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**Article — Published Version**

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China & World Economy

**Provided in Cooperation with:**

John Wiley & Sons

*Suggested Citation:* Fang, Guopei; Görg, Holger; Hanley, Aoife; Mao, Haiou (2022) : Foreign Divestment – Crisis or Chance for China's Innovation Edge?, China & World Economy, ISSN 1749-124X, Wiley, Hoboken, NJ, Vol. 30, Iss. 6, pp. 1-33, <https://doi.org/10.1111/cwe.12444>

This Version is available at:

<https://hdl.handle.net/10419/287932>

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## Foreign Divestment – Crisis or Chance for China's Innovation Edge?

Guopei Fang, Holger Görg, Aoife Hanley, Haiou Mao\*

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### Abstract

*The recent move towards decoupling from China, prompted by the 2018 trade conflict, has implications for the innovativeness of Chinese firms. Using patent data from the Chinese State Intellectual Property Office, together with comprehensive firm-level data, and applying an inverse propensity score reweighting methodology to deal with selection bias, we estimated changes in the patenting activity of firms following ownership transition to Chinese owners, linking these changes to the differential taxation incentives offered to foreign investors. Far from crippling innovation, divestment has sparked an increase in patent applications – including higher end invention patents – and other innovation measures. Together with robustness checks, our estimations suggest a real improvement in innovation rather than just a window-dressing exercise. We suggest that one possible explanation may be an effort by the new Chinese owners to reduce their tax burden. Our supplementary findings on tax payments and subsidy receipts following divestment appear in line with this interpretation.*

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**Keywords:** China, foreign divestment, innovation, patents, research and development  
**JEL codes:** F23, G34, O31

### I. Introduction

The US trade conflict with China commenced in 2018 and cast a long shadow. This legacy of the Trump presidency is predicted to continue, despite the change in the US administration (Bloomberg, 2020; Reuters, 2020). The new global dynamic –

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Funding Statement: Open Access funding enabled and organized by Projekt DEAL.

a move towards increased decoupling from China – may have implications for the operations of foreign multinational firms, which may reduce their engagement in China. This, in turn, has consequences for the innovativeness of domestic Chinese firms. However, in the absence of empirical evidence, it is difficult to tell how serious this will be.

China has actively used policy measures to encourage foreign investors to set up technology-intensive affiliates.<sup>1</sup> These policies included the establishment of special economic zones, tax concessions, and subsidies (Long, 2005). For years, China has been the recipient of the second largest share of foreign investment in the world, after the US. However, along with the inflow of new foreign firms, substantial numbers of foreign multinationals have been divesting their affiliates from China – even before the trade conflict with the US emerged. From 2005 to 2007, our period of analysis, 79,459 foreign affiliates were closed, compared with 123,407 newly established foreign affiliates.<sup>2</sup> From 2009 to 2018, after the global financial crisis, 142,501 foreign affiliates were closed, and 300,840 new foreign affiliates were established.

The importance of foreign divestment, which accompanies new investments, has been largely overlooked by academic research. Such ownership transfers also have not featured strongly in the policy debate. However, these transfers raise important questions, not least about the innovation trajectory of firms following the transition to local ownership. Two issues deserve our particular attention. First, a relatively straightforward question – what happens to innovation in the affiliate after the foreign owner's withdrawal? Second, how will the newly divested affiliates adjust to the loss of incentives, which, certainly in the case of China, are strongly linked to its technological performance and only made available to foreign owners? Unfortunately, the existing literature does not answer these questions.

We can glean, from past studies and anecdotal evidence, some clues as to what happens to the divested affiliates. A commonly held view is that divestment is merely

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<sup>1</sup>Many countries expend vast effort to entice foreign firms, especially those with cutting-edge technologies or strategic products, and China is no exception to this. An important rationale for such measures, often in the form of tax concessions or outright subsidies, is that it facilitates knowledge spillovers to the local economy (Görg and Greenaway, 2004; Meyer and Sinani, 2009). The arrival of foreign firms also generally boosts the innovation of foreign-owned affiliates (Girma et al., 2008; Bertrand, 2009; Guadalupe et al., 2012).

<sup>2</sup>The difference between registered foreign firm capital in year  $t$  and year  $t - 1$  is the net new foreign firm amount, which is the result of new foreign establishments and foreign divestments. By using the amount of net new foreign firms minus gross number of new established foreign firms, we can calculate the amount of foreign divestment. The number of newly established foreign firms is extracted from the *Chinese Foreign Investment Statistics Bulletin* (Ministry of Commerce of China, 2007). The number of registered foreign firms is taken from *China Trade and External Economic Statistical Yearbook* (NBS, 2007).

the reverse of an acquisition by a foreign owner.<sup>3</sup> Studies examining the transfer of ownership from domestic to foreign owners have reported increases in their innovation performance, attributed to technology transfers from the parent (e.g., Bertrand, 2009; Guadalupe et al., 2012). By extension, selling off an affiliate to local owners is expected to result in a freeze in technology transfers. This technology freeze could trigger a deterioration in the performance of the divested firm – a view advanced by Javorcik and Poelhekke (2017) and Mohr et al. (2020). In both studies, the focus was on how divestment affected the overall performance of the affiliate, where performance was measured as output, productivity, and exports. However, neither of these studies considered the special case of innovation.<sup>4</sup> Using Chinese data, Bao et al. (2020) looked at the performance of local firms terminating joint ventures with foreign companies. They showed that such local firms experienced higher productivity, export propensity, and export intensity, but there was no significant effect on innovation (which they measured as sales of new products).

Apart from the studies mentioned above, we can illustrate the processes of divestment in practice. The Chinese firm Foshan Chiral Pharmaceuticals was acquired in 2005 and divested in 2014 by the US multinational Actavis. Data from the State Intellectual Property Office of China revealed that Foshan applied for six patents between 2005 and 2014, all of which were design patents (one of the least disruptive types of innovation). Following the transition to Chinese ownership, the firm applied for 26 patents between 2015 and 2018, including 11 inventions, 11 utility, and 4 design patents, respectively. Foshan also shifted its business away from pharmaceuticals toward traditional Chinese medicine. This strategic shift was reflected in some of the new invention patents. Accordingly, neither the quantity nor the quality of patents was adversely affected in Foshan – quite the contrary. However, Foshan is only one firm of many. A more definitive assessment of what happens to innovation following the withdrawal of foreign owners necessitates a more careful empirical assessment, which we attempt to provide in this paper.

<sup>3</sup>As early as the 1980s, Boddewyn (1983a, b) examined what determines foreign divestment. Some studies showed that changes in economic or institutional conditions in the host country, such as economic growth (Benito, 1997), labor cost (Belderbos and Zou, 2006), employment protection (Dewit et al., 2019), terrorism (Liu and Li, 2020), and corruption (Sartor and Beamish, 2020) mattered for the divestment decision, whereas others focused on subsidiaries' own characteristics such as ownership structure, human capital, productivity, size, and international performance (Duhaime and Baird, 1987; Mata and Portugal, 2000; Engel et al., 2013; Tan and Sousa, 2018).

<sup>4</sup>Numerous studies have looked into the effect of foreign divestment on the performance of the multinational parent firm in the home (but not host) country (e.g., Borde et al., 1998; Engel and Procher, 2013; Zschoche, 2016).

To anticipate our results, we found evidence in our analysis of large-scale firm-level data that the shift of affiliate ownership back to Chinese investors stimulated innovation across a number of innovation measures. This empirical finding requires careful interpretation. Innovation remained buoyant despite the inevitable stoppage of technology transfers to the affiliate that accompanied a change in ownership. For this to happen, other compensating mechanisms must have been at work – offsetting and even reversing this negative shock. We considered two plausible reasons for this. The first explanation is that divestment may trigger a process of business reallocation within the affiliate, as the ownership change shifts resources towards higher efficiency uses. The second explanation is in line with the work by Jovanovic and Rousseau (2008), among others. However, such improvements in allocative efficiency should extend to the overall performance of the firm (e.g., output and efficiency). Instead, we saw that the effect was restricted to the innovation metrics – patent application, research and development (R&D), and sales from new products. An alternative mechanism must therefore underpin this difference.

We turn to the role of government policy that prevailed at the time of our data panel. Other China-based studies have highlighted the pivotal role of policy instruments in stimulating patents (Li, 2012; Guo et al., 2016; Eberhardt et al., 2017). Despite the removal of tax-breaks enjoyed by the foreign owner, there was an important way for the divested affiliate to remain competitive. During the timeframe of our data, tax breaks were targeted toward domestic Chinese firms at the more innovative end of the innovation spectrum. In practice, this meant that one possibility to secure a tax break was for the Chinese firm to seek classification as a high and new technology enterprise. An important eligibility criterion was tangible proof of the firm's innovation capability. Patenting represents an important innovation metric, so proving patenting activity helped elevate the firm to this favored innovation category. Accordingly, there were strong incentives for the newly divested firms to invest time and energy in filing patents. To investigate this interpretation, we carried out supplementary regressions on the firm's taxation burden and its receipt of subsidies, also considering the role of technology parks. Our findings from these investigations showed that, after divestment, affiliates indeed benefited from increased tax concessions or subsidies, consistent with this interpretation.

