct output coefficient matrix, which is in turn computed by dividing the direct usage of the output of industry i in industry j, by the total output of industry i. In other words, industry i's output will impact industry j both directly by being used in j as input, and indirectly by being used as inputs in other industries, which in turn produce outputs that are used as inputs in industry j. In computing the direct and complete coefficients, we include the impact of imported goods in each industry, but exclude the impact of export goods.[14] Finally, we compute for each industry i a weighted average of the FDI presence in all other industries that serve as its clients with the complete *output* coefficient as the weight. This measure is referred to as the forward linkage (or downstream FDI presence). The backward linkage is computed similarly, except with complete *input* coefficient matrix.

Then, for each of the measures of FDI presence–same industry, backward, and forward linkages–we estimate the following regression

$$TFP_{ispt} = \alpha_i + \alpha_t + \beta_1 FRN_{spt-1} + \beta_2 HMT_{spt-1} + \varepsilon_{it}$$

where TFP is a measure of TFP as constructed in Section 2.1 for firm i in sector s province p and year t; α_i and α_t are firm and year fixed effects; FRN and HMT are measures of FDI presence in sector s province p lagged one year; error term ε_{it} is allowed to be AR(1). We estimate these regressions for the full sample, and for private and SOE firms, separately. We also conduct the analysis by sector, again for all firms, and for private and SOE firms, separately.

While most of the results are reported at the two-digit CIC sector, there are a few three-digit sectors that we find particularly interesting. First of all, we consider it crucial to separate the pharmaceutical industry into Chinese traditional medicines and western medicines, because there may not be much room for spillovers in the traditional Chinese medicine sector. Next, within the electronics industry we study computer and telecommunication sectors, separately, mainly because we know that the FDI into computer industry occurred mostly prior to our sample period, while FDI into telecommunications occurred mostly during our sample period. We also isolate the auto industry from the overall transportation industry, because this is an industry that has drawn a lot of attention due to large FDI inflow in the case of China. Finally, we found it useful to split plastics into industrial and consumer plastics to estimate the production function and maintain the categorization below.

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[14] This is a different approach than used by Girma and Görg (2007), who exclude imported inputs. We believe that including imported inputs is important because they might be one of the channels, by which foreign firm bring in new technology into China.

2.3 Summary Statistics

Table 1 presents the composition of firms in our sample. Note that while the total share of firms with foreign capital (from any source) did not change much during our sample period, we do observe an increase in the share of firms with majority foreign ownership, especially with foreign capital from sources other than HMT.

Table 2 presents summary statistics for our key variables in the various samples. We will first describe the overall dynamics we observe and then discuss differences across samples. The typical size of Chinese firms has generally increased over the 2000-2006 period in terms of value added (see log(value added)), but has dropped in employment (see log(labor)). The average level of fixed assets, however, remains relatively constant. This implies an upward trend in both labor productivity and capital intensity in Chinese firms during this time period. As the Chinese economy grew over time, the number of large and medium-sized firms also increased during this time period. The main change in the criteria for inclusion into the large and medium sized firm survey occurred in 2003, which simplified and unified the standards across different ownership types, leading to a jump in the sample size in 2004. The small reduction in the sample size in 2005 may result from the over-due deletion of old large firms that had fallen below the threshold.

A seemingly paradoxical pattern is the decreasing firm age over time. The reason is most likely the large number of new entrants into the survey. Note that these are not necessarily new firms: they may also be firms that have newly exceeded the threshold level and have thus been newly included into the survey or firms that changed names and thus registration numbers when going through restructuring. Market share tends to decrease over time, indicating more competition within industry on average, while export/sales ratio and new product sales/sales ratio fluctuate and show no clear trends during the time period.

A comparison between domestic firms and foreign-invested firms highlights the following patterns: (1) Domestic firms are smaller than HMT firms, which are in turn smaller than firms with investment from other sources, regardless whether size is measured in the amount of fixed asset, employment, or sales (see market share); (2) Domestic firms are less capital intensive than HMT firms, which are less capital intensive than other foreign firms; (3) Both HMT firms and other foreign firms have a higher export/sales ratio than domestic firms; and, (4) Firms with foreign investment from sources other than HMT tend to have a higher percentage of sales made up by new products, while HMT-invested firms are not different from domestic firms in this respect. These differences between domestic and foreign firms confirm the conventional beliefs of foreign firms having higher capital intensity, being more internationally oriented, and being more technologically innovative.

Figure 1 presents FRN and HMT shares for each of the industries in our sample. We can see that while FRN increased for all industries, HMT did not increase or actually declined in food manufacturing, leather/fur, timber processing, overall pharmaceuticals and western medicine in particular, consumer plastics, and computers. On average FRN share increased by a factor of 2.4 while HMT share increased by a factor of 1.9. This is important for our analysis, because due to firm fixed effects the identification in our regressions comes from over-time variation in TFP and FDI presence.

3. Empirical Results

In this section we report the results of our parametric analysis. Since we estimate a lot of regressions–9 for each industry, which we present in Tables 3-5–we will discuss the results based on a graphical representation of estimated coefficients shown in Figures 2-4.

3.1 Horizontal Spillovers

Horizontal spillover effects may arise due to competition and demonstration effects. When foreign capital flows into the industry, domestic firms might find both input and output markets more competitive. Competition on the output markets may lower measured TFP (by lowering output prices) but may also increase actual TFP by creating incentives for the firms to increase efficiency. Competition on input markets, such as a market for skilled labor (Hale and Long, 2008), is likely to lower measured TFP through an increase in cost of inputs. Demonstration effects are expected to be positive, as they describe ways in which domestic firms can learn superior technology from foreign-invested firms though observation, worker mobility, and informal interaction.

Our results for the regressions where FDI measures are for the same industry are presented in Table 3 and Figure 2. An important observation is that there are statistically significant positive and negative effects–in some industries competition effects seem to dominate, while in others demonstration effects are more prevalent. Importantly, this implies that in the full sample, the effects of FDI presence are either zero or small, as we can see from the top row of Table 3.

Looking more closely, we can see that there are more positive spillovers from foreign investment from outside the greater China area (FRN) than from investment from Hong Kong, Macao, and Taiwan (HMT). In fact, for the full sample of the firms we find small but statistically positive spillover effect from FRN, but not from HMT. We can see that this result comes predominantly from the sample of private firms, for which the full sample coefficient is also positive and statistically significant, consistently with the distribution of coefficients for private firms skewed towards positive. Moreover, we find strong positive spillovers in telecommunications and negative spillovers in specialized equipment, across the board. Possibly, the know-how in the specialized equipment industry is well guarded by foreign firms or not easily transferable due to the heterogeneous nature of the output. Moreover, special equipment is a net-importing industry in China, implying that firms have less opportunity for exporting. Thus the competition effect is more important in determining horizontal FDI spillovers for firms in this industry, which is consistent with the negative horizontal FDI effects observed in the data.

3.2 Backward Linkages

Spillovers through backward linkages occur because with foreign entry in the downstream industries demand for output of upstream domestic firms is likely to increase, raising volume and thus productivity if there are economies of scale. Moreover, foreign firms may help upstream firms improve their technology in order to produce inputs and parts more efficiently. In some cases, foreign firms even provide their suppliers with technological blueprints: According to a survey of Chinese firms conducted by the World Bank in 2000, over 25 percent of Chinese domestic firms that produced parts or other inputs for foreign firms, used licensed technologies or processes provided by foreign firms to introduce new process improvements.[15] There may be a negative impact as well, however, if foreign firms demand higher quality inputs, which may lower domestic firms' productivity if it takes them time to adjust or if some of their output are rejected. Competition effects are unlikely in the case of backward linkages, because firms are in sufficiently different industries and therefore do not compete directly on input or output markets.

