China's export registration in the automobile industry: Effects on manufacturer-intermediary match efficiency

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Abstract

In 2007, China implemented a policy requiring automobile producers to distribute through at most three trade intermediaries and list their intermediaries on a registry. Motivated by the registration requirements and granularity in the order sizes handled by most intermediaries, this paper develops a model to describe the matches between automakers and intermediaries. The model shows market division arises endogenously due to the regulation. It creates inefficiencies in matching and double marginalization. The model predictions coincide with a number of stylized facts: a strong decline in the number of auto intermediaries, assortative matching, export price increases for intermediaries, and substantial churning in the sets of intermediaries registered by the automakers. Welfare analysis in terms of total profit shows that this regulation benefits automakers, especially those relatively less efficient ones while intermediaries are made worse off.

Keywords: trade intermediary; matching; export regulation

JEL Classification: F13, F14

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1 Introduction

China's auto industry has experienced rapid growth over the past fifteen years.[1] While most of this new production was destined for the Chinese market—exports are only 5% of production—automobile exports have risen rapidly as well. Accompanying the growth in exports was a dramatic rise in the number of intermediaries exporting automobiles. Over 700 intermediaries with auto exports were identified from China's Customs records in 2006. In response to this surge in auto exporting intermediaries, the Chinese government introduced a registration policy where auto manufacturers were required to list and use at most three intermediaries. This paper investigates how the structure and performance of China's automobile export sector reacted to the regulation. It provides a model of exporting through intermediaries and explores the efficiency consequences of the regulation.

Unlike developed countries where big brand passenger cars dominate the export market, China's automobile exports mainly consist of commercial vehicles. Its top destinations include Russia, Iran, Ukraine, Vietnam, and other developing economies. China's automobile industry is very fragmented. There were at least 250 motor vehicle manufacturers (auto-parts makers not included) in China when the registration policy took place. The registration policy, initiated in 2007, requires automakers who *intend* to export automobiles the next year to register with the government and to authorize at most three intermediaries as their export agents. Automakers are allowed to export directly by themselves as well. The policy did not put restrictions on automaker or intermediary qualifications. That is, any automaker with a valid production permit could register and list any intermediary they prefer.

The registration list reveals a unique set of information on matches between automakers and intermediaries. It also highlights a series of stylized facts that inform my modeling decisions. Specifically, automakers typically list three intermediaries while most intermediaries are not listed by multiple automakers. The automaker-intermediary partnerships are more likely to form among closely located pairs although churning on the list occurs frequently. Intermediaries with larger previous export orders have higher probability of being listed again. Among the matched pairs, positive assortative matching is observed where larger automakers are matched with intermediaries

[1] Its share of global motor vehicle production surged from less than 5% in 2000 to almost 25% in 2011.

capable of bringing more export orders. Moreover, the regulation triggers changes in the intermediary industry as the number of auto intermediaries declines and the export prices of surviving ones increase.

Motivated by the fragmented export orders handled by intermediaries and institutional information of the regulation, a model is developed to emphasize the impact of regulation on automaker-intermediary matches. Intermediaries are heterogeneous in quality and higher quality draws are associated with larger demand shocks. They obtain export orders and contract with an automaker to fulfill them. Automakers (or sellers) produce homogeneous products and engage in Bertrand competition for orders of intermediaries. Each intermediary sources from his lowest cost automaker before the regulation. The registration policy restricts the number of intermediaries that each automaker could list on the registry to three. The listing occurs before the realization of intermediary demand shocks and before prices are offered by automakers. As a result, market division is endogenously implemented by the regulation. Each automaker lists a different set of intermediaries as an equilibrium outcome. Relatively less efficient automakers benefit from this regulation because intermediaries who are unable to contract with the lowest cost automaker are pushed towards the higher cost ones. Surviving intermediaries face higher wholesale prices and the lowest quality ones exit the market. Inefficiencies are generated due to market partition, double marginalization, and potential existence of non-assortative matching equilibria.

This paper is related to a number of studies examining the role of intermediaries in international trade. Both Ahn et al. (2011) and Crozet et al. (2013) show that intermediated share of exports are higher for more difficult destination markets and extends the **?** model to allow economies of scale in export intermediation. Akerman et al. (2010), investigates wholesalers' advantages in handling multiple goods due to economies of scope. Blum et al. (2009) examines the matches between importers and exporters to find that importing intermediaries help small exporters save bilateral match costs. All these papers model homogeneous intermediaries who serve as a means to avoid fixed costs. In my model, intermediaries are heterogeneous in quality. High quality intermediaries are connected to a large pool of potential buyers while low quality ones have positive probabilities of receiving zero export orders. Rather than having supply at hand and searching for customers abroad, intermediaries in my model obtain orders and then search for domestic automakers to fill them.