Some more details on the empirical approach are in order. Using patent data for the early 2000s from the Chinese State Intellectual Property Office (SIPO), together with firm-level data from the Annual Survey of Industrial Enterprises (ASIE), we investigated two related issues – (i) the quantity and quality of patents following foreign firm divestment and (ii) the interpretation of any innovation changes in the context of prevailing government incentives.

Our preferred innovation measure is patenting activity. We distinguish invention, utility, and design patents in an attempt to look at the quality of the patents, with the first category clearly representing the most technologically advanced type (Eberhardt et al., 2017). We also expand the concept of innovation to include research and development (R&D) and sales of new products as alternative performance outcomes in a further attempt to shed light on the quality of innovation (Guo et al., 2016). Based on an econometric analysis of our large data set, we find that, far from crippling Chinese firms, the transition to Chinese ownership spurred patenting for all three patent categories. R&D and product innovation are also positively affected, which is in line with our illustration from the pharma industry – the divestment of the Chinese affiliate Foshan Chiral Pharmaceuticals.

To ensure that our findings do not merely reflect the fact that previous foreign owners patented Chinese innovations in their home country and not in China, we distinguished divestments by fully and partially owned foreign affiliates. While the former exercise full control over the Chinese affiliate and may therefore be more likely to register patents in the home versus host economy, this is not the case for partially owned firms where control is shared with a domestic owner. Our estimated positive effects were found for both investor types but were stronger for partially owned affiliates, suggesting that this control issue did not drive our results. We also presented a number of robustness checks to alleviate several concerns. Chief among these was the possibility that our results were driven by differences in the treatment of patent applications submitted by foreign owners versus Chinese nationals. In the event of systematic differences, any changeover to Chinese owners could be construed as benefitting the firm by eliminating any possible adverse treatment of foreign owners. Conducting a number of robustness checks (including the full-partial ownership distinction and changing the control group), we are reasonably confident that this caveat did not drive results.

Our identification strategy exploited the change in firm ownership observed due to foreign divestments. To deal with potential bias due to the selection of divestment targets, we compared the innovation performance of divested subsidiaries with that of continuing foreign-owned subsidiaries, controlling for selection using inverse propensity score reweighting (IPW) combined with covariate adjustment (Guadalupe et al., 2012; Girma et al., 2015a, 2019). A nonrandomized divestment decision would otherwise bias our estimates. The expected bias was negative, as foreign firms were more likely to lose interest in affiliates that were performing poorly, thereby selecting them for divestment. Unless this selectivity is considered, the impact of the divestment on the affiliate's subsequent performance –

the component driven by the new Chinese owners – is impossible to calculate accurately.

Our paper contributes to the literature in a number of ways. To the best of our knowledge, we provide first-time evidence on the effect of divestment on the affiliate's innovation performance. Although our data focusing on the period 2005–2009 are retrospective – data constraints preventing us from widening this window – this historic snapshot does provide an important glimpse into the mechanisms by which innovation was actively promoted in Chinese firms. Our results help us assess the current consequences for China as the US and other nations seek to decouple some of their investments. Far from plunging divested firms into a crisis, the pullout seems to have presented fresh chances for these firms.

The combination of tax rules and technology incentives appears to have spurred these firms to redouble their innovation efforts under their new Chinese owners. The result was an increase not only in overall patents but also in higher end invention patents. This finding echoes other studies revealing the effects of fiscal measures or subsidies in stimulating technological outputs (Guo et al., 2016; Eberhardt et al., 2017). Our combination of innovation metrics suggests that this heightened innovation activity following divestment is not merely “window dressing” – a cosmetic makeover to elicit more favorable taxes. On the contrary, divestment appears to have caused a deepening in the firm's own R&D effort and spurred the firm to increase the share of output devoted to new products.

The remainder of our paper is structured as follows. Section II outlines the empirical strategy we employ. The dataset is described in Section III, while empirical results are presented and discussed in Section IV. Section V provides a summary and some concluding comments.

## II. Empirical strategy

The main research question of this paper is whether a hitherto foreign-owned affiliate becomes more or less innovation-intensive as a result of the foreign owner's pull-out from the affiliate. In other words, this paper aims to estimate the causal effect of foreign divestment on the innovation performance of the divested affiliate. This section sets out the details of our estimation strategy.

Put simply, foreign divestment is mechanically the reverse of foreign investment. Specifically, we mean the withdrawal of capital from a foreign affiliate, the selling off or closure of an affiliate in a host country (Boddewyn, 1979; Benito, 1997). Our study restricts itself to one category of foreign divestment – the complete transfer of



ownership to local owners – such that all capital now resides in Chinese hands. We apply this interpretation of divestment for two reasons. First, this definition allows us to observe a clear ownership change from foreign to domestic. Second, examining transfers rather than closures ensures that we can compare the performance pre- and post-divestment.

In the first instance, innovation activity is measured as the number of patent applications by a firm in a given year. To calculate the causal effect of foreign divestment (the average treatment effects), we estimate the difference between the mean innovation outcome of all divested affiliates and the mean outcome of comparable foreign affiliates remaining in foreign ownership. That is done in a difference-in-differences (DID) setting, taking the following form:

$$Innovation_{i,t+2} = \gamma_0 + \gamma_1 (FD_i \times T_t) + \gamma_2 FD_i + \gamma_3 T_t + \delta X_{i,t} + \mu_i + \epsilon_t + \epsilon_{it}, \quad (1)$$

where  $FD_i$  is a dummy indicating whether foreign affiliate  $i$  belongs to the treatment group.<sup>5</sup> If affiliate  $i$  experiences foreign divestment at some stage during the analysis period,  $FD_i = 1$ ; otherwise,  $FD_i = 0$ , and affiliate  $i$  belongs to the control group. Once foreign divestment takes place in time  $t$ ,  $T_t = 1$ ; otherwise,  $T_t = 0$ .  $X_{i,t}$  is a vector of firm and industry level time-varying controls, consisting of R&D investment and other factors influencing patent applications, namely the export ratio, firm size, state ownership, subsidy share to sale value, tax rate, industry's capital intensity, and the degree of industry competition measured by the Herfindahl-Hirschman Index (HHI) (Cohen and Klepper, 1996; Aghion et al., 2005; Yasuda, 2005).  $\mu_i$  means firm fixed effect, and  $\epsilon_t$  indicates year fixed effect.

The coefficient  $\gamma_1$  is the DID estimate of divestment on innovation performance. This parameter gives an unbiased estimate if the selection into treatment is random. Affiliates experiencing divestment may, however, not represent a random sample of all foreign affiliates. That is because research shows that the characteristics of affiliates represent important drivers of the divestment decision, whereas poorly performing affiliates are more likely to be divested (Duhaime and Baird, 1987; Mata and Portugal, 2000; Engel et al., 2013; Tan and Sousa, 2018). To the extent that such characteristics may also be related to future innovation performance, this may lead to a negative bias in the estimation.

We propose dealing with this problem using inverse propensity score reweighting (IPW), where observations are given different weights in the regressions depending on

<sup>5</sup>The number of patent applications (as innovation output on the left-hand side) are measured in  $t + 2$ . This allows for time lags in the patenting process, which, as argued by Pakes and Griliches (1984) and Wang and Hagedoorn (2014), are important.



their ex ante probabilities of experiencing foreign divestments.<sup>6</sup> These probabilities are estimated using observable affiliate pre-treatment characteristics. We combine IPW with regression adjustment by including an additional vector of covariates  $\mathbf{X}_{i,t}$  in Equation (1). The latter provides an additional avenue for adjustment in the event that the propensity score model is misspecified. The assumption necessary for estimating unbiased effects is selection-on-observables, which means there are no unobserved time-varying affiliate characteristics that determine divestment and are correlated with future innovation performance.<sup>7</sup>

To generate the propensity score, we estimate the probability that affiliate  $i$  undergoes a divestment, using a logit model:

$$p(FD_{i,t} = 1) = \Phi(\mathbf{Z}_{i,t-1}), \quad (2)$$

where  $\mathbf{Z}_{i,t-1}$  is a vector of affiliate characteristics observed in the period prior to the foreign divestment. The propensity scores are then generated as predicted values from this model.