Our results for the regressions where FDI measures are for the downstream industries are presented in Table 4 and Figure 3. We can see that, compared to horizontal spillovers, there are more positive than negative effects and that most of the positive effects, especially for FRN are concentrated in private firms. Average positive effect is statistically significant for HMT for SOEs (although it is driven by large positive coefficients in the industries with not much FDI growth), and for FRN for the sample of all firms. Positive spillovers from FRN in the private firms are widespread across industries, while there are hardly any positive spillovers from FRN for SOEs. In fact, average effect of FDI from FRN is negative for state-owned firms. We believe this could be due to the fact that SOEs are on average older and less flexible and therefore stand less to gain from foreign presence downstream. Moreover, foreign firms may prefer to deal with private firms than with SOEs and therefore spillovers through backward linkages to SOEs will be limited. Finally, as we include FDI measures that are lagged only one period, it may be the case that SOEs take longer to adjust and begin benefitting from foreign presence downstream.

3.3 Forward Linkages

The most obvious reason for spillovers through forward linkages is the availability of higher quality inputs. In addition, more sophisticated inputs may lead to higher TFP through superior technologies. Negative spillover effects except may arise because some adjustment may be required in the short run to incorporate new inputs into production processes, which can be costly in the short run.

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15 Source: Author's computations based on the survey data from the Study of Competitiveness, Technology, and Firm Linkages, World Bank, 2000.

Our results for the regressions where FDI measures are for the upstream industries are presented in Table 5 and Figure 4. The patterns we find are similar overall to backward linkages–there are mostly positive spillovers and they are widespread for private firms, but not for the SOEs. The only significant effect we find for the sample of all industries is a negative effect of FRN on state-owned firms. Once again, we believe that SOEs may have less interaction with foreign suppliers, and even if they do, they may be less flexible and may take longer to adjust to new types of inputs. Larger spillovers from FRN are likely reflecting greater technological advantage of the regions outside the greater China area.

3.4 Overall Patterns

Before we move on to the generalizations of what we found, it is worth mentioning the industries for which we find no vertical or horizontal spillovers. The most surprising is probably the fact that we find no effects for firms in the computer industry. However, as we pointed out above, most of the FDI into computer and computer-related industries and spillovers from them may have occurred prior to our sample period (see Figure 1). Similarly, not much increase in FDI was observed in consumer plastics, which may explain why we do not find much spillover effects. In addition, because foreign share is large in the computer industry (in 2006, share of FRN was 0.6 on average, while share of HMT was 0.3), the sample size of domestic firms is not very large (with Lenovo plants likely dominating the sample of non-private firms). As we would expect, we find no spillover effects for Chinese medicines because there may not be much that Chinese firms can learn from foreigners, because inputs are agricultural and outputs go to Chinese service sector, neither of which have much FDI.

Equally surprisingly, we did not find spillover effects in transportation equipment industry overall or in the auto industry in particular. It is possible that production processes in these industries are vertically disintegrated and foreigners guard their technologies. It is also possible that most of the spillovers occurred prior to our sample period. Another explanation is that foreign firms in transportation equipment (the auto industry included) as well as in the computer industry are so large that their market and sphere of influence are the whole nation. As we use foreign presence in the industry-province as the FDI measure, our results miss the more relevant FDI spillover effects.

That said, how can we summarize all our findings? First of all, we find that while some industries experienced positive horizontal spillovers, in other industries horizontal spillover effects were negative. Given that competition effects that would result to lower output prices and higher input prices are likely to have a negative impact, while demonstration effects are likely to have positive impacts, it is not surprizing to find that the competition effect dominates in some industries, while the demonstration effect dominates in others. This points to the importance of disaggregated analysis. Secondly, we find that vertical spillover effects are most prominent for private firms that we believe are more flexible and stand to gain more from foreign presence upstream and downstream. Furthermore, we find more positive spillovers from FRN than from HMT, consistent with the belief that foreign investment from outside the Greater China Area tends to embody more advanced technologies and managerial expertise. Alternatively, part of the FDI from the greater China area could represent round-tripping, which would not lead to any spillovers and therefore may bury some of the spillover effects from HMT.

Finally, we find that industries that are negatively impacted by FDI presence tend to possess one or both of the following characteristics, suggesting potential reasons for the negative FDI spillovers: (1) They are sectors where China is a net-importer (for example, equipment, special equipment, and metal products), thus demand in foreign markets for their products is limited; and, (2) They are sectors with economy of scale and thus dominated by large firms, thus the relevant FDI spillovers may be from the national level (for example, agro-products, auto, coal, fuel processing, and non-ferrous smelting).

4. Conclusion

Overall, we found evidence of positive spillovers from FDI in China. However, we must point out that such spillovers are distributed very unevenly across industries, types of spillovers, origin of foreign capital, and ownership structure of the firms. Most positive effects are found in spillovers through backwards and forwards linkages of private firms. And most of these spillovers came from the presence of foreign capital from outside the greater China area.

The fact that spillover effects are unevenly distributed across industries, ownership types, and sources of FDI helps us understand why there is such diversity of findings in the vast literature on FDI spillovers in China. The results in pooled or aggregate data depend on the sample of firms included in the study, the sample period, as well as additional controls and restrictions. We believe our analysis provides good reasons for further studies at the disaggregated level and we hope that it will encourage further empirical work in this direction.

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Table 1. Composition of Firms in our Sample

Year	2000	2001	2002	2003	2004	2005	2006
Total number of firms	139479	143218	151285	162868	245480	240140	271830
Fully domestic firms	115997	117685	124000	132708	198025	193671	220970
- percent of total	83%	82%	82%	81%	81%	81%	81%
Firms with foreign share	23482	25533	27285	30160	47455	46469	50860
- percent of total	17%	18%	18%	19%	19%	19%	19%
Firms with HMT share	13230	14378	14582	16091	25348	23043	24874
- percent of total	9%	10%	10%	10%	10%	10%	9%
Firms with other for. share	10664	11607	13173	14494	22583	23856	26455
- percent of total	8%	8%	9%	9%	9%	10%	10%
Firms with maj. for. share	14292	16479	18088	20892	34719	34800	38745
- percent of total	10%	12%	12%	13%	14%	14%	14%
Firms with maj. HMT share	7866	9131	9537	11172	18832	17416	19075
- percent of total	6%	6%	6%	7%	8%	7%	7%
Firms with maj.other for. share	6430	7349	8557	9727	15897	17398	19684
- percent of total	5%	5%	6%	6%	6%	7%	7%
Average foreign share	11.2%	12.4%	12.9%	13.6%	15.0%	15.3%	14.9%
Average HMT share	6.31%	6.97%	6.86%	7.34%	8.14%	7.66%	7.39%
Average other for. share	4.90%	5.43%	6.01%	6.30%	6.89%	7.61%	7.55%

Table 2. Means of Key Variables in Subsamples

Year	2000	2001	2002	2003	2004	2005	2006
Full sample means							
Log(value added)	7.90	7.97	8.10	8.26	8.22	8.45	8.59
Log(capital)	8.47	8.43	8.43	8.46	8.23	8.41	8.46
Employees	137.49	130.22	127.08	125.40	101.32	108.06	103.59
Firm age (years)	18.53	16.06	13.41	11.49	8.82	8.70	8.48
Market share	.0052%	.0049%	.0047%	.0043%	.0031%	.0032%	0.0028%
Export/sales	15.4%	16.2%	16.1%	16.5%	17.4%	16.3%	15.3%
New product sales/sales	3.15%	4.02%	3.49%	2.63%	N.A.	4.43%	3.94%
Means for domestic firms							
Log(value added)	7.74	7.81	7.95	8.11	8.09	8.32	8.47
Log(capital)	8.36	8.31	8.32	8.34	8.10	8.29	8.33
Employees	131.17	123.04	119.14	116.48	92.12	97.82	93.01
Firm age (years)	20.59	17.69	14.68	12.38	9.44	9.15	8.80
Market share	.0043%	.0042%	.0040%	.0037%	.0027%	.0028%	0.0025%
Export/sales	9.49%	9.17%	9.71%	10.12%	10.17%	9.57%	9.01%
New product sales/sales	2.96%	3.99%	3.52%	2.52%	N.A.	4.51%	3.72%
Means for firms with HMT share							
Log(value added)	8.49	8.51	8.63	8.76	8.69	8.81	8.97
Log(capital)	8.87	8.85	8.84	8.85	8.71	8.78	8.85
Employees	172.15	169.45	173.42	177.92	157.42	171.15	176.12
Firm age (years)	8.59	8.75	8.05	7.98	6.61	7.20	7.55
Market share	.0108%	.0096%	.0087%	.0077%	.0051%	.0049%	0.0044%
Export/sales	43.85%	50.85%	44.33%	43.89%	46.67%	44.65%	43.40%
New product sales/sales	3.42%	3.27%	2.94%	2.60%	N.A.	3.58%	4.30%
Means for firms with other for. shares							
Log(value added)	8.86	8.85	8.89	9.02	8.85	9.11	9.28
Log(capital)	9.28	9.20	9.14	9.15	8.85	9.08	9.16
Employees	178.88	172.20	169.92	171.87	142.69	157.87	156.38
Firm age (years)	8.24	8.31	7.39	7.24	5.84	6.51	6.71
Market share	.0137%	.0117%	.0103%	.0089%	.0055%	.0057%	0.0051%
Export/sales	41.93%	42.79%	43.69%	44.33%	46.56%	42.97%	41.45%
New product sales/sales	5.11%	5.53%	3.97%	3.88%	N.A.	4.78%	5.52%

