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**Patent Data Appendix for  
Quid Pro Quo: Technology Capital  
Transfers for Market Access in China\***

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\*The views expressed herein are those of the authors and not necessarily those of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.

# 1 Overview

The document discusses the patent data used in Holmes, McGrattan, and Prescott (2013) and explains the construction of the sample of foreign multinational firms used in the study.

The web page [www.econ.umn.edu/~holmes/data/chinapatent](http://www.econ.umn.edu/~holmes/data/chinapatent) provides the data used for all the patent results presented in our paper. It consists of files we constructed, including those linking China-published patents for the period 2005–2010 to U.S.- and WIPO-published applications. It also includes our raw patent file data on China-published patents, U.S.-published applications, and WIPO-published applications. For the potential benefit of other researchers, we post data for all years we have collected so far, not just for the sample years of our study. The web page also provides some links to supplementary tables for various data sets.

## 2 Multinationals in China

We construct a sample of multinational firms doing business in China. We begin with information provided by China’s Ministry of Commerce.<sup>1</sup> This information is in the form of lists of Top 500 foreign affiliates in China, ranked by sales volume, for selected years. Two points need to be made about each list. First, a particular foreign company may appear several times on the list if it has multiple affiliates in China. For example, in the 2007 list, Volkswagen has two different joint ventures for automobile manufacturing—one with FAW ranked 9 on the list and one with SAIC ranked 17 on the list. In addition, the sales operation for each joint venture is organized as a distinct business unit, resulting in two additional entries for Volkswagen on the Top 500 list, for a total of four entries. The second point about the list is that it contains businesses that are not foreign but are included in the list because the business units are based out of Hong Kong, possibly for tax considerations.

We took the Top 500 lists for 2006 and 2007, the two most recent years for which the lists are available. Excluding Hong Kong-based and Taiwan-based businesses and consolidating business units of the same foreign firms resulted in a list of 114 multinational enterprises with affiliates in China (the exclusion of Taiwan eliminates 29 companies). We refer to these enterprises as *large multinationals*, or *LMNs*. Appendix Table A1 provides summary statistics for all firms as a group and for the four countries with the largest sales of the top firms. Across the 114 LMNs, mean sales from the Top 500 list for 2007 per LMN is \$3.0

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<sup>1</sup>These files were downloaded at Invest in China, <http://www.fdi.gov.cn/>.

billion (U.S.), and total sales is \$342.7 billion. Appendix Table A2 provides a detailed list of all 114 firms.

Looking at firms based in the United States, we can see in Table A1 that there are 34 U.S. firms in the LMN list. These average \$2.2 billion in 2007 Top 500 sales, with a total of \$73.2 billion. By comparison, the Bureau of Economic Analysis (BEA) reports total sales of U.S.-based affiliates in China of \$139.4 billion for 2007—approximately twice as much. We expect the Top 500 sales figure to be less than the BEA figure for two reasons. First, the Top 500 sales figure contains information for only the largest 23 U.S. LMNs in China, whereas the BEA attempts to estimate sales in China for all U.S. affiliates. Second, the 23 LMNs that we are tracking may yet have additional affiliates in China that are not big enough to make the Top 500 affiliate list, and to the extent that this is true, we understate sales in China by affiliates of these 23 LMNs. This second issue will not pose a problem here, because our analysis focuses on patent data, not on sales data, and we will be extracting all the patent records of a given LMN. Because of the first issue, we do miss out on the activity of smaller firms. By focusing on this sample of firms with large affiliate activity, however, we are tracking a significant fraction of overall activity.

### **3 Joint Ventures with Domestic Partners Are Significant**

As discussed in the main text, foreign firms are often required to participate in a joint venture with a domestic partner, as quid pro quo for market access. Our first exercise is to show that it is indeed the case that joint ventures are significant in our sample of firms.