Based on the empirical literature,  $\mathbf{Z}_{i,t-1}$  consists of R&D investment, patent applications, profit rate, export ratio, the foreign capital ratio from Hong Kong SAR, Macao SAR, and Taiwan Province (HMT) owners, the foreign capital ratio from other foreign owners, state-owned dummy, political connections, affiliate size, industry's capital intensity and competition degree measured by the HHI index in the pre-divestment period. We also controlled for industry and city fixed effects. The performance of the affiliate, captured in metrics such as the profit ratio, was the driving force of foreign owner divestment (Berry, 2013). Tan and Sousa (2018) found that the international performance of affiliates was negatively related to foreign divestment. For this reason, we included the export and foreign capital ratios. Affiliates possessing special ownership structures are more likely to be divested by their foreign owners (Hennart et al., 1998; Mata and Portugal, 2000), and we therefore controlled state ownership and political connections. Duhaime and Baird (1987) similarly showed that the size of a subsidiary exerted an impact on divestment decisions. Furthermore, we included pre-divestment R&D investment and the number of patent applications among the factors that drive foreign divestment.

<sup>6</sup>Recent examples of using IPW in the FDI literature are Guadalupe et al. (2012) and Girma et al. (2015a, b; 2019).

<sup>7</sup>Time-invariant affiliate characteristics, including the location of the affiliate, are controlled in the DID setting. Recall that any remaining bias due to unobserved time-varying characteristics would introduce a downward bias in our estimation due to negative selection.

Our data, described in more detail in the subsequent section, covered the period from 2005 to 2009.<sup>8</sup> We considered 2006 as the treatment year and, in Equation (2), used propensity score estimation to estimate the probability of experiencing divestment in 2006 conditional on  $\mathbf{Z}$  in 2005. As in Guadalupe et al. (2012) and Girma et al. (2015a), we used the estimated propensity score  $\hat{p}$  to weight the outcome with Equation (1). Specifically, the weight for each treated affiliate was  $1/\hat{p}$ , and the weight for each control group affiliate not experiencing divestment was  $1/(1-\hat{p})$ .<sup>9</sup>

A complication for our analysis arises from the nature of our dependent variable – the number of patents. That is a discrete count variable estimated using a Poisson count model.<sup>10</sup> As the Poisson model is nonlinear, the estimated  $\gamma_1$  itself does not have a straightforward economic interpretation. However, the exponentiated coefficient ( $e^{\gamma_1}$ ) can be interpreted as the incidence ratio, which means the change in the probability of patenting due to divestment. For example, if  $\widehat{e^{\gamma_1}} = 1.2$ , this means that the probability of patenting increased by 20 percent after divestment by the foreign owner.

### III. Data source and description

We merged the ASIE firm-level panel data and firm-level patent data from the SIPO. That provided us with a unique dataset, including information on firm performance and innovation outcomes in terms of patenting at the firm level. The ASIE is constructed and maintained by the National Bureau of Statistics of China and reports the key financial data for all firms that are state owned or have sales values of more than RMB5 million. State Intellectual Property Office patents cover information such as patent application number, applicant, patent type, patent description, and time of application. We first matched the firm name in ASIE with the patent assignee name, then aggregated the total number of patent applications by patent type (invention, utility, and design patent), firm name, and year (He et al., 2016).

Patent applications filed with the SIPO can only be enforced in China and they are, therefore, particularly important for sales on the domestic Chinese market. Foreign affiliates are generally more export oriented than domestic firms, and foreign firms may rely for those export markets on patents filed in their home country or the US or EU.

<sup>8</sup>To allow for the time lag in patenting, as pointed out in the previous footnote.

<sup>9</sup>Intuitively, control group affiliates with high  $\hat{p}$  are underrepresented in the sample (compared to a random sample) and are, hence, given a higher weight in the regression. The same goes for treated affiliates with a low propensity score.

<sup>10</sup>This is consistent with theoretical considerations, which model the patent-producing function as a Poisson process (Hausman et al., 1984; Pakes and Griliches, 1984).

However, they also sell significant shares of their output domestically.<sup>11</sup> According to Chinese and international patent law,<sup>12</sup> foreign patents do not provide protection in the Chinese market unless they are applied for again in China. Hence, both foreign and domestic firms have a similar incentive to apply for Chinese patents.

We only used information from the ASIE data set for firms for which we had data for all 3 years from 2005 to 2007. This constraint is due to information on R&D investment only being available for those 3 years. We used the information on patent applications from the SIPO up to 2009 to allow for the time lag in innovation activity.

Following Cai and Liu (2009) and Feenstra et al. (2014), and guided by generally accepted accounting principles, we deleted observations in our linked data set if any of the following rules were violated: (i) the total assets had to be higher than the liquid assets; (ii) the total assets had to exceed the total fixed assets; and (iii) the total assets had to exceed the net value of the fixed assets. We also dropped observations with fewer than 10 employees or that had anomalous data for the number of establishment years.

After the cleaning procedure, we had a panel of surviving firms for the period 2005–2007 from the ASIE, with information on patents up to 2009. This allowed us to compare the pre-performance and post-performance of divested affiliates, where divestment happened in 2006. In our analysis, we only kept foreign-owned firms. Recall that our definition of divestment was that a foreign affiliate is sold fully to a domestic owner. Hence, we treated firms with a foreign ownership share in 2005 and that reported no foreign shares in 2006 and 2007 as affiliates that had undergone foreign divestment. There were 1,085 affiliates in our data.<sup>13</sup>

Figure 1 shows the geographical distribution of those divestments. We can tell from the figure that most divestment occurred in provinces with the most foreign firms, such as Guangdong, Shandong, and Jiangsu. This indicates that foreign divestment was an accompaniment of inward FDI.

Table 1 shows the innovating performance of affiliates in 2005 and 2007 – both for those affiliates experiencing divestment in 2006 and those continuing under foreign

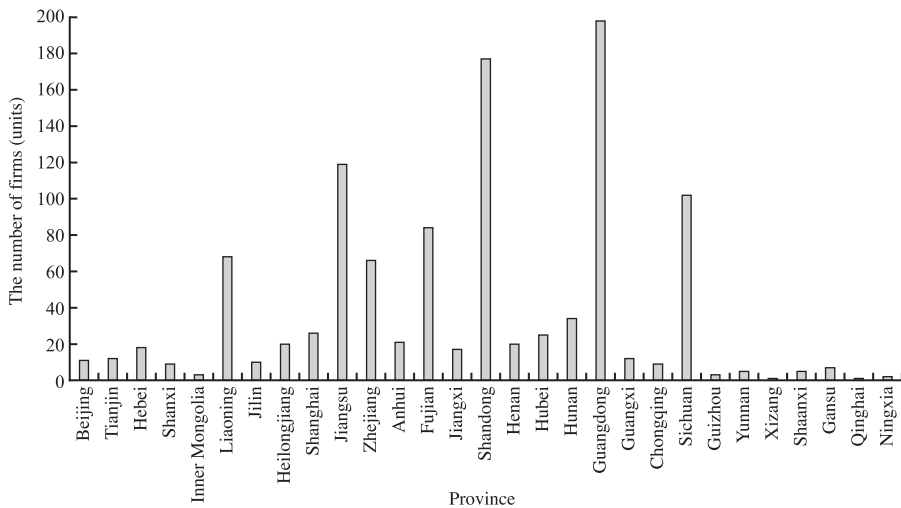
<sup>11</sup>Among our treatment group, 61 percent of divested affiliates have no exports at all, while only 12 percent have an export ratio of 100 percent before divestment. Roughly three quarters of divested affiliates sell at least 50 percent of their output domestically.

<sup>12</sup>Paris Convention for the Protection of Industrial Property and Patent Cooperation Treaty.

<sup>13</sup>These are far fewer than the numbers cited in the introduction for a number of reasons. First, we only consider ownership changes for continuing affiliates, while the total number of divestments in the introduction also includes closures. Second, our data cover all firms above a certain threshold but not the population of firms in China, so we miss out ownership changes and closures of smaller affiliates. Third, we may lose some additional observations due to missing values for key variables.

ownership. The first point to note is that the number of patent applications in 2005 was substantially less for firms experiencing divestment in 2006 than for those that did not. This points towards a negative selection of divestment affiliates, as expected. Comparisons between 2005 and 2007 reveal that the number of patent applications more than doubled for firms experiencing divestments, from 0.11 in 2005 to 0.26 in the year after the divestment. Patenting also increased for the control group of affiliates that remained in foreign hands, although the measured increase is less relative to that observed for divested affiliates.

Figure 1. The geographical distribution of foreign divested firms in 2006



Source: Authors' calculation based on data from the Annual Survey of Industrial Enterprises.

Table 1. Average patent applications before and after being divested

Firm type	Before being divested (2005)	After being divested (2007)	Observations
Foreign divested subsidiaries	0.1152	0.2618	1,085
Foreign-owned subsidiaries (continuing)	0.3583	0.6729	35,843

Source: Authors' calculations based on data from the Annual Survey of Industrial Enterprises.