Table 3. FDI Spillover: FE with AR(1) Correction: Single Lag: Horizontal FDI Measures: p14v6c2i.do.

Sector	HMT All dom.	FRN All dom.	Observations All dom.	Firms All dom.	HMT Private	FRN Private	Observations Private	Firms Private	HMT SOE	FRN SOE	Observations SOE	Firms SOE
FullSample	0.021	0.079***	371368	170691	0.027	0.070*	161216	88452	-0.121	0.020	42966	18011
coal	0.453	7.636**	9822	4367	-3.940	3.125	2074	1317	-6.058	11.902**	2901	1003
ferrous metals	.546	1.065	2507	1324	11.050**	3.970	909	618	-5.338	5.261	286	109
nonferr metals	0.910	0.319	2417	1171	-1.625	0.767	569	358	1.178	-2.026	470	206
nonmetals	-0.864	0.022	3837	1888	-0.781	-0.981	1073	697	-0.994	0.522	800	310
agroproducts	-0.416*	-0.204	24050	11529	-0.207	-0.094	9684	5557	-1.754**	-0.122	4191	1931
food	0.224	0.172	7965	3626	0.217	0.099	2833	1550	-0.319	0.513	1467	671
beverage	0.243	0.312	6961	2986	-0.136	-0.296	2394	1240	0.147	1.012	1419	635
tobacco	1.184	-3.380	693	243	.	.	.	.	1.577	-2.563	526	192
textiles	0.029	0.087	30798	14862	-0.049	0.184	17811	9679	2.201*	-0.605	1297	635
garments	0.469***	0.182	12083	5790	0.344	0.254	6590	3604	0.307	-0.167	427	186
leather/fur	0.022	-0.099	6213	3124	0.347	0.440**	3816	2091	0.511	0.386	157	72
timber	-0.279	-0.024	6355	3511	-0.618**	0.191	3311	2094	0.570	-1.461	421	212
furniture	0.155	0.024	3141	1614	0.112	0.036	1587	923	-0.877	0.143	179	80
paper	0.044	0.108	13387	5803	0.199	0.104	5729	2942	1.479	2.226	832	380
printing	0.511**	0.539*	9867	3955	0.250	0.661	2664	1418	0.343	0.967	3759	1311
sports goods	-0.244	0.094	2991	1442	-0.601**	-0.286	1677	899	-0.376	0.859	133	50
fuel processing	0.724**	0.737**	2858	1354	0.296	0.246	1034	604	-0.406	0.174	291	124
raw chemicals	0.220	0.325*	29527	12943	0.126	0.162	12130	6464	-0.671	-0.275	3270	1430
pharma	0.266	0.009	9122	3562	0.140	0.185	2842	1410	0.631	0.461	1181	541
chinese meds.	0.492	-0.039	3558	1468	-0.039	0.271	1079	545	1.050	0.822	465	248
western meds.	0.410	0.150	4838	1981	0.798	0.203	1503	779	0.419	0.393	647	295
chemical fiber	-0.483	-0.149	1485	774	-0.553	0.015	816	501	-2.265	-1.182	111	62
rubber prods.	0.345	0.228	3941	1778	0.129	0.043	1704	925	0.842	1.308	297	133
ind.plastics	0.353**	0.293***	7575	3814	-0.258	-0.029	3804	2143	1.844*	1.451***	326	174
cons.plastics	-0.017	0.138	5048	2727	-0.213	-0.080	2859	1688	1.615	0.763	136	57
mineral prods.	-0.160	-0.050	40635	16940	0.525*	0.267	15836	8120	0.066	0.374	4598	1899
ferr. smelting	0.344	-0.321	9137	4675	0.631	0.209	4238	2564	-0.794	-0.367	670	282
nonferr. smelt.	-0.111	0.006	6250	3070	-0.309	0.286	2747	1612	1.239	-0.351	458	205
metal prods.	-0.101	-0.162	16537	8276	0.213	0.185	7925	4569	-1.428	-3.105*	753	341
equipment	-0.647***	-0.609***	27868	12873	-0.197	-0.184	13421	7279	-0.412	-0.851	2970	1201
spec.equipment	-0.142	-0.304*	13730	6291	-0.036	-0.628***	5612	3095	0.166	0.182	2535	1009
transport	-0.157	0.065	17993	7736	-0.468	-0.294	6865	3632	0.608	-0.233	2978	1225
autos	-0.673**	-0.220	10059	4648	-0.530	0.026	3887	2166	-1.805	-0.187	1494	670
electric eq.	0.022	0.166	20628	9301	0.135	0.279**	9255	4924	-1.434**	-1.752**	1409	616
electronics	-0.169	0.031	6311	3063	0.002	0.067	2537	1484	-0.998	-0.837	845	365
telecom	0.529	0.659*	1216	575	1.014*	1.253**	395	236	-1.221	-0.547	187	88
computers	-0.846	-0.694	499	279	-0.990	-0.408	153	109	0.117	-0.597	59	32
instruments	0.258	0.347	3738	1722	-0.115	-0.095	1612	874	2.005*	2.070*	604	254
handicraft	-0.045	0.304	5418	2674	-0.130	0.502*	3002	1599	-1.236	0.946	244	115

Estimations implemented using STATA XTREGAR package. Dependent variable is TFP which is generated by running one-step GMM-SYS (p14v6c1). Domestic firms with non-zero frnshare or hmtshare excluded. Private firms defined as firms with majority individual share ($a33/a39 > 0.5$). Non-private firms (SOEs) defined as firms with majority state shares ($a30/a29 > 0.5$).

Modified: 1/26/10
Stata do-file: **p14v6c2i.do**
Raw Tex file: **p14v6c2iA-C.tex**
Edited Tex file: **p14v6c2iAx-Cx.tex**
Compilation Tex file: **p14v6c2imain.tex**

Table 4. FDI Spillover: FE with AR(1) Correction: Single Lag: Backward Linkages FDI Measures: p14v6c2i.do.