We proceed in two ways. In our first approach, we examine the names of each of the affiliated companies in the Top 500 Foreign Affiliate file provided by the Ministry of Commerce. We determine whether the affiliate name includes the name of a Chinese company. If so, we say the affiliate is a “Joint Venture with Chinese Firm in Name.” For example, the category includes the affiliate FAW-Volkswagen Automotive Company, which has the Chinese firm FAW (First Automobile Works) in its name. Analogously, the category includes Shanghai Volkswagen Automobile Company, which includes part of the name of the Chinese firm, Shanghai Automotive Industry Corporation, or SAIC.

Appendix Table A3 shows the distribution of the affiliates as to whether they have a joint

venture in which a Chinese firm shows up in the affiliate name. Out of the 217 affiliates, 74 are a joint venture with a Chinese firm in the name, and these account for 46 percent of affiliate sales.

Focusing on cases in which the affiliate has a Chinese firm in the name is a strong requirement. The foreign firm may set up a joint venture in which the Chinese firm's share is far less than half, in which case the Chinese firm would be unlikely to appear in the name. For example, LG Electronics (Nanjing) Plasma Company is a joint venture subsidiary of LG (the Korean electronics firm) for which LG has a 70 percent stake. The partner's name does not make it into the affiliate name (though the location, Nanjing, does). Another possibility is that the foreign firm sets up a wholly owned subsidiary, based in China, which is a holding company for joint ventures in China. Finally, a particular foreign firm participating in some joint ventures might be considered a *quid pro quo* firm for being allowed to have some wholly owned subsidiaries. This discussion motivates our second approach for defining joint venture status. We start with our sample of firms and say the firm has "Some Joint Venture" if the firm has at least one affiliate that is a joint venture (and not requiring that the partner's name be in the affiliate name). We track down this information by examining annual reports, studying news announcements at company websites, and noting general news reports. To save on data collection, we focus only on the top 50 firms, as ranked by 2007 affiliate sales.

We first note that if we restrict attention to just the top 50 firms, just look at their affiliates, and use our first criterion that the name of the Chinese partner shows up in the affiliate name, the results are similar to those in the broader set of firms. By this first approach, 48 percent of affiliate sales occur in joint ventures. Turning next to the second approach, 43 out of the top 50 firms have some joint venture activity, and the sales of these 43 firms account for 90 percent of the sales of the top 50 firms.

We conclude that in our sample of foreign firms, joint ventures figure prominently with respect to how multinational firms sell in China.

## 4 Multinationals and Patents

We begin with patent-level data collected from the website of the State Intellectual Property Office (SIPO) of China.<sup>2</sup> We use the English language version of the data. In our analysis, we restrict attention to patents classified as *invention patents*. SIPO also grants *utility*

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<sup>2</sup>We are grateful to Jing Fang for having collected these data, which are used in Fang (2013).

*patents* according to a lower standard and with a shorter term of protection. The number of utility patents obtained by foreign firms is negligible, and this fact motivates our focus on the higher-quality patents classified as the invention type. Note, however, that the raw data we post on our data page include utility patents as well as invention patents.

The patents published at the SIPO website are at the *publication* phase, which is an intermediate phase between initial application and the point at which patents are granted. Throughout, we will refer to these documents as *published patents*. These documents are referred to as simply *patents* at the SIPO website. The current legal status of any particular published patent is provided at the SIPO website (in Chinese only).<sup>3</sup>

We restrict attention to invention patents published between 2005 and 2010. We use the Applicant Name text field to select out the patents containing the names of the 114 LMNs on our list. In particular, we classify a particular LMN as being an *owner* of a given patent if we find its name on the patent. We conduct manual processing to allow for various ways in which the text might be entered. There are 209,594 invention patents classified as having a foreign owner for the period 2005–2010.