Note: Patents of all types applied for in 2005 and 2007 are reported here.

Table 2 presents the definitions of the main variables used in the subsequent analysis, together with their sample means and standard deviations.

Table 2. Summary statistics

Variables	Definition of variables	Mean	Min	Max
Dependent variables				
$Patent_{i,t+2}$	Patent application in period $t+2$	0.81	0	2,624
$Patent\_in_{i,t+2}$	Inventing patent application in period $t+2$	0.30	0	2,331
$Patent\_uti_{i,t+2}$	Utility patent application in period $t+2$	0.27	0	807
$Patent\_des_{i,t+2}$	design patent application in period $t+2$	0.24	0	874
$R\&D_{i,t}$	R&D investment (in thousand RMB)	735.36	0	1,800,000
$Newp_{i,t}$	Sales of new products	27,260.39	0	110,000,000
$\ln TFP_{i,t}$	Log term of total factor productivity	6.73	4.81	8.97
$\ln Sale_{i,t}$	Log term of sales value	10.76	3.40	19.06
$\ln Employ_{i,t}$	Log term of total employment	5.22	2.40	12.15
$Profit\_ratio_{i,t}$	Ratio of profit to total sales value	0.04	−0.35	0.34
$Lever_{i,t}$	Ratio of total liability to total asset	0.51	0.02	1.27
$\ln Exp_{i,t}$	Log term of (1 + total export)	6.81	0	19.03
$Tax_{i,t}$	Firm's income tax	769.25	0	17,909
$Tax\_rate_{i,t}$	Ratio of income tax to total profit measured as a percentage	8.03	0	27.00
$Sub_{i,t}$	Firm's received subsidy	200.37	0	684,267
$Pa\_gran_{i,t}$	The ratio of granted patent number to the total applicated patent number	0.66	0	1
$Pa\_gran\_in_{i,t}$	The ratio of granted patent number to the total applicated patent number in invention patents	0.31	0	1
$Pa\_gran\_uti_{i,t}$	The ratio of granted patent number to the total applicated patent number in utility patents	0.80	0	1
$Pa\_gran\_des_{i,t}$	The ratio of granted patent number to the total applicated patent number in design patents	0.70	0	1
Independent variables				
$Patent_{i,t}$	Patent application in year $t$	0.54	0	1,818
$Fdi\_ratio_{i,t}$	Foreign equity share	0.82	0	3.02
$Hmt\_ratio_{i,t}$	Foreign equity share of the owner from Hong Kong SAR, Macao SAR, and Taiwan Province	0.41	0	1
$For\_ratio_{i,t}$	Foreign equity share of the owner from other foreign countries	0.41	0	1
$Export\_ratio_{i,t}$	Ratio of export to sale	0.47	0	1
$Profit\_ratio_{i,t}$	Ratio of profit to sale	0.04	−0.35	0.34
$Sub\_ratio_{i,t}$	Ratio of subsidy received to sale	0.00	0.00	0.07
$Tax\_rate_{i,t}$	Ratio of income tax to total profit measured as a percentage	8.03	0	27.00
$Scale_{i,t}$	Log term of output value	10.78	3.40	19.06
$\ln(1 + Age)_{i,t}$	Log term of the sum of 1 and firm $i$ 's age	1.97	0.00	4.04
$D\_for_{i,t}$	Dummy variable for being foreign firm	0.20	0	1
$\ln Cap\_int_{i,t}$	The log of capital intensity	3.69	0.03	6.72
$SOE_{i,t}$	Firm $i$ is state-owned or not	0.00	0	1
$Pol\_conn_{i,t}$	Political connection dummy indicating if firm $i$ affiliates with the central or provincial government.	0.02	0	1
$\ln Pcap\_ind_{i,t}$	Log term of capital intensity of industry that firm $i$ operates in	3.43	2.66	4.84
$HHI_{i,t}$	The Herfindahl-Hirschman Index of industry calculated by the share of the sales value of top 5 firms	0.00	0.00	0.03

Source: Authors' calculations based on data from the Annual Survey of Industrial Enterprises.

Notes: R&D, research and development; SOE, state-owned enterprise; TFP, total factor productivity.

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Funding Statement: Open Access funding enabled and organized by Projekt DEAL.

## IV. Empirical results

### 1. Propensity score estimation and selection

We started by estimating the propensity score, i.e., the probability of experiencing divestment conditional on covariates, as in Equation (2). Recall that the control group was firms that remained in foreign ownership throughout the period under investigation.<sup>14</sup> The results are reported in Table 3. The role of propensity score

Table 3. Propensity score estimation: The probability of being divested

	FD
$\ln(1 + R\&D)$	-0.0185 (-0.83)
$\ln(1 + Patent)$	-0.0669 (-0.49)
<i>Export_ratio</i>	-1.2472*** (-13.52)
<i>Scale</i>	-0.1806*** (-5.84)
$\ln Pcap\_ind$	0.0494 (0.16)
<i>HHI</i>	-85.5458 (-1.42)
<i>SOE</i>	1.6107** (2.35)
<i>Pol_conn</i>	-0.1033 (-0.38)
<i>Profit_ratio</i>	0.3824 (1.36)
<i>Sub_ratio</i>	6.4755 (1.30)
$\ln(1 + Age)$	0.0036 (0.07)
<i>Hmt_ratio</i>	-0.3454*** (-2.64)
<i>For_ratio</i>	-0.7218*** (-5.22)
Constant	-1.8983* (0.10)
Industry FE	Yes
City FE	Yes
Observations	34,287

Source: Authors' estimation based on data from the Annual Survey of Industrial Enterprises.

Notes: \*\*\*, \*\*, and \* represent significance at the 1, 5, and 10 percent levels, respectively. The numbers in parentheses are *t*-values; FD, foreign divestment; FE, fixed effects; R&D, research and development; SOE, state-owned enterprise. Variable definitions are provided in Table 2.

<sup>14</sup>We eliminated firms with a foreign share of less than 25 percent from the treatment and control groups as these are considered domestic firms by the Chinese authorities.

estimation in treatment effects models with observational data was not so much about providing a causal explanation for the mechanisms generating the treatment level as offering a “balancing score,” in the sense of weighting the observations to eliminate biases in estimated treatment effects due to differences in the distribution of the baseline covariates.<sup>15</sup> Nevertheless, looking at the results provides some interesting evidence on the nature of selection in the divestment decision.

We found that the probability of being divested was negatively correlated with patenting and R&D activity in the pre-divestment period, although the coefficient on patent applications was not statistically significant at conventional levels. This shows that affiliates with low patenting or R&D activity were more likely to be selected for divestment. It clearly points to negative selection – poorly performing affiliates were more likely to be divested. Export activity, size, foreign ownership share, and political connections were also negatively correlated, supporting this conjecture.<sup>16</sup> Furthermore, state-owned enterprises (SOEs) were more likely to experience a divestment.<sup>17</sup>

## 2. Foreign divestment and innovating performance

Utilizing the estimated propensity scores, we can then estimate variants of Equation (1) using IPW. The results are shown in Table 4, where we report exponentiated coefficients, which can be interpreted as incidence ratios.<sup>18</sup> The results show that divested affiliates applied for more patents after divestment. Based on the estimated incidence ratio, column (1) suggests that a divestment increased the probability of applying for a patent by 10 percent. This is an economically meaningful effect of the divestment.

As in Eberhardt et al. (2017), who used data most similar to ours, we have information on three types of patents – invention, utility, and design patents, respectively. In terms of quality, invention patents were likely to be the most technology-intensive of the three types, followed by utility patents and then design patents. In columns (2) to (4) of Table 4, we investigated the effect of divestments on these three patent categories separately to gauge the impact of foreign owner divestment on innovating activity with

<sup>15</sup>See, for example, Imbens and Rubin (2015), Chapter 13.

<sup>16</sup>Using data similar to ours, Du and Girma (2010) established that private firms with political connections performed better than others. Hence, the negative correlation with divestment also points to negative selection.

<sup>17</sup>We carried out balancing tests to check whether our propensity score reweighting strategy helped to control for pre-treatment differences between treatment and control groups. The balancing tests after propensity score reweighting are shown in Table A1 in the appendix. There are no statistically significant differences in pre-treatment characteristics between the two groups of firms.

<sup>18</sup>We are grateful to an anonymous reviewer who suggested looking at firms that apply patents continuously during the sample period, for robustness. The results, which are reported in Table A2 in the appendix to save space, look similar to those reported in Table 4.



different technology content. This was done by replacing the total number of patent applications with the number of inventing, utility, or design patents, respectively. As can be seen, we found significant effects for all three types of patents, although the impact was strongest for invention patents. This suggested that patenting activity had also increased among those of the highest quality in terms of high technological content. Hence, our findings appeared to reflect a boost in real innovation activity rather than just being a window-dressing exercise involving trivial improvements with little technological progress (Eberhardt et al., 2017).