Sector	HMT All dom.	FRN All dom.	Observations All dom.	Firms All dom.	HMT Private	FRN Private	Observations Private	Firms Private	HMT SOE	FRN SOE	Observations SOE	Firms SOE
FullSample	-0.004	0.087**	371368	170691	0.029	0.073	161216	88452	0.605**	-0.403**	42966	18011
coal	.812	0.233	9822	4367	-3.312	-5.331*	2074	1317	4.619*	0.337	2901	1003
ferrous metals	.199**	2.245	2507	1324	12.974**	3.605	909	618	3.922	-7.087	286	109
nonferr metals	3.404*	-1.114	2417	1171	-2.429	9.994**	569	358	-1.374	-3.102	470	206
nonmetals	-1.360	2.054	3837	1888	2.528	2.155	1073	697	-5.223	5.231*	800	310
agroproducts	1.514**	-0.467	24050	11529	1.605*	-0.528	9684	5557	2.122	0.948	4191	1931
food	1.596**	1.387**	7965	3626	1.176	0.803	2833	1550	-3.110	2.600	1467	671
beverage	0.056	0.154	6961	2986	-0.225	-0.275	2394	1240	0.429	-0.586	1419	635
tobacco	1.892	0.780	693	243	.	.	.	.	1.908	-0.150	526	192
textiles	0.032	0.132	30798	14862	0.184	0.383**	17811	9679	1.184	-0.598	1297	635
garments	0.434	0.374	12083	5790	0.668*	0.564*	6590	3604	-0.182	-0.859	427	186
leather/fur	0.047	-0.218	6213	3124	0.299	0.161	3816	2091	-0.317	-4.776	157	72
timber	0.223	0.077	6355	3511	-0.591	0.260	3311	2094	17.535***	4.197	421	212
furniture	0.116	-0.190	3141	1614	0.398	0.219	1587	923	-2.508	-1.179	179	80
paper	-0.137	-0.057	13387	5803	-0.347	-0.361	5729	2942	2.673	-0.973	832	380
printing	0.766**	0.074	9867	3955	0.274	0.052	2664	1418	1.993***	0.180	3759	1311
sports goods	0.446	0.695	2991	1442	0.523	0.724	1677	899	3.281	-0.572	133	50
fuel processing	-0.486**	4.115***	2858	1354	-0.442*	0.571	1034	604	-2.870	-2.500	291	124
raw chemicals	0.100	0.342**	29527	12943	0.405*	0.329	12130	6464	-0.399	-0.914	3270	1430
pharma	0.207	0.305	9122	3562	1.282**	1.132**	2842	1410	-0.188	-0.645	1181	541
chinese meds.	0.558	0.533	3558	1468	0.122	0.303	1079	545	-0.458	-1.136	465	248
western meds.	0.340	0.486	4838	1981	2.912***	2.686***	1503	779	0.686	0.319	647	295
chemical fiber	0.621	0.497	1485	774	1.191	0.707	816	501	4.771	-1.719	111	62
rubber prods.	0.116	0.172	3941	1778	0.196	0.225	1704	925	1.169	0.910	297	133
ind.plastics	0.294	0.296	7575	3814	-0.271	-0.071	3804	2143	1.101	1.431	326	174
cons.plastics	-0.041	0.136	5048	2727	-0.309	-0.147	2859	1688	2.428	1.283	136	57
mineral prods.	-0.069	0.363*	40635	16940	0.271	-0.014	15836	8120	1.379	-0.034	4598	1899
ferr. smelting	0.183	0.101	9137	4675	0.260	0.439	4238	2564	-0.866	-0.656	670	282
nonferr. smelt.	-0.612	0.468	6250	3070	-0.732	1.104*	2747	1612	-2.496	-0.861	458	205
metal prods.	-0.612**	-0.137	16537	8276	-0.345	-0.068	7925	4569	-1.483	-3.257*	753	341
equipment	-0.418***	-0.233**	27868	12873	-0.019	0.076	13421	7279	-1.173	-0.915	2970	1201
spec.equipment	-0.147	-0.583***	13730	6291	-0.361	-0.942***	5612	3095	2.267*	-1.694	2535	1009
transport	-0.118	-0.027	17993	7736	-0.118	-0.056	6865	3632	0.552	-0.296	2978	1225
autos	-0.280	-0.001	10059	4648	-0.541	-0.140	3887	2166	-0.847	0.371	1494	670
electric eq.	0.297*	0.390***	20628	9301	-0.060	0.093	9255	4924	1.779	0.254	1409	616
electronics	-0.071	0.099	6311	3063	-0.028	0.070	2537	1484	-0.819	-0.887	845	365
telecom	0.444	0.589	1216	575	0.696	0.982*	395	236	-1.468	-0.553	187	88
computers	-0.839	-0.674	499	279	-1.189	-0.532	153	109	1.455	0.667	59	32
instruments	0.030	0.020	3738	1722	0.588	0.554	1612	874	-1.077	-1.970	604	254
handicraft	1.281**	1.813***	5418	2674	0.336	1.490***	3002	1599	16.038**	10.075	244	115

Table 5. FDI Spillover: FE with AR(1) Correction: Single Lag: Forward Linkages FDI Measures: p14v6c2i.do.

Sector	HMT All dom.	FRN All dom.	Observations All dom.	Firms All dom.	HMT Private	FRN Private	Observations Private	Firms Private	HMT SOE	FRN SOE	Observations SOE	Firms SOE
FullSample	-0.052	0.012	371368	170691	0.028	0.053	161216	88452	0.241	-0.323*	42966	18011
coal	0.861	0.092	9822	4367	-0.429	-1.761	2074	1317	2.134*	0.057	2901	1003
ferrous metals	-0.104	-0.189	2507	1324	1.936*	0.606	909	618	-0.630	-2.070*	286	109
nonferr metals	-0.299	-0.181	2417	1171	-0.582	2.069**	569	358	-0.657	-0.042	470	206
nonmetals	-1.339	1.384	3837	1888	2.695	0.950	1073	697	-3.627	3.625*	800	310
agroproducts	1.474	-1.229	24050	11529	2.012	-0.853	9684	5557	1.103	0.918	4191	1931
food	2.082*	2.067**	7965	3626	1.831	1.615	2833	1550	-5.287	2.500	1467	671
beverage	-0.580	0.152	6961	2986	-1.982	-0.056	2394	1240	0.124	-0.123	1419	635
tobacco	0.273	1.551	693	243	.	.	.	.	-0.021	2.041	526	192
textiles	0.111	0.105	30798	14862	0.038	0.103	17811	9679	1.659	1.204	1297	635
garments	1.916*	1.607*	12083	5790	2.490**	2.183**	6590	3604	-2.979	-0.147	427	186
leather/fur	-0.802	-1.725	6213	3124	0.119	0.056	3816	2091	1.113	-8.513	157	72
timber	0.351	0.186	6355	3511	-0.548	0.497	3311	2094	22.701***	6.140	421	212
furniture	0.288	-0.052	3141	1614	0.620	0.383	1587	923	-1.896	0.346	179	80
paper	-0.136	-0.009	13387	5803	-0.128	-0.178	5729	2942	2.236	-0.903	832	380
printing	0.608**	0.187	9867	3955	0.349	0.175	2664	1418	1.442**	0.446	3759	1311
sports goods	0.411	0.759*	2991	1442	0.528	0.821*	1677	899	0.687	-1.357	133	50
fuel processing	0.211	1.005**	2858	1354	1.028	1.153**	1034	604	2.139	1.342	291	124
raw chemicals	-0.036	0.013	29527	12943	0.222	0.103	12130	6464	-0.305	-0.621	3270	1430
pharma	0.147	0.109	9122	3562	0.786**	0.748**	2842	1410	-0.244	-0.566	1181	541
chinese meds.	0.397	0.226	3558	1468	0.112	0.227	1079	545	-0.745	-0.878	465	248
western meds.	0.222	0.235	4838	1981	1.722***	1.607***	1503	779	0.724	0.227	647	295
chemical fiber	0.246	0.199	1485	774	0.471	0.366	816	501	1.511	-1.515	111	62
rubber prods.	0.143	0.091	3941	1778	0.389	0.362	1704	925	-0.539	-1.455	297	133
ind.plastics	0.107	0.097	7575	3814	-0.324	-0.207	3804	2143	0.844	1.053	326	174
cons.plastics	0.033	0.130	5048	2727	-0.058	0.019	2859	1688	-0.405	-0.968	136	57
mineral prods.	0.017	0.224	40635	16940	0.438	0.197	15836	8120	-0.430	-0.396	4598	1899
ferr. smelting	0.023	0.028	9137	4675	0.037	0.077	4238	2564	-0.450	-0.745	670	282
nonferr. smelt.	-0.389*	-0.082	6250	3070	-0.443	-0.105	2747	1612	-0.019	0.142	458	205
metal prods.	-0.481*	-0.275	16537	8276	-0.342	-0.145	7925	4569	-1.488	-2.016	753	341
equipment	-0.573***	-0.373**	27868	12873	0.094	0.185	13421	7279	-1.499	-1.230	2970	1201
spec.equipment	-0.197	-0.634**	13730	6291	-0.244	-0.983***	5612	3095	2.418	-1.295	2535	1009
transport	-0.110	0.038	17993	7736	-0.352	-0.190	6865	3632	0.654	-0.484	2978	1225
autos	-0.394	-0.009	10059	4648	-0.617	-0.043	3887	2166	-1.096	0.356	1494	670
electric eq.	0.318**	0.416***	20628	9301	-0.110	0.001	9255	4924	0.541	0.092	1409	616
electronics	-0.119	0.072	6311	3063	-0.027	0.058	2537	1484	-0.964	-0.898	845	365
telecom	0.500	0.641	1216	575	0.866	1.138**	395	236	-1.569	-0.726	187	88
computers	-1.096	-0.920	499	279	-1.214	-0.564	153	109	0.443	-0.230	59	32
instruments	0.731	0.583	3738	1722	1.079	1.007	1612	874	3.786	0.054	604	254
handicraft	2.033**	2.823***	5418	2674	1.250	2.498***	3002	1599	16.104	12.203	244	115