We manually process the Applicant Name text field of these records to determine whether there is any connection to China in the field, including a location or the name of a partner Chinese firm. These are classified as having a “China Link,” and there are 14,605 patents of this type. For example, consider a patent record in which the applicant is listed as Shanghai LG Electronics Co LTD. We classify this applicant as an LMN because the Korean company LG is one of these 114 companies. We classify the applicant as having a China link because the text contains the word “Shanghai.”

We further process the records with a China link and classify the records as being “Shared with Chinese Partner” or not. We define two ways in which a record could be classified as “Shared.” The first way is if the name of a Chinese company or entity is in the Applicant Name field, along with the name of the foreign firm. For example, a patent listing the applicant as FAW-Volkswagen Automobile Co., Ltd, is classified as a “Shared with Chinese Partner” because the Chinese company FAW, as well as the foreign company Volkswagen, are listed in the text field. In some cases, we use Internet searches to determine whether a particular entity is Chinese.

The second way in which a record is classified as a joint venture is if the particular business unit is reported to be a joint venture in company documents, such as annual reports and Securities and Exchange Commission (SEC) filings, and in various news sources. For

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<sup>3</sup>See State Intellectual Property Office of P.R.C., <http://search.sipo.gov.cn/zljs/searchflzt.jsp>.

example, from the 2009 annual report for LG, we determined that the affiliate mentioned above, Shanghai LG Electronics Co LTD, is 70 percent owned by LG, as of the date of the report. In this case, we presume the residual 30 percent share is Chinese owned and therefore classify the unit as one in which ownership is shared. Using these two criteria, we classify 10,184 LMN patents as “Shared.”

We link the published Chinese patents to U.S. patent applications and WIPO patent applications. In the United States, publication of the application is also an intermediate stage between initial application and grant. The U.S. patent office refers to these records as published applications, and we use the same terminology. Similarly, we refer to the WIPO documents as published applications. For the United States, text files for patent applications are distributed in bulk form at Google’s Bulk Download patent website (through an arrangement with the U.S. patent office). We use the application data for patents published over the period 2000–2012 (3.3 million applications). We note that the United States began publishing application data only in 2000, and not all applications were necessarily published in the early years. When the coverage of applications being published is very good, however, we will focus on the period 2005–2010. From the WIPO website, we downloaded all WIPO patent applications that were published during the period 1999–2012 (1.8 million applications).

We link Chinese patents with U.S. and WIPO applications through foreign priority information included with the patent records. We link in both directions: patents filed in China claiming foreign priority outside of China, and patents filed outside of China claiming the foreign priority of a China patent. Specifically, we match the Chinese patents to U.S. applications as follows. First, we take all Chinese patents claiming foreign priority. If the foreign priority claim was based on a U.S. patent, we link to the U.S. patent by merging on both the foreign priority date (which is the application date in the U.S. file) and the application number. We employ various text modifications of the application number format to facilitate clean matches; most matches were obtained this way. We also obtain additional matches, however, through merging on the patent title or first inventor name (note that we also require a match on the application date). We obtain a match rate of 90 percent. This explains how we match Chinese patents claiming U.S. foreign priority. Next, for Chinese patents claiming priority based on a filing in some other country besides the United States, we merge in the foreign priority information in the U.S. patent. Next, we reverse the process, linking applications in the United States claiming foreign priority in China to the corresponding Chinese patents. Similarly, we link Chinese patents and the WIPO patent

applications in both directions.

In the paper, we compare Chinese patents owned by LMNs with patents owned by Chinese firms only. The data on Chinese patents reported at the SIPO website do not contain direct information about nationality. Chinese patents that do not report any foreign priority information, however, are primarily Chinese applicants, including Taiwan applications. With this in mind, we use the following procedure to isolate patents owned by Chinese firms. Nationality is not directly reported in the published patent data that we have. To estimate the set of Chinese firm-owned patents, we proceed as follows.