Table 4. The impact of foreign divestment on firm's patent application

Variables	<i>Patent</i> <sub><i>t</i>+2</sub>	<i>Patent_in</i> <sub><i>t</i>+2</sub>	<i>Patent_utili</i> <sub><i>t</i>+2</sub>	<i>Patent_des</i> <sub><i>t</i>+2</sub>
	(1)	(2)	(3)	(4)
$FD_i \times T_t$	1.1004*** (8.10)	1.4818*** (19.44)	1.1559*** (6.46)	1.0641*** (2.62)
Control variables	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	13,239	6,813	9,615	5,064

Source: Authors' estimation based on data from the Annual Survey of Industrial Enterprises.

Notes: \*\*\* represents significance at the 1 percent level. Estimated using the Poisson regression. Control variables include R&D investment, firm's scale, export ratio, state-owner enterprise dummy, industry's capital intensity, and HHI index. The control group is continuing foreign-owned firms. Numbers in parentheses are *t*-values. *Patent*<sub>*t*+2</sub> includes all three kinds of patents. Exponentiated coefficients are reported, which could be interpreted as incidence-rate ratios. In our case, the exponentiated coefficients mean the relative possibility of patenting between the divested affiliate and foreign owned affiliate. FE, fixed effects; HHI, the Herfindahl-Hirschman Index; R&D, research and development. Variable definitions are provided in section II and Table 2.

To further assuage concerns about a lack of genuine innovation activity, we considered two other aspects of the innovation process. First, we examined changes in R&D activity after divestment. Research and development is an important input into the innovative production process; hence, an increase in this activity after divestment may also indicate a move towards increased innovation activity. Second, we looked at an alternative measure of innovation output, namely the output value due to new products. The latter variable provided a more immediate measure of innovation output than patents. It was also used by Girma et al. (2008) and Guo et al. (2016), the latter referring to it as "commercialized innovation." We can tell from Table 5 that foreign divestment had a positive effect on R&D investment as well as on sales of new products introduced by the affiliate. This again suggests that the increase in patenting activity due to divestment likely reflected genuine innovative activity.

Table 5. Alternative measurements of innovation

Variables	$R\&D_{i,t}$ (1)	$Newp_{i,t}$ (2)
$FD_i \times T_i$	1.0116*** (23.88)	1.1087*** (772.17)
Control variables	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
Observations	9,771	7,152

Source: Authors' estimation based on data from the Annual Survey of Industrial Enterprises.

Notes: \*\*\* represents significance at the 1 percent level. Results are estimated using Poisson regression.

Control variables include R&D investment (not in column (1)), firm's scale, export ratio, state-owner enterprise dummy, industry's capital intensity, and HHI, as well as firm and year fixed effect. The control group continued to be foreign-owned firms. Exponentiated coefficients are reported. Numbers in parentheses are *t*-values. HHI, the Herfindahl-Hirschman Index; R&D, research and development. Variable definitions are provided in section II and Table 2.

One might argue that the increase in patenting activity that we estimated may not be due to divestment but may just reflect the general “patent explosion” in China (e.g., Hu and Jefferson, 2009; Li, 2012; Dang and Motohashi, 2015). The latter phenomenon was aided substantially by local government patent subsidies – a point to which we will return. While our analysis time covers the same period of intensified patenting activity, such a general effect cannot explain our results. The general rise in patent applications would affect all firms. This is indeed something we observe in Table 1. However, our estimated coefficients within a DID setup represent differential effects that only accrue to divested firms compared to firms that remain in foreign hands. Furthermore, our estimation controlled for the receipt of subsidies by the firm in the propensity score.

### (1) The role of discrimination

A further concern with the finding that patenting benefitted from the ownership change is that SIPO may discriminate against foreign applicants. Tong et al. (2018) revealed empirical evidence that patent applications filed by foreign applicants took substantially longer to be approved by SIPO. Such a delay may discourage foreign-owned firms from filing patent applications in China. Once ownership changed, this source of discrimination disappeared. In this case, our finding of a patenting boost following divestment may not suggest any new innovation activity. Rather, this new patenting impetus should then be attributed to the lifting of any discrimination targeted against the firm's former owners.

While such discrimination (relating to the timing of approval decisions) is a distinct possibility, it is, however, unlikely to drive our results. First, as established in Table 5,

the increase in innovation activity that followed divestment was not limited to the patents measure alone. Other measures of innovation were similarly affected by the ownership change. Unlike in the case of patent applications, these other measures were unlikely to be influenced by the possibility that foreign-owned firms were systematically disadvantaged in the patent approval process.

Second, even if there was a delay in the approval decision (which is what the literature highlights), this does not necessarily imply that applications by foreign applicants are more likely to be rejected. To illustrate this argument, we applied data on approved and rejected patent applications. Performing a simple ordinary least squares (OLS) analysis for the percentage of receiving approval conditional on firm characteristics (including size, age, export activity, foreign ownership as well as industry, province, and year fixed effects), we can show that foreign applicants did not report any statistically different percentage of receiving approval.<sup>19</sup> Given that foreign-owned firms had an incentive to apply for patents to protect their products and processes on the domestic market, the above result, if known to non-nationals, may have encouraged (rather than dissuaded) the latter to submit patents.

Third, although our analysis – to this point – has compared divested firms with other foreign firms, replacing the comparison group with domestic firms does not substantially change our finding. Using a matched control group comprising domestic (rather than foreign) firms may control for the systematic discrimination against non-nationals by the national patent office. Domestic firms and firms reverting to domestic ownership have the same ownership post-treatment. Accordingly, this discrimination caveat is unlikely to apply. To carry out this robustness check, we re-estimated the propensity score model in Equation (2), using continuously domestically owned firms as the control group, against which to compare our divested foreign-owned firms.<sup>20</sup> These propensity scores were then used for reweighting estimation of Equation (1). The results in Table 6 are comparable with those already displayed in Table 4. Foreign divestment has a positive impact on patent applications, even when using undivested Chinese-owned firms as the control group. This indicates that the estimated increase in patenting activity is not an artifact of the comparison category. Rather, it points to real changes in how the firms conduct their innovation effort.

## (2) Patent assignment

One might argue that our results could also be interpreted as a consequence of a shift in the attribution of patents rather than a shift in the underlying innovation rate. To illustrate, consider the following case. A foreign parent decides to protect the

<sup>19</sup>Results are presented in Table A3 in the appendix.

<sup>20</sup>Results are not reported here but are available upon request from the authors.

Table 6. The impact of foreign divestment on firm's patent application when domestic firms are the control group

Variables	$Patent_{i+2}$ (1)	$Patent\_in_{i+2}$ (2)	$Patent\_uti_{i+2}$ (3)	$Patent\_des_{i+2}$ (4)
$FD_i \times T_i$	1.4781*** (41.10)	1.2912*** (15.37)	1.7288*** (30.81)	1.6512*** (28.05)
Control variables	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	33,780	19,218	23,745	10,872

Source: Authors' estimations based on data from the Annual Survey of Industrial Enterprises.

Notes: \*\*\* represents significance at the 1 percent level. Control variables and estimation method are as in Table 4, but using domestic firms as the control group. Exponentiated coefficients are reported. Numbers in parentheses are *t*-values. FE, fixed effects. Variable definitions are provided in section II and Table 2.

innovations created by its Chinese affiliate. To do this, it chooses to file these patents in its home country rather than in the host economy, China. In this illustration, these patents would fail to be recorded as innovation outputs of the affiliate in China. Only after the departure of the foreign parent would the affiliate be in a position to appropriate any further innovations. Claiming the innovations for itself, the affiliate would file them with the local Chinese patent office. Such an interpretation would mean that any jump in patenting activity (following a change in ownership) would be due to changes in how the patents were recorded. In other words, any patent increase would be a consequence of changes in the attribution of patents and would not necessarily signal any substantive improvements in the innovativeness of the affiliate.

As already discussed, this scenario is unlikely if the foreign firm also sells products in the domestic Chinese market. This is because only patents registered in China (and hence in our data) would afford such protection on the Chinese market against imitation by local competitors. Most foreign firms in China also sell significant shares of their output on the domestic market, so domestic patents may be needed. Furthermore, in Table 5 we found not only a positive effect on patents but also on other innovation measures (R&D, new products), which suggests real changes in innovation activity.