Table 6. GMM-SYS One-Step Estimations by Industry (p14v6c1.do)

L.output_2	0.0722***	0.0533**	0.0731*	0.176***	0.205***	0.179***	0.183***	0.293***	0.0596***
	(0.0184)	(0.0214)	(0.0439)	(0.0467)	(0.0748)	(0.0420)	(0.0412)	(0.0791)	(0.0104)
capitaln_2	0.0478***	0.0474	0.0977**	0.0925**	0.0604***	0.0746***	0.0745***	0.133**	0.0364***
	(0.0139)	(0.0316)	(0.0471)	(0.0435)	(0.0115)	(0.0238)	(0.0232)	(0.0627)	(0.00578)
laborln	0.154***	0.152***	0.0690*	0.208***	0.188***	0.168***	0.167***	0.0944	0.0970***
	(0.0578)	(0.0430)	(0.0380)	(0.0712)	(0.0312)	(0.0322)	(0.0491)	(0.116)	(0.0138)
thruput_2	0.852***	0.813***	0.850***	0.711***	0.734***	0.752***	0.731***	0.623***	0.844***
	(0.0104)	(0.0329)	(0.0332)	(0.0428)	(0.0445)	(0.0344)	(0.0350)	(0.0818)	(0.0172)
_Iyear_2001	-0.160***	-0.276***	-0.156***	-0.201***	-0.0691	-0.0376	-0.0898***	-0.0235	-0.137***
	(0.0387)	(0.0798)	(0.0387)	(0.0389)	(0.0564)	(0.0328)	(0.0310)	(0.0873)	(0.0240)
_Iyear_2002	-0.200***	-0.283***	-0.198**	-0.199***	-0.0437	-0.0592	-0.103***	-0.0458	-0.0940***
	(0.0417)	(0.0830)	(0.0834)	(0.0397)	(0.0522)	(0.0379)	(0.0312)	(0.0874)	(0.0193)
_Iyear_2003	-0.144***	-0.141***	-0.102***	-0.164***	-0.0233	-0.0443	-0.0894***	-0.0206	-0.0572***
	(0.0343)	(0.0506)	(0.0323)	(0.0277)	(0.0437)	(0.0308)	(0.0234)	(0.0614)	(0.0140)
_Iyear_2004	0.0170	0.0297	-0.00512	-0.0285	0.0270	0.00526	-0.0262	0.0813	-0.0382***
	(0.0174)	(0.0471)	(0.0232)	(0.0191)	(0.0345)	(0.0221)	(0.0261)	(0.0767)	(0.00849)
_Iyear_2005	0.0134	-0.0268	-0.0358**	-0.0146	0.0184	-0.00163	-0.0149	0.0631***	-0.00845**
	(0.0158)	(0.0237)	(0.0140)	(0.0118)	(0.0196)	(0.0131)	(0.0112)	(0.0239)	(0.00329)
_cons	-0.0276	0.590	-0.0421	-0.322	-0.507	-0.527	-0.383	-0.713***	0.404***
	(0.394)	(0.390)	(0.277)	(0.544)	(0.529)	(0.349)	(0.539)	(0.242)	(0.0790)
N	16336	4621	4173	6570	40272	13046	11056	1003	50177
N_g	6514	2114	1756	2733	16222	5081	4095	310	19379
j	93	93	93	93	93	93	93	93	93
chi2p	0	0	0	0	0	0	0	0	0
hansenp	1.000	1.000	1	1.000	1.000	1.000	1.000	1.000	1.000
ar2p	0.808	0.208	0.460	0.281	0.603	0.562	0.606	0.132	0.265
p_CRS	0.483	0.795	0.812	0.856	0.351	0.822	0.496	0.0317	0.0297
industry	coal	ferrous	non-ferrous	mineral mining	agroproducts	food	beverage	tobacco	textile
subsector									
outlier	0	0	0	0	0	0	0	1	1

Notes: Estimation implemented using STATA XTABOND2 package. Dependent variable is output_2. y = output_2; k = capitaln_2; l = laborln; m = thruput_2. Output, capital, and throughput are deflated to 2000 prices using China national headline CPI (source: FAME). For all GMM-SYS estimations, the instruments are y_{t-3}, k_{t-1}, l_{t-1}, m_{t-1} and earlier in the differenced equations and Δy_{t-2}, Δk_t, Δl_t, Δm_t in the levels equations. p_CRS is the p-value from the Wald test of the constant returns to scale hypothesis $\beta_k + \beta_l + \beta_m = 1$. The indicators "industry" denotes CIC, "subsector" denotes the division of CIC 30 (1 if 301-305, 2 if 306-309) and "outlier" denotes whether outliers were dropped (1 = dropped, 0 otherwise). Standard errors clustered on province-sector dyads.

For industries with two-digit CIC 16, 17, and 30 we first drop outliers in top and bottom 1% (using dropOutlier v05.ado). For industry with two-digit CIC 30 (Plastic Products), we split the industry into two sub-sector groups; one with three-digit CIC 301 through 305 (Industrial Plastics) and another with three-digit CIC 306 through 309 (Consumer Plastics). The decision to drop outliers and to divide industry into sub-sector groups is based on request made by Galina Hale after analyzing regression results from p14v5a2e1b2.do and p14v5a2e1b2a2.do (CIC 30).

Domestic firms with non-zero frnshare or hmtshare excluded.

Modified: 1/25/2010
Stata do-file: **p14v6c1.do**
Raw Tex file: **p14v6c1t1-t4.tex**
Edited Tex file: **p14v6c1t1x-t4x.tex**
Compilation Tex file: **p14v6c1main.tex**

Table 7. GMM-SYS One-Step Estimations by Industry (p14v6c1.do)