First, we restrict attention to patents first filed in China (which we measure by whether a firm claims foreign priority). Second, we eliminate all patents in our previously constructed data set of patents that large foreign multinationals either wholly own or share. Third, we delete all records with the words “University,” “Academy,” or “Institute” in the applicant name in order to focus on firms, not academic entities.

Fourth, we create a variable, *applicant\_name\_trun*, which is a truncated version (first 50 characters, with punctuation removed) of the applicant name. We group patents on this variable and count the number of patents for a given value, *applicant\_name\_trun*. We sort from the highest value to the lowest. We manually process the cases with the highest counts to any additional foreign firms that we did not eliminate the earlier step. In addition, we remove cases (from the largest patentors) in which the applicant is an individual rather than a firm. We continue the process until the top 100 values *applicant\_name\_trun* do not include foreign firms or individuals, based on manual processing (including Internet searches of the various firm names). We do not manually process records outside of the top 100. This is not problematic, because in the text we focus on the top 100 patentors.

In the paper, we classify inventors as to whether or not they have a Chinese name.<sup>4</sup> We construct this classification as follows. For each inventor, we select up to three name components (i.e., first, middle, and last). Each inventor on each patent can be classified by whether or not the patent claims foreign priority. If no foreign priority is claimed, we classify the patent as originating in China. If foreign priority is claimed on the patent, we restrict attention to patents claiming priority from the following countries: the United States, Germany, Japan, France, and Korea. In this way, we associate each patent as originating in one of these six countries (including China) or otherwise place the patent in a residual category. For the patents of each country, we calculate the percentile distribution of the name components. For example, for patents originating in China, the most common name

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<sup>4</sup>See Kerr (2008) for earlier work using the ethnicity information of inventor names with patent data.

component is Wang, which makes up a share .039 of all name components. For patents originating in France, the most common name component is Jean.

Next, for each inventor on each patent, we take the name components (up to three) and calculate where these name components fall along the distribution for each of the six countries. We calculate the minimum value over all six countries and over all name components of an individual inventor and classify the inventor according to the country where the minimum value is obtained. That is, we assign an individual to the country where the first, middle, or last name is the most common. We then determine whether a patent has at least one inventor classified as Chinese, based on the inventor’s name.

## 5 Patenting in the Automobile Industry

In Appendix Table A4, we report the list of automakers cited in the text. This list contains all the automakers producing 200,000 units or more in 2012. The original source is the China Association of Automobile Manufacturers (CAAM), as cited in Chow (2013). The firms are sorted in descending order of output. The top seven firms are all joint venture operations. The remaining six firms are independent. To obtain patent counts for these firms, we match the names of the firms to the Applicant Name text field in the patent data, analogous to the way in which we did this for the LMNs.

Note that we gave special treatment to the independent Chinese automaker BYD. We did this because in addition to being an automaker, BYD also makes rechargeable batteries for cell phones, and many of its patents are for its cell phone business. For the results reported in the paper, we include all those patents that we attribute to its auto business. To separate these out, we first take the patents owned by foreign auto producers in China and select the first listed international patent classification (IPC) code for each patent at the three-digit level. We take the top 15 three-digit classifications, and these account for just over 90 percent of all the foreign automaker patents in China. To isolate BYD’s auto patents, we select only those patents for which one of the listed three-digit IPC codes is in the set of top 15 auto IPC codes. Selecting patents in this way, we eliminate 721 of BYD’s patents, leaving BYD with 1,300 patents instead of 2,021.<sup>5</sup> If we leave these 721 patents in the sample, the difference in results is negligible.

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<sup>5</sup>We included cases in which the patent title included any of the following words: “automobile,” “vehicle,” “steering,” “motor,” and “wheel,” but this made little difference because virtually all of these patents were included anyway, based on the top 15 automobile industry three-digit IPC code selection criteria.