### (3) *Withdrawal in years and one-time withdrawal*

Thus far, our definition of divestment relates to a change in ownership from foreign in 2005 to domestic in 2006. However, divestment may not always be this instantaneous, but foreign owners may reduce their ownership share over a few years. In this case, the foreign owner reducing its equity may be a signal for its local partner or manager that the local partner could start to cope with this shock in advance. However, such an

adjustment may not be possible if divestment is indeed instantaneous. We therefore expect that the local affiliate could cope better with a reduction in ownership over time rather than an instantaneous one-time withdrawal.

In order to investigate this, we first generated a dummy  $con\_withdraw_i$  identifying firms that experienced a reduction in ownership share over time. If a foreign firm experienced a reduction of foreign equity in 2005 and 2006,  $Con\_withdraw_i = 1$ ; otherwise,  $Con\_withdraw_i = 0$  (as we only looked at foreign divestment happening in 2006). Then, we interacted it with our key independent variable  $FD_i \times T_i$ . The coefficient of  $FD_i \times T_i \times Con\_withdraw_i$  shows the difference between divestment over time and instantaneous withdrawal. The results are shown in Table 7. Exponentiated coefficients are larger than 1, showing that local affiliates cope better with withdrawal over time.

Table 7. The impact on the patent of continuously withdraw and one-time withdraw

Variables	$Patent_{i+2}$ (1)	$Patent\_in_{i+2}$ (2)	$Patent\_uti_{i+2}$ (3)	$Patent\_des_{i+2}$ (4)
$FD_i \times T_i \times Con\_withdraw_i$	1.0664*** (3.14)	1.9730*** (19.13)	0.3864*** (-23.97)	1.0918*** (2.12)
Control variables	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	13,239	6,813	9,615	5,064

Source: Authors' estimations based on data from the Annual Survey of Industrial Enterprises.

Notes: \*\*\* represents significance at the 1 percent level. The control group is continuing foreign-owned firms.

Exponentiated coefficients are reported. Numbers in parentheses are *t*-values. FE, fixed effects. Variable definitions are provided in section II and Table 2.

### 3. Mechanisms

In this section, we look into the possible reasons for the positive innovation effect of divestment. The few papers that have empirically investigated the effects of divestment on the performance of the affiliate found a negative effect and attribute this to a loss in technology after the foreign owner pulled out (Javorcik and Poelhekke, 2017; Mohr et al., 2020). Given that we found a positive effect on innovation, this is unlikely to be the sole mechanism in our case. Even if technology is transferred back to the parent, there must be other compensating factors leading to an overall positive effect.

There are two potential mechanisms to consider. The first is efficiency-enhancing shakeups due to a change in management, and the second is a compensation mechanism in order to benefit from technology-related state concessions. Both have the potential to enhance innovation activity in the firm. We consider both of these in turn.

*(1) Increase in the efficiency of resource allocation after the ownership change*

Rather than necessarily viewing divestment as an adverse event, one may view it as representing a positive shock to the firm (similar to Jovanovic and Rousseau, 2008). These benefits to the firm would arise from technological advantage, management changes, resource allocation improvements, and business strategy advances. Thus, similar to firms' experiences during management buyouts or privatization (e.g., Munari, 2003; Harris et al., 2005), the transfer of ownership from foreign into domestic hands can lead to a shake-up of established structures that may have become inefficient over time. The shock may lead to a refocus of business strategy and a shift of resources towards more efficient production, ultimately improving efficiency as well as innovation activity.

If our results arise from such efficiency improvements, we should also expect to observe a similar improvement in other performance outcomes (e.g., productivity, firm scale, profitability). To check this possibility, we ran some tests on the effect of divestment on other performance measures, namely productivity (total factor productivity, TFP),<sup>21</sup> firm size (measured by total employment and sales value), profits (measured by the rate of total profit to total revenue), debt rate (measured by the ratio of total liability to total assets), and the firm's export ratio.

The coefficients in Table 8 reveal that these other performance measures in divested affiliates remained, by and large, unaffected following the divestment of ownership. These results are difficult to reconcile with the idea that efficiency improvements drive the observed positive effect on innovation activity. We, therefore, now turn to another possible mechanism that may underpin our results – one based on China's FDI and innovation policy. In this policy environment, divested affiliates may have an added incentive to engage in innovation to attract policy support, particularly tax deductions.

Table 8. The impact of foreign divestment on other firm performance measures

Variables	$\ln TFP_{i,t}$ (1)	$\ln Employ_{i,t}$ (2)	$\ln Sale_{i,t}$ (3)	$Profit\_ratio_{i,t}$ (4)	$Lever_{i,t}$ (5)	$\ln Exp_{i,t}$ (6)
$FD_i \times T_i$	-0.0075 (-0.76)	-0.0396 (-1.57)	-0.0595** (-2.04)	-0.0014 (-0.53)	0.0007 (0.06)	-0.0111 (-0.11)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	110,784	110,784	110,784	110,784	110,784	110,784

Source: Authors' estimations based on data from the Annual Survey of Industrial Enterprises.

Notes: \*\* represents significance at the 5 percent level. We report estimated coefficients from a linear regression model using IPW. Numbers in parentheses are *t*-values. Control variables are the same as in Table 4, except that firm scale is not controlled in column (3), and the export ratio is not controlled in column (6). FE, fixed effects. Variable definitions are provided in section II and Table 2.

<sup>21</sup>We use the Levinsohn and Petrin (2003) method to calculate TFP.

## (2) *The role of China's FDI policy and innovation policy*

During the period of our analysis, China provided policy support to attract the location of foreign-owned companies. Under the Foreign Investment Enterprise and Foreign Enterprise Income Tax Law, foreign firms meeting certain criteria enjoyed substantial tax concessions.<sup>22</sup> One criterion was the location of the affiliate within a designated commercial area (Special Economic Zone or Economic and Technological Development Zone). In such a case, business profits were taxed at a rate of 15 percent. A tax rate of 24 percent is applied if the foreign firm is located outside the zone. This compares with a standard rate of 33 percent. Further incentives included a staggered taxation schedule, with zero or reduced taxes in the earlier years of a firm's operations, rising after that. Finally, additional tax concessions were available to foreign firm owners who reinvested some (or all) of their revenue back into the business.

These support mechanisms are important in our case because, following divestment by the foreign firm and a change in ownership to domestic owners, these taxation windfalls disappear. The new Chinese owners faced the harsher tax regime served to domestic businesses. Specifically, this corresponded to a tax rate of 33 percent on corporate profits.<sup>23</sup> Hence, newly divested affiliates were exposed to a tougher tax environment with lower concessions than the same affiliate would have enjoyed had it remained under foreign ownership.

It is, therefore, plausible that the new domestic owners would have sought to compensate for the loss of these concessions. One option for such compensation would be to secure any tax concessions available for innovation. In particular, the high and new technology enterprises taxation rules provided such government support, irrespective of the nationality of the firm's owners. Firms able to obtain the label of high technology enterprises were only required to pay a tax rate of 15 percent.<sup>24</sup> This taxation windfall was invariably accompanied by other financial incentives, often awarded by the local government. There is some evidence that the high and new technology enterprises rules and related support acted as a spur to innovation (e.g., Hu and Jefferson, 2009; Li, 2012; Dang and Motohashi, 2015).

<sup>22</sup>Information is available from: <http://www.npc.gov.cn/npc/c217/200712/3aeb1804b545482f846e46ff6c310dc8.shtml>. This law came into force in 1991 and was repealed in 2008.

<sup>23</sup>From the Provisional Regulations of the People's Republic of China on Enterprise Income Tax, which were released in 1993 and repealed in 2008.

<sup>24</sup>Information is available from: [http://www.wehdz.gov.cn/zwgk\\_53/zcfg/zcfgqgfwxwj/202001/t20200119\\_897834.shtml](http://www.wehdz.gov.cn/zwgk_53/zcfg/zcfgqgfwxwj/202001/t20200119_897834.shtml).



This taxation provision, drafted by the State Council of China, first came into effect in 1991. It bracketed off certain technology categories, deemed to be high-tech or novel, as eligible for tax concessions. These technologies included some activities for which we have matching sectoral identifiers (e.g., aerospace technology applied in the aerospace industry), while others are more difficult to match to the standard industry classifiers (e.g., geoscience and ocean engineering technology). In any case, these technologies were highly specialized and not very likely to be utilized by smaller firms. Moreover, these activities were not deemed to be very important for China's manufacturing mix during our sample period.

However, there are provisions within the high and new technology enterprises category, where a more representative group of Chinese firms could hope to compete for tax relief. What was necessary was proof that the firm – even in a traditional industry – introduced new production processes or technologies. This is where patents play a role – namely, as documentary evidence that a firm had indeed upgraded its technological capability. Hence, increasing innovation and documenting this through patenting represented a simple way to reduce the tax burden for firms recently transferred to Chinese ownership.

A plausible interpretation of our finding that divestment leads to higher innovation activity is therefore in terms of the provisions of the high and new technology enterprises classification, whereby the new domestic owners had a strong incentive to earn this classification in order to benefit from government support, in particular to receive tax concessions.