L.output_2	0.159***	0.154*	0.147**	0.0787**	0.182**	0.298***	0.120***	0.0714***	0.160***
	(0.0293)	(0.0842)	(0.0588)	(0.0324)	(0.0758)	(0.0501)	(0.0335)	(0.0216)	(0.0425)
capitaln_2	0.0530***	0.0538**	0.0486**	0.0313*	0.0483***	0.0554***	0.0973**	0.0630***	0.0569***
	(0.0151)	(0.0246)	(0.0247)	(0.0179)	(0.0154)	(0.0131)	(0.0384)	(0.0175)	(0.0140)
laborln	0.199***	0.161***	0.144***	0.213***	0.194***	0.158***	0.166***	0.0481*	0.230***
	(0.0483)	(0.0505)	(0.0497)	(0.0633)	(0.0557)	(0.0204)	(0.0630)	(0.0266)	(0.0547)
thruput_2	0.709***	0.731***	0.770***	0.711***	0.733***	0.659***	0.636***	0.808***	0.692***
	(0.0492)	(0.0890)	(0.0650)	(0.0715)	(0.0601)	(0.0407)	(0.0961)	(0.0315)	(0.0787)
_Iyear_2001	-0.0128	-0.0302	-0.0958*	-0.103	-0.0323	-0.0124	-0.101*	-0.0865***	-0.145***
	(0.0232)	(0.0317)	(0.0514)	(0.0655)	(0.0450)	(0.0184)	(0.0555)	(0.0320)	(0.0371)
_Iyear_2002	-0.0263	-0.0108	-0.0870**	-0.124	-0.0252	-0.00674	-0.117**	-0.0707**	-0.117***
	(0.0248)	(0.0277)	(0.0401)	(0.0850)	(0.0372)	(0.0176)	(0.0571)	(0.0278)	(0.0331)
_Iyear_2003	-0.0147	-0.0160	-0.0648*	-0.104	-0.0156	-0.0199	-0.0780	-0.00885	-0.0804***
	(0.0199)	(0.0222)	(0.0346)	(0.0679)	(0.0311)	(0.0144)	(0.0546)	(0.0315)	(0.0243)
_Iyear_2004	-0.0131	-0.0268**	-0.00797	-0.0320	0.00257	0.0297**	-0.0562**	0.0135	-0.0215
	(0.0176)	(0.0107)	(0.0159)	(0.0337)	(0.0228)	(0.0127)	(0.0278)	(0.0234)	(0.0201)
_Iyear_2005	0.00638	-0.00964	0.0161	-0.0107	0.00151	-0.00416	-0.00737	-0.0311***	-0.00345
	(0.0127)	(0.00834)	(0.0154)	(0.0165)	(0.0119)	(0.00466)	(0.0130)	(0.0105)	(0.00933)
_cons	0.0520	0.127	-0.0142	1.019***	-0.303	-0.553**	0.996**	0.754***	0.190
	(0.240)	(0.400)	(0.345)	(0.381)	(0.564)	(0.268)	(0.438)	(0.174)	(0.443)
N	19911	10498	11557	5398	20906	15007	4997	4814	46726
N_g	7828	4285	5202	2257	7519	5140	2006	1956	17199
j	93	93	93	93	93	93	93	93	93
chi2p	0	0	0	0	0	0	0	0	0
hansenp	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
ar2p	0.515	0.638	0.224	0.307	0.256	0.172	0.874	0.995	0.170
p_CRS	0.395	0.109	0.143	0.0238	0.336	0.00457	0.000657	0.0000856	0.554
industry	garments	leather/fur	timber	furniture	paper	printing	sports goods	fuel process.	raw chem.
subsector									
outlier	0	0	0	0	0	0	0	0	0

Table 8. GMM-SYS One-Step Estimations by Industry (p14v6c1.do)

L.output_2	0.194***	0.0526***	0.166**	0.0961***	0.124***	0.186***	0.0426***	0.0369**
	(0.0497)	(0.0194)	(0.0798)	(0.0200)	(0.0287)	(0.0461)	(0.0108)	(0.0167)
capitaln_2	0.0908***	0.00751	0.0496**	0.0446***	0.00747	0.0649***	0.0423***	0.0520***
	(0.0227)	(0.0154)	(0.0221)	(0.00977)	(0.0133)	(0.0184)	(0.0136)	(0.0167)
laborln	0.228***	0.176**	0.258***	0.0972***	0.141***	0.234***	0.199***	0.168**
	(0.0490)	(0.0687)	(0.0872)	(0.0173)	(0.0224)	(0.0491)	(0.0604)	(0.0716)
thruput_2	0.670***	0.872***	0.717***	0.828***	0.817***	0.720***	0.789***	0.772***
	(0.0530)	(0.0252)	(0.0950)	(0.0295)	(0.0278)	(0.0452)	(0.0523)	(0.0924)
_Iyear_2001	-0.0282	-0.146***	-0.186***	-0.0811***	-0.0125	-0.115***	-0.149***	-0.273**
	(0.0310)	(0.0499)	(0.0616)	(0.0189)	(0.0214)	(0.0230)	(0.0459)	(0.108)
_Iyear_2002	-0.0101	-0.0766**	-0.161***	-0.0894***	-0.0174	-0.105***	-0.120***	-0.247**
	(0.0344)	(0.0346)	(0.0415)	(0.0196)	(0.0179)	(0.0286)	(0.0424)	(0.102)
_Iyear_2003	-0.0310	-0.0553	-0.0922***	-0.0660***	-0.0175	-0.0731***	-0.0509*	-0.173**
	(0.0260)	(0.0347)	(0.0257)	(0.0171)	(0.0166)	(0.0223)	(0.0270)	(0.0753)
_Iyear_2004	-0.0128	-0.0277	-0.0464*	-0.0150	0.00545	-0.0225	0.0176	-0.0833
	(0.0193)	(0.0219)	(0.0256)	(0.0113)	(0.0101)	(0.0162)	(0.0133)	(0.0529)
_Iyear_2005	-0.00523	0.000806	-0.0259*	-0.00864	0.00428	-0.0196*	-0.0196***	-0.0701**
	(0.0151)	(0.00825)	(0.0149)	(0.00748)	(0.00515)	(0.0103)	(0.00602)	(0.0305)
_cons	-0.452	0.0717	-0.272	0.176	0.0919	-0.561	0.668***	1.092*
	(0.400)	(0.506)	(0.512)	(0.136)	(0.219)	(0.429)	(0.234)	(0.601)
N	13830	2452	6306	13025	9078	62824	15642	10485
N_g	4708	967	2365	5450	4030	22189	6505	4235
j	93	93	93	93	93	93	93	93
chi2p	0	0	0	0	0	0	0	0
hansenp	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
ar2p	0.118	0.740	0.655	0.314	0.852	0.559	0.649	0.115
p_CRS	0.751	0.458	0.637	0.0414	0.0236	0.576	0.179	0.815
industry	pharma	chem. fiber	rubber	ind.plastics	cons.plastics	minerals	ferrous smelt.	nonferr. smelt.
subsector				1	2			
outlier	0	0	0	1	1	0	0	0

Table 9. GMM-SYS One-Step Estimations by Industry (p14v6c1.do)

L.output_2	0.202***	0.154***	0.166***	0.269***	0.253***	0.197***	0.128***	0.149***
	(0.0395)	(0.0281)	(0.0406)	(0.0346)	(0.0596)	(0.0521)	(0.0353)	(0.0230)
capitaln_2	0.104***	0.0723***	0.0867***	0.0645**	0.0379**	0.0340***	0.124***	0.0370***
	(0.0298)	(0.0186)	(0.0182)	(0.0270)	(0.0155)	(0.0130)	(0.0455)	(0.00893)
laborln	0.186***	0.248***	0.228***	0.264***	0.284***	0.182***	0.274***	0.141***
	(0.0308)	(0.0483)	(0.0453)	(0.0666)	(0.101)	(0.0460)	(0.0777)	(0.0372)
thruput_2	0.708***	0.654***	0.678***	0.602***	0.580***	0.752***	0.580***	0.735***
	(0.0546)	(0.0456)	(0.0559)	(0.0656)	(0.101)	(0.0352)	(0.129)	(0.0519)
_Iyear_2001	-0.124***	-0.122***	-0.108***	-0.0139	-0.0652	-0.0824**	-0.187**	-0.145***
	(0.0297)	(0.0167)	(0.0305)	(0.0342)	(0.0641)	(0.0366)	(0.0941)	(0.0371)
_Iyear_2002	-0.0841***	-0.0781***	-0.0940***	0.00118	-0.0453	-0.0612*	-0.171**	-0.118***
	(0.0250)	(0.0198)	(0.0275)	(0.0279)	(0.0586)	(0.0336)	(0.0787)	(0.0342)
_Iyear_2003	-0.0389**	-0.0731***	-0.0544***	0.00562	-0.0447	-0.0171	-0.105**	-0.0762***
	(0.0178)	(0.0164)	(0.0202)	(0.0274)	(0.0378)	(0.0188)	(0.0515)	(0.0257)
_Iyear_2004	0.0143	-0.0137**	-0.0238	0.0602***	0.0337	0.000631	-0.0609	-0.0285*
	(0.0118)	(0.00683)	(0.0154)	(0.0177)	(0.0306)	(0.0124)	(0.0415)	(0.0153)
_Iyear_2005	0.00977	-0.0240***	-0.0223***	0.0119	0.00601	0.0149	-0.0271	-0.0145**
	(0.00693)	(0.00597)	(0.00728)	(0.0137)	(0.0158)	(0.0139)	(0.0192)	(0.00706)
_cons	-0.679**	0.283	0.00438	-0.344	0.162	-0.422	0.831	0.389
	(0.295)	(0.200)	(0.307)	(0.381)	(0.441)	(0.405)	(0.814)	(0.270)
N	22246	28269	32708	10378	6088	9145	27870	44895
N_g	8516	10276	12080	4067	2350	3727	11333	17027
j	93	93	93	93	93	93	93	93
chi2p	0	0	0	0	0	0	0	0
hansenp	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
ar2p	0.414	0.967	0.551	0.213	0.568	0.918	0.0932	0.926
p_CRS	0.964	0.390	0.763	0.0810	0.0624	0.319	0.557	0.0187
industry	Spec. equipment	transport eq.	electric eq.	electronics	instruments	handicraft	metal prod.	equipment
subsector								
outlier	0	0	0	0	0	0	0	0