## 6 Appendix References

### References

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Table A1

## Summary Statistics for Top Foreign Firms in China

	Number of Top Foreign Firms	Mean 2007 Sales from Top 500 List (billions of USD)	Total 2007 Sales from Top 500 List (billions of USD)
All Top Firms			
	114	3.0	342.7
Top Firms by Selected Home Country			
Japan	34	3.0	100.9
United States	34	2.2	73.2
Germany	12	4.2	50.5
Korea	7	6.9	48.6

Source: Constructed from China Ministry of Commerce Data on Top 500 Sales of Foreign Affiliates, as discussed in the text.

Table A2

List of LMNs (Large Multinationals) in China as Aggregated from Top 500 Sales List

2007 Sales Rank	LMN Name	Home Country	Number of Affiliates in China in 2007	Total 2007 Sales
1	Volkswagen	DE	4	32.0
2	Toyota	JP	8	22.8
3	Samsung	KR	14	22.3
4	Nokia	FI	3	19.6
5	General Motors	US	4	12.1
6	LG	KR	10	11.5
7	Motorola	US	2	10.8
8	Honda	JP	3	10.0
9	Sony	JP	6	8.8
10	Flextronics	SG	5	8.3
11	Matsushita Panasonic	JP	5	6.6
12	Hyundai	KR	4	6.3
13	Hewlett Packard	US	4	5.8
14	Nissan	JP	2	5.8
15	Dell	US	2	5.4
16	Ericsson	SE	4	5.4
17	BP	GB	4	5.4
18	Sharp	JP	5	5.2
19	Hitachi	JP	7	4.9
20	Total	FR	1	4.9
21	Shell	NL	3	4.5
22	Canon	JP	5	4.5
23	POSCO	KR	3	4.2
24	BMW	DE	2	4.1
25	Walmart	US	2	3.9
26	Seagate	US	1	3.4
27	Mazda	JP	2	3.2
28	Toshiba	JP	4	3.1
29	Ford	US	2	3.1
30	BASF	DE	2	3.1
31	Mitsubishi	JP	3	2.8
32	Peugeot Citroen	FR	1	2.8
33	Siemens	DE	3	2.7
34	IBM	US	2	2.4
35	Qimonda	DE	2	2.4
36	Daimler	DE	1	2.2
37	Alcatel	FR	1	2.2
38	SK Hynix	KR	2	2.2
39	Suzuki	JP	2	2.1
40	Jabil Circuit	US	2	2.1
41	Sumitomo	JP	1	2.0

42	Amway	US	1	1.9
43	Procter Gamble	US	1	1.9
44	Freescale	US	1	1.8
45	Solectron	US	2	1.7
46	Komatsu	JP	2	1.7
47	Unilever	GB	2	1.7
48	NEC	JP	2	1.6
49	Daikin	JP	2	1.5
50	Epson	JP	2	1.5
51	Iveco	IT	2	1.5
52	Celestica	CA	2	1.2
53	Ingram Micro	US	1	1.2
54	Schneider	FR	1	1.2
55	Mitsui	JP	2	1.2
56	Nippon Mining Metal	JP	1	1.2
57	Saudi Aramco	SA	2	1.2
58	Exxon	US	2	1.2
59	Isuzu	JP	2	1.2
60	KIA	KR	1	1.2
61	Synnex Technology	US	1	1.2
62	Otis Elevator	US	1	1.1
63	Caterpillar	US	2	1.1
64	Philips	NL	2	1.1
65	DHL Danzas	DE	1	1.0
66	Pacific Steel	US	1	1.0
67	Doosan	KR	1	0.9
68	Nike	US	1	0.9
69	Ricoh	JP	1	0.9
70	Anheuser Busch InBev	BE	1	0.9
71	Auchan	FR	1	0.8
72	Brother	JP	1	0.8
73	Cummins	US	1	0.8
74	ECS Technology	SG	1	0.8
75	Best Buy	US	1	0.8
76	L'Oreal	FR	1	0.8
77	Nippon Steel	JP	1	0.7
78	Arcelor	LU	1	0.7
79	Kobelco	JP	1	0.7
80	Nestle	CH	1	0.7
81	Sanmina SCI	US	1	0.7
82	Morgan Stanley	US	1	0.7
83	Johnson Controls	US	1	0.7
84	Wrigley	US	1	0.7
85	Inco	CA	1	0.7
86	Itochu	JP	1	0.7
87	Bayer	DE	1	0.6
88	Cargill	US	1	0.6
89	Emerson	US	1	0.6
90	Kuehne Nagel	CH	1	0.6