To check this taxation conjecture, we made use of information in the ASIE data on the tax burden and subsidies received by firms. If the new domestic owners did indeed engage in innovation to benefit from support, we would expect that divestment would have been accompanied by a reduction in the tax burden. As pointed out above, foreign firms are charged a 15 or 24 percent tax rate, while high and new technology enterprises enjoy a competitive tax rate of 15 percent. Hence, the average tax rate facing those technology firms would be, on average, lower than that faced by foreign firms. We further checked whether the technology enterprises also benefitted from an increase in the receipt of subsidies.

Hence, we re-ran our estimations, using alternative dependent variables – taxes paid and subsidies received, respectively. Our results are shown in Table 9. We found a negative effect on the tax burden for the divested affiliate following divestment by the foreign owner. At the same time, divested affiliates enjoyed higher subsidy levels following the departure of the foreign firm. This reduction in taxation and increase in subsidies was not caused by output increases (Table 8).

Table 9. The impact of foreign divestment on tax and subsidy rate

Variables	$\ln(1 + Tax_{i,t})$	$Tax\_rate_{i,t}$	$Sub_{i,t}$
	(1)	(2)	(3)
$FD_i \times T_i$	-0.2763*** (-2.62)	-3.2538* (-1.70)	0.4100*** (341.93)
Control variables	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	105,599	105,599	10,884

Source: Authors' estimations based on data from the Annual Survey of Industrial Enterprises.

Notes: \*\*\* and \* represent significance at the 1 and 10 percent levels, respectively. Results in columns (1) and (2) are based on OLS estimations. Column (3) is estimated using a Poisson model as only a very small number of firms receive subsidies. Propensity score reweighted regressions are used for coefficient estimation. Control variables here are the log term of R&D, export ratio, firm's scale, state-owned enterprise dummy, the log term of industry's capital intensity, and HHI index. Numbers in parentheses are *t*-values. FE, fixed effects. Variable definitions are provided in section II and Table 2.

Summing up, the estimated effects on taxation and subsidies suggest that divested affiliates received higher concessions after the departure of the foreign firm. Could this just be an artifact of the different taxation regimes extended to foreign-owned versus domestic-owned firms and a focus of policy on the latter? Table 10, which provides mean values of tax and subsidies for domestic and foreign firms, suggests the story is not so black-and-white. Domestic firms, on average, attracted higher subsidies than their foreign peers. However, domestic firms were also targeted for increased taxation. On balance, there is no clear evidence that China's policy favored domestic firms more than foreign firms in the context of overall taxation and subsidization.

Table 10. Comparison between tax paid, tax rate, and subsidy between domestic and foreign firm

Firm type	$Tax_{i,t}$	$Tax\_rate_{i,t}(\%)$	$Sub_{i,t}$
Foreign firms	1188.04 (12,396.05)	7.99 (9.84)	197.68 (5,000.30)
Domestic firms	763.08 (16,490.53)	15.75 (14.78)	252.84 (4,654.89)

Source: Authors' estimation based on data from the Annual Survey of Industrial Enterprises.

Notes: Standard deviations are in parentheses. Variable definitions are provided in Table 2.

Accordingly, our results point to a post-divestment environment for the domestic firm that was highly conducive to innovation. This interpretation is based on our investigations into various forms of innovation (patents, R&D, and new products), coupled with our consideration of the overall impact of taxation and subsidization.

To further support this conjecture, we conducted an additional robustness check. The high and new technology enterprises scheme contained certain exemption clauses, which we could exploit to investigate the mechanisms at work. Specifically, firms located in designated technology parks were not subjected to the same rigorous eligibility requirements as those elsewhere.<sup>25</sup> Firms located outside the technology parks that nonetheless wanted to qualify for equal status were required to report (i) annual total revenue in excess of RMB30 million, (ii) labor productivity of more than RMB150,000, (iii) annual profit and tax per capita of more than RMB30,000, and (iv) yearly R&D investment of at least 4 percent of the company's annual revenue. There were no such requirements for total revenue, labor productivity, profit, or taxes for firms located in the designated technology parks. Moreover, R&D investment only needed to account for at least 3 percent. This implies that a firm located within a technology park could simply receive the accreditation for high and new technology enterprises through the procedure of applying for patents. However, firms located outside a technology park needed to fulfill additional stronger criteria. Technology park incumbents could therefore concentrate fully on patenting in order to receive government concessions and, hence, we might expect a disproportional patent and tax effect for affiliates within technology parks as opposed to their peers.

To test this hypothesis, we generated a dummy variable  $sci\_park_i$ , where  $sci\_park_i = 1$  when the firm was located in a city with a national high-tech industrial park, and  $sci\_park_i = 0$  otherwise. We added an interaction term  $FD_i \times T_i \times sci\_park_i$  into Equation (1), the coefficient of which would indicate performance differences between divested affiliates located in a technology park and those outside.

The results, shown in Table 11, indicate that divested foreign affiliates located in science parks applied for more patents, paid less tax, and received a higher subsidy than divested foreign affiliates not located in science parks. This finding was in line with expectations – if divested foreign affiliates increased their innovation in order to obtain financial concessions.

To strengthen the link between tax rate and patent application, we show the relationship between patent applications and tax rate or subsidy in Table 12. We ran regressions using tax rate or subsidy as the dependent variable and patent applications as the independent variable for all firms. These simple regression results indicate that firms with more patent applications enjoyed a lower tax rate and a higher subsidy, on average,

<sup>25</sup>Fifty-four national high-tech industrial parks were admitted into the scheme by the State Council of China prior to 2007. Of these, 27 are located in nonprovincial capital cities; 56,401 of our observations (firms) are located in cities with access to one of these designated technology parks, amounting to 56 percent of all observations.

Table 11. The difference in ATEs between divested affiliate locating in science park and those that are not

Variables	$Patent_{i,t+2}$ (1)	$Tax\_rate_{i,t}$ (2)	$Sub_{i,t}$ (3)
$FD_i \times T_i \times Sci\_park_i$	1.4019*** (13.86)	-62.6038 (-0.93)	1.5597*** (462.38)
Control variables	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	13,239	104,734	27,288

Source: Authors' estimations based on data from the Annual Survey of Industrial Enterprises.

Notes: \*\*\* represents significance at the 1 percent level. In this setting, the treatment group is divested foreign firms located in the science park. Control variables are the same as in Table 4. The results for patent and subsidy were estimated using the Poisson model, the same as in Tables 4 and 10. The result for the tax rate was estimated using the OLS method. Hence, the exponentiated coefficients are reported for columns (1) and (3), and the coefficient is reported for column (2). ATE, average treatment effect; FE, fixed effects. Variable definitions are provided in section II and Table 2.

Table 12. The relation between patent application, tax rate, and subsidy

A simple relation between patent application and tax rate				
Variables	(1) $Tax\_rate$	(2) $Tax\_rate$	(3) $Tax\_rate$	(4) $Tax\_rate$
$\ln(1 + Patent)$	-0.1520* (-1.83)			
$\ln(1 + Patent\_in)$		-0.8028*** (-5.44)		
$\ln(1 + Patent\_uti)$			0.0064 (0.05)	
$\ln(1 + Patent\_des)$				-0.2123 (-1.63)
Control variables	Yes	Yes	Yes	Yes
Observations	510,997	510,997	510,997	510,997
A simple relation between patent application and subsidy				
Variables	(1) $\ln(1 + Sub)$	(2) $\ln(1 + Sub)$	(3) $\ln(1 + Sub)$	(4) $\ln(1 + Sub)$
$\ln(1 + Patent)$	0.3493*** (20.35)			
$\ln(1 + Patent\_in)$		0.5789*** (14.25)		
$\ln(1 + Patent\_uti)$			0.3916*** (14.97)	
$\ln(1 + Patent\_des)$				0.3246*** (12.74)
Control variables	Yes	Yes	Yes	Yes
Observations	518,821	518,821	518,821	518,821

Source: Authors' estimations based on data from the Annual Survey of Industrial Enterprises.

Notes: \*\*\* and \* represent significance at the 1 and 10 percent levels, respectively. Control variables are the same as in Table 4. Variable definitions are provided in Table 2.

especially for inventing patents. Table 12, along with Table 10, thus give evidence that divested foreign affiliates used patent applications as a strategy to receive tax and subsidy support.<sup>26</sup>

## V. Conclusion

This paper explored the consequences of innovation in an affiliate following its divestment by a foreign owner. Linking production and patent application data at the firm level for China and using propensity score methods for dealing with selection bias, we found that divested affiliates increased their patent applications – including higher-end invention patents – as a result of the divestment. The estimated treatment effects imply an economically meaningful, substantial increase following divestment. Other innovation metrics – R&D investment and sales from new products – also received a boost. Together with a number of robustness checks, our findings suggest that our estimations picked up a real improvement in innovation rather than just a window-dressing exercise.