Figure 1. FRN and HMT Shares in 2000 and 2006

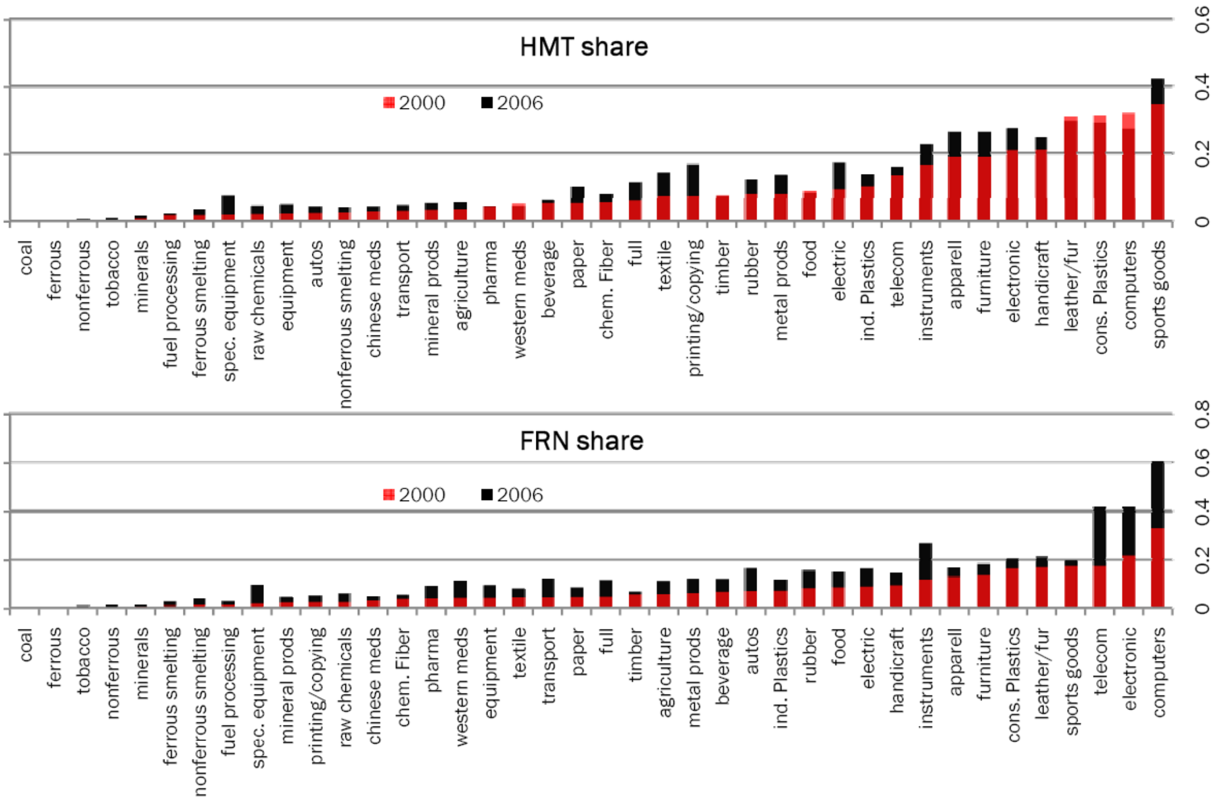
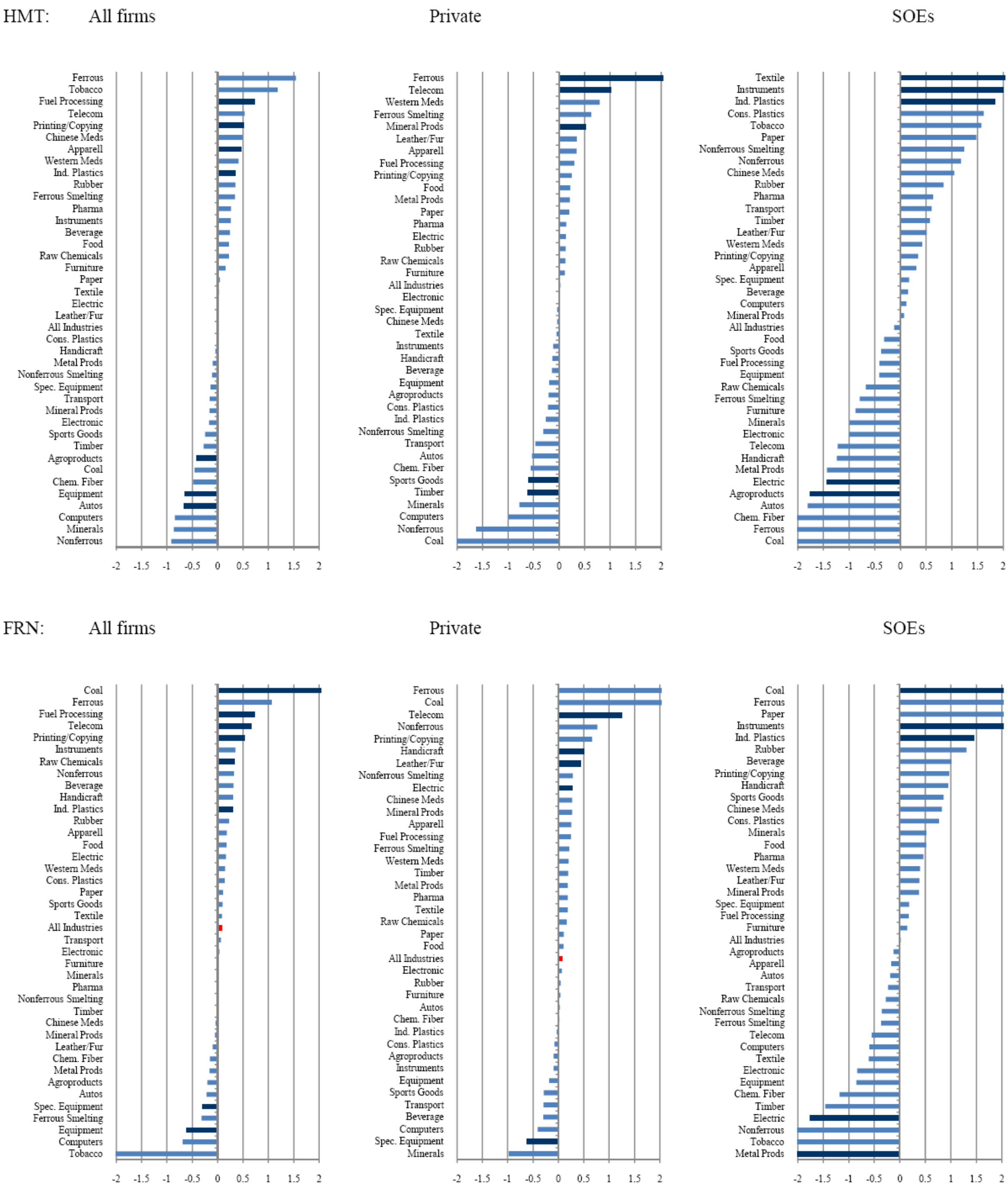
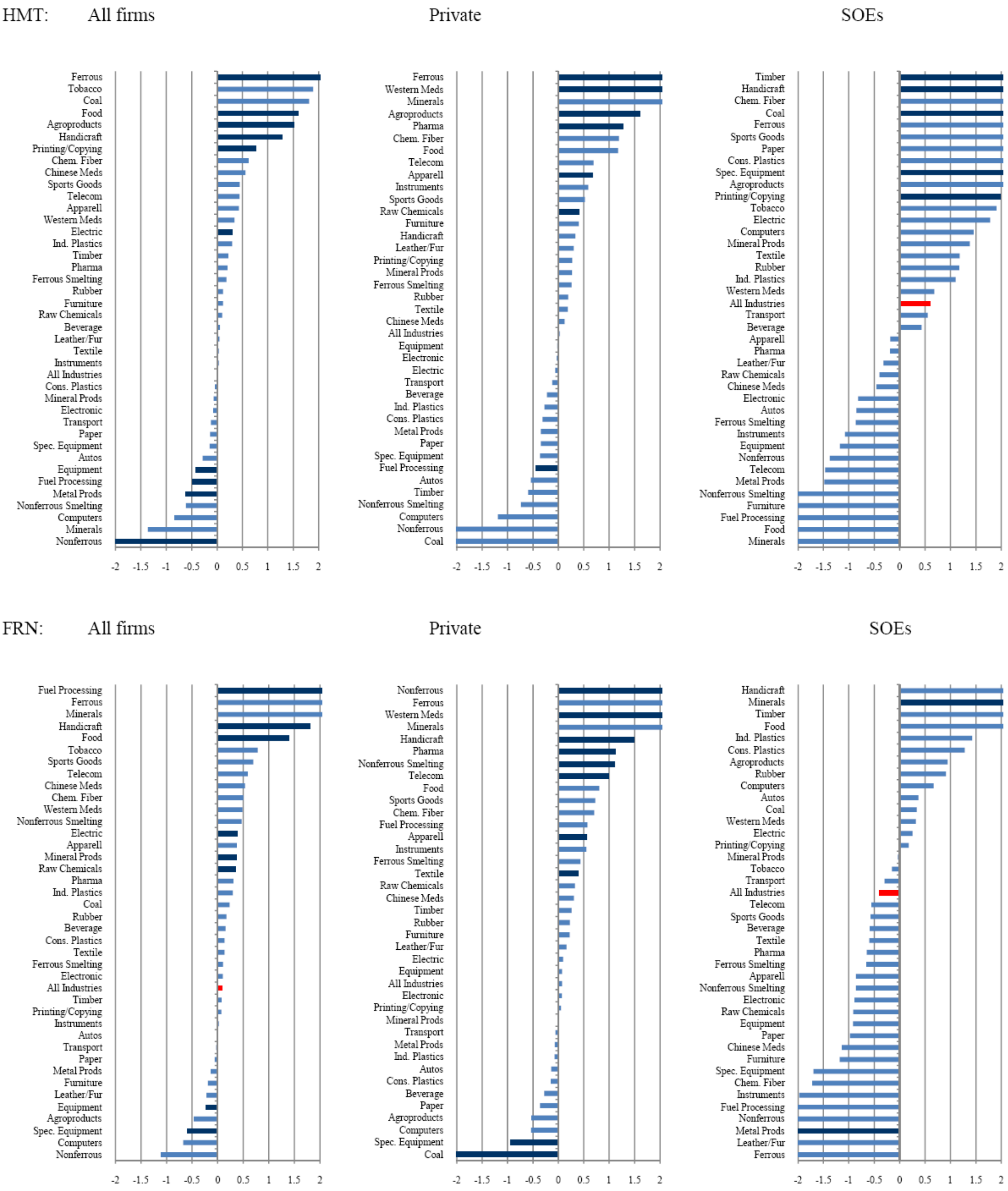