91	Bosch	DE	1	0.6
92	Coca Cola	US	1	0.6
93	Makita	JP	1	0.6
94	Adidas	DE	1	0.6
95	Sanyo	JP	1	0.6
96	Microsoft	US	1	0.6
97	UPM Kymmene	FI	1	0.6
98	Carrefour	FR	1	0.6
99	Kyocera Mita	JP	1	0.6
100	Mitsumi	JP	1	0.6
101	Pioneer	JP	1	0.6
102	Leo Burnett Advertising	US	1	0.6
103	ABB	CH	1	0.6
104	Fuji	JP	1	0.6
105	Xerox	US	1	0.6
106	Jebsen Jessen	DE	1	0.6
107	Bridgestone	JP	1	0.6
108	Krupp	DE	1	0.6
109	Logitech	CH	1	0.6
110	Nisshin Steel	JP	1	0.6
111	Hanwa	JP	1	0.6
112	Delphi Packard	US	1	0.5
113	Wilmar	SG	1	0.4
114	ADM	US	1	0.4

Source: Constructed from China Ministry of Commerce Data on Top 500 Sales of Foreign Affiliates, as discussed in the text.

Table A3

## Joint Venture Status of LMN

	Meet Joint Venture Definition	All	Share Joint Venture
Definition 1: Affiliates with Chinese Partner Name in Affiliate Name			
Top affiliates of all LMNs			
Number of affiliates	74 affiliates	217 affiliates	34 percent of affiliates
Sales (billions of USD)	156.3	342.7	46 percent of sales
Top affiliates of top 50 LMNs			
Number of affiliates	56 affiliates	154 affiliates	36 percent of affiliates
Sales (billions of USD)	140.5	293.4	48 percent of sales
Definition 2: Firms with Some Joint Venture, of Top 50 Firms			
Number of LMNs	43 LMNs	50 LMNs	86 percent of LMNs
Sales (billions of USD)	276.3	306.1	90 percent of sales

Source: Authors' calculations from China Ministry of Commerce Data on Top 500 Sales of Foreign Affiliates.

Table A4  
 Top Automakers in China  
 (automakers with unit sales of more than 200,000 in 2012)

Automaker	Unit Sales	Joint Ventures
Joint Venture Chinese Auto Companies		
SAIC (Shanghai Auto Industry Corp)	4,461,393	Volkswagen, GM
Dongfeng	3,078,494	PSA Peugeot Citroën, Kia, Nissan, Honda
FAW (First Automobile Works)	2,645,924	Volkswagen, Toyota
Changan	1,956,391	Ford, Mazda
BAIC (Beijing Automotive Industry Group )	1,691,117	Hyundai, Daimler
GAC (Guangzhou Auto Corp)	712,164	Toyota, Honda, Fiat
Brilliance	637,979	BMW
Total joint venture unit sales	15,183,462	
Independent Chinese Auto Companies		
Great Wall	624,602	
Chery	563,305	
Geely	491,444	
JAC (Anhui Jianghuai Automobile Co.)	486,760	
BYD	456,056	
Lifan	270,303	
Total independent unit sales	2,892,470	

Source: China Association of Automobile Manufacturers (CAAM), as cited in Chow (2013). The joint venture partners are reported in the article, except for the joint venture of BMW with Brilliance, which is verified from company documents.