Probing into the mechanisms behind our results, we found evidence in line with the idea that government policy – in particular, the move by the newly domestic-owned affiliate to seek tax break actively – may have played a major role. Although the divested affiliate would have stood to lose tax privileges enjoyed by its previous foreign owners, there were ways of compensating for these losses – namely, to succeed in being acknowledged as a high and new technology enterprise. This would bring with it benefits in terms of tax concessions and subsidies. To be eligible for this scheme, firms needed to fulfill certain technology standards, evidenced through patent applications. Our supplementary findings on tax payments and subsidy receipts following divestment appear in line with this interpretation.

From a policy perspective – and moving to the current events prompted by the trade conflict with China – our findings suggest that a future full or partial withdrawal of foreign investors from China may not necessarily spell an end to China's technological performance. Instead, the endgame depends very much on the incentives given to the decoupled affiliates. This is an important point to consider, not only for China but also for other host countries facing possible divestments from multinationals that shift production elsewhere.

Of course, the findings of our paper should also be placed in the context of the well established literature analyzing the positive as well as negative effects of inward

<sup>26</sup>Such strategic behavior by Chinese firms was also found by Li and Zheng (2016).

foreign direct investment (Lu et al., 2017; Girma et al., 2015a; 2019). Given the importance of foreign divestments, our paper aims to stimulate debate on the impact of such divestments on host countries – a much neglected topic but one likely to gain in importance with the backlash against globalization experienced in recent years. It would be interesting to see whether outward FDI by Chinese firms has a similar or different effect on innovation performance at home. Unfortunately, we do not have data to look at outward FDI, and hence this must be left for future research.

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## Appendix

Table A1. Balancing tests for propensity score reweighting

Variables	Balance test for whole sample					
	Before reweighting			After reweighting		
	Treatment group	Control group	<i>p</i> -value	Treatment group	Control group	<i>p</i> -value
$\ln(1 + RD)$	0.47	0.60	0.01	0.75	0.60	0.33
<i>Patent</i>	0.03	0.04	0.03	0.07	0.04	0.18
<i>Export_ratio</i>	0.27	0.49	0.00	0.51	0.48	0.34
<i>Scale</i>	10.32	10.61	0.00	10.63	10.60	0.81
$\ln Pcap\_ind$	3.45	3.43	0.07	3.41	3.43	0.51
<i>HHI</i>	0.00	0.00	0.00	0.00	0.00	0.66
<i>SOE</i>	0.00	0.00	0.15	0.00	0.00	0.99
<i>Profit_ratio</i>	0.03	0.03	0.57	0.03	0.03	0.54
<i>Sub_ratio</i>	0.00	0.00	0.15	0.00	0.00	0.92
$\ln(1 + Age)$	1.79	1.86	0.00	1.93	1.86	0.21
<i>Hmt_ratio</i>	0.46	0.41	0.00	0.37	0.41	0.10
<i>For_ratio</i>	0.31	0.42	0.00	0.43	0.42	0.81
<i>Pol_conn</i>	0.02	0.02	0.09	0.05	0.02	0.10
Variables	Balance test for minority foreign owner divestment sample					
	Before reweighting			After reweighting		
	Treatment group	Control group	<i>p</i> -value	Treatment group	Control group	<i>p</i> -value
$\ln(1 + RD)$	0.74	0.90	0.90	0.84	0.90	0.72
<i>Patent</i>	0.08	0.08	0.08	0.10	0.08	0.52
<i>Export_ratio</i>	0.23	0.38	0.38	0.33	0.37	0.24
<i>Scale</i>	10.61	10.60	10.60	10.69	10.60	0.34
$\ln Pcap\_ind$	3.52	3.43	3.43	3.46	3.43	0.37
<i>HHI</i>	0.00	0.00	0.00	0.00	0.00	0.97
<i>SOE</i>	0.01	0.00	0.00	0.00	0.00	0.71
<i>Profit_ratio</i>	0.67	0.63	0.63	0.64	0.63	0.97
<i>Sub_ratio</i>	0.00	0.00	0.00	0.00	0.00	0.38
$\ln(1 + Age)$	1.95	1.92	1.92	1.99	1.92	0.12
<i>Hmt_ratio</i>	0.18	0.16	0.16	0.18	0.16	0.20
<i>For_ratio</i>	0.17	0.20	0.20	0.17	0.19	0.17
<i>Pol_conn</i>	0.05	0.06	0.06	0.06	0.06	0.99

(Continued on the next page)

(Table A1 continued)

Balance test for majority foreign owner divestment sample						
Variables	Before reweighting			After reweighting		
	Treatment group	Control group	<i>p</i> -value	Treatment group	Control group	<i>p</i> -value
$\ln(1 + RD)$	0.40	0.56	0.01	0.56	0.53	0.83
<i>Patent</i>	0.03	0.06	0.00	0.07	0.06	0.72
<i>Export_ratio</i>	0.27	0.51	0.00	0.54	0.51	0.41
<i>Scale</i>	10.30	10.64	0.00	10.63	10.62	0.93
$\ln Pcap\_ind$	3.44	3.43	0.63	3.39	3.43	0.23
<i>HHI</i>	0.00	0.00	0.55	0.00	0.00	0.72
<i>Profit_ratio</i>	0.52	0.55	0.70	0.56	0.56	0.95
<i>Sub_ratio</i>	0.00	0.00	0.28	0.00	0.00	0.38
$\ln(1 + Age)$	1.81	1.89	0.00	1.92	1.86	0.36
<i>Hmt_ratio</i>	0.57	0.48	0.00	0.45	0.48	0.44
<i>For_ratio</i>	0.36	0.48	0.00	0.50	0.47	0.53
<i>Pol_conn</i>	0.01	0.02	0.17	0.01	0.02	0.71

Source: Authors' estimation based on data from the Annual Survey of Industrial Enterprises.

Notes: The *p* values of *t*-statistics are reported. We report the balance test for whole sample, minority foreign owner divestment, and majority foreign owner divestment separately. SOE, state-owned enterprise. Variable definitions are provided in Table 2.

Table A2. The impact of foreign divestment on firm's patent application when using continuously patent applying firms

Dependent variable	$Patent_{i+2}$	$Patent\_in_{i+2}$	$Patent\_uti_{i+2}$	$Patent\_des_{i+2}$
	(1)	(2)	(3)	(4)
$FD_i \times T_i$	1.0975*** (6.44)	1.6319*** (21.02)	1.0957*** (3.13)	1.1997*** (2.62)
Control variables	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	2,616	1,959	2,262	1,578

Source: Authors' estimations based on data from the Annual Survey of Industrial Enterprises.

Notes: \*\*\* represents significance at the 1 percent level. Except for using firms who continuously apply patent during sample period, the other treatments are the same as Table 4. FE, fixed effects. Variable definitions are provided in section II and Table 2.

Table A3. Foreign ownership and firm's patent grant rate

	$Pa\_gran_{i,t}$	$Pa\_gran\_in_{i,t}$	$Pa\_gran\_uti_{i,t}$	$Pa\_gran\_des_{i,t}$	$Pa\_gran_{i,t}$
	(1)	(2)	(3)	(4)	(5)
$D\_for_{i,t}$	0.0060 (0.36)	0.1013*** (2.94)	-0.0295 (-1.45)	0.0154 (0.64)	0.0094 (0.44)
$Scale_{i,t}$	0.0616*** (16.22)	-0.0186** (-2.11)	0.0768*** (15.83)	0.0689*** (12.09)	0.0669*** (13.83)
$\ln(1 + Age)_{i,t}$	-0.0758*** (-12.38)	0.0631*** (4.13)	-0.1058*** (-14.38)	-0.1256*** (-13.07)	-0.0656*** (-8.62)
$\ln Cap\_int_{i,t}$	0.0016 (0.48)	-0.0032 (-0.40)	0.0044 (1.03)	-0.0056 (-1.10)	0.0069 (1.56)
$Export\_ratio_{i,t}$	-0.0155 (-1.04)	-0.0060 (-0.15)	0.0203 (1.07)	-0.0181 (-0.88)	-0.0417** (-2.25)
Industry FE	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	86,115	23,879	49,181	34,108	55,547

Source: Authors' estimations based on data from the Annual Survey of Industrial Enterprises.

Notes: \*\*\* and \*\* represent significance at the 1 and 5 percent levels, respectively. Samples include firms with patents granted or patents rejected and cover the years 1998 to 2009, except for column (5) using sample from 1998 to 2007 as a robust check. FE, fixed effects. Variable definitions are provided in section II and Table 2.

(Edited by Shuyu Chang)