Figure 2. Horizontal Spillovers



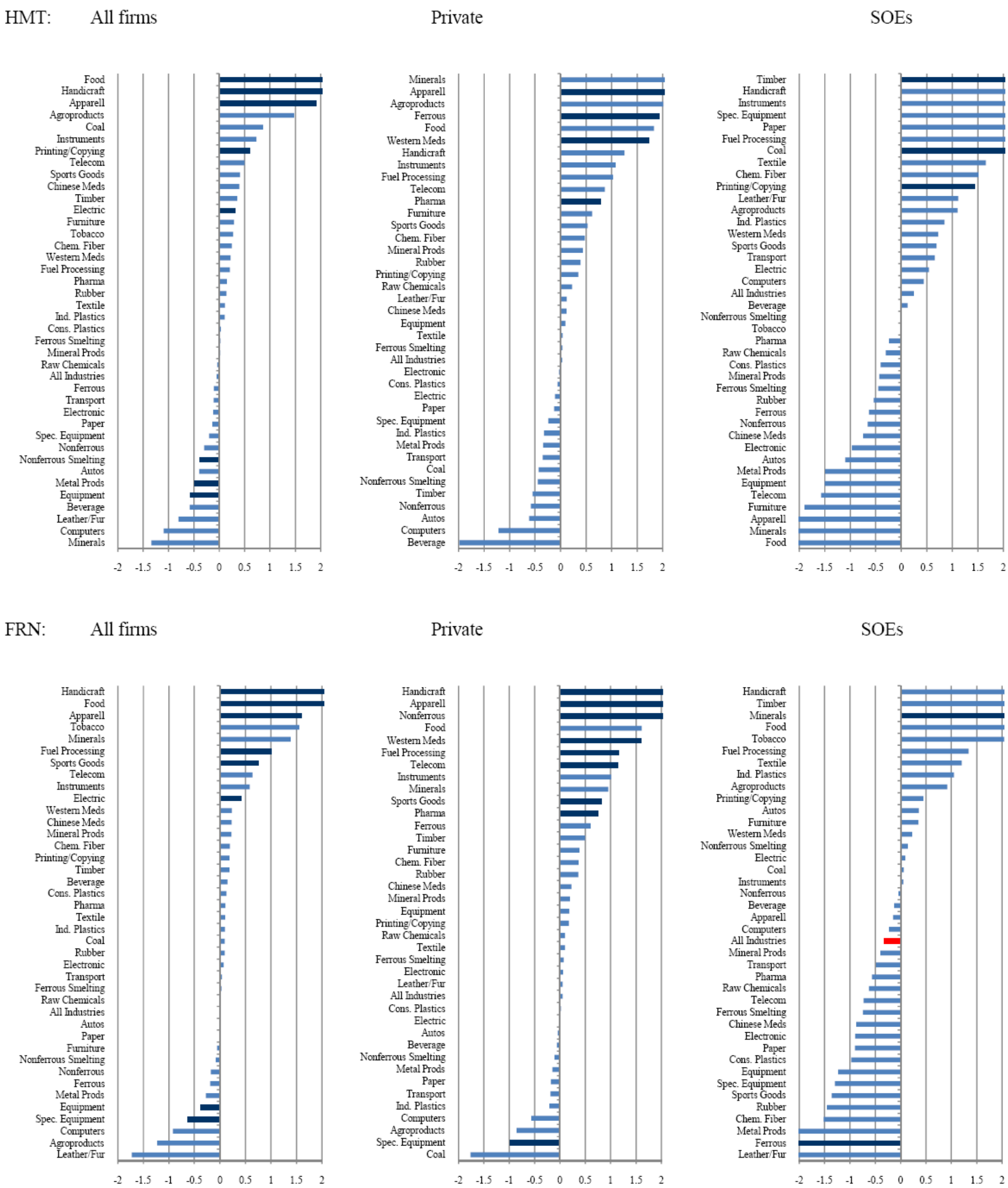
Note: Dark bars represent coefficients that are statistically significant at least at 10% level.

Figure 3. Backward Linkages



Note: Dark bars represent coefficients that are statistically significant at least at 10% level.

Figure 4. Forward Linkages



Note: Dark bars represent coefficients that are statistically significant at least at 10% level.