A common challenge faced by researchers studying the role of trade intermediaries is the identification of intermediaries. As Blum et al. (2009) points out that using Customs data it is difficult to identify with precision importing intermediaries from final consumers. It is equally hard to distinguish manufacturers from exporting intermediaries. Therefore, Ahn et al. (2011) utilizes firm name orthography as indications of their business type while **?** infers intermediaries from direct exporting manufacturers by examining the discrepancy between customs records and self-report export values in national surveys. Even when intermediaries are identified, which producers they source from remain largely unknown. By focusing on the automobile industry, this paper is able to identify automakers and intermediaries with great precision. Further, the exact listing of automaker-intermediary pairs on the registry provides a unique opportunity to examine the linkages between export intermediaries and their domestic suppliers.

This research also contributes to the growing literature documenting matching between international sellers and buyers (Blum et al., 2010; Bernard et al., 2014; Eslava et al., 2015; Tybout et al., 2016). Most of these studies have intermediaries in terms of wholesalers or retailers on either or both sides of the matches across boarders. Blum et al. (2010) shows that at least one party in the relationship is large and Bernard et al. (2014) finds negative assortative matching in terms of firm connections. This paper presents a slightly different perspective: low cost (or large) automakers are predicted to be favored by intermediaries of various sizes in the pre-regulation scenario of the model; and positive assortative matching in terms of firm sizes is observed among post-regulation automaker-intermediary pairs. Another pattern found by previous matching literature is the high probability of breaking relationships (e.g., Tybout et al., 2016). Consistent with Tybout et al. (2016), this paper also shows high pair level drop rate among automakers and intermediaries over time. While previous research shows seller-buyer matching patterns under free market conditions, analyses in this paper add to the literature by considering effects of a registration policy limiting match opportunities and its impact on equilibrium and efficiency.

In order to rationalize the prevalence of intermediaries with extremely small or even zero auto export orders, this paper takes advantage of recent developments in modeling with granularity (e.g., Eaton et al., 2012; Head et al., 2016). In particular, Eaton et al. (2012) assume that the number of exporters is the realization of a Poisson random variable instead of a fixed measure of firms. Zero trade flows in their model imply that no firm *happened* to be efficient enough.

Following their wisdom, intermediaries are assumed to receive demand shocks from a random Poisson distribution based on their quality parameters. Lower quality intermediaries are more likely to have bad demand shocks and generate zero export orders. This method helps to reconcile the existence of intermediaries with zero or small amount of auto export orders. Dynamics emerge because automakers update priors about intermediary quality based on realizations of order draws.

The rest of the paper is organized as follows. Section 2 first describes information revealed by the registration lists and introduces other sources of data used in this paper. Then, stylized facts featuring China's automobile exports and impacts of regulation are shown. In section 3, a model is proposed to rationalize the data patterns and capture the matching process among automakers and intermediaries both before and after the registration policy. Before showing simulation results, Section 4 explains the choice of key parameters of the model. The last section concludes the paper.

2 Data and stylized facts of the industry

The data set used in this paper features the registration list of automaker and intermediary pairs from 2007 to 2011. They are combined with transaction level export data from Chinese Customs records and firm level balance sheet information from manufacturer surveys of the same period.

Before 2004, domestically owned firms below a registered capital threshold were prohibited from direct exporting. They had to export through state owned intermediaries who had monopoly trading rights. As part of China's commitment to joining the WTO these restrictions were removed by 2004 (**?**; Chen and Li, 2014). The liberalization of trading rights also facilitates entry of intermediaries. From 1999 to 2000, private firms with larger than 10 million USD exports in the previous year are allowed to export directly and export products of other firms (i.e., being an intermediary). After 2001, any domestic firm with over 3 million RMB registered capital can be a trade intermediary (Chen and Li, 2014). The auto registration policy was going against the previous trend of liberalizing who can export in a more subtle way.

According to the regulation, automakers who intend to export automobiles the next year are required to register by the end of the current year. On the registration, automakers are allowed to list at most three intermediaries as their authorized agents to export for them. Intermediaries not listed by an automaker are not allowed to export that automaker's vehicles. Automakers could also export directly by themselves.[2]

The registration lists since 2007 are available on the government website as public notices. For automakers, the lists include name (in Chinese), location (i.e., province), Customs identification (ID) number (if available[3]), and general product categories[4]. The lists also include name and Customs ID number of intermediaries. If an automaker only plans to export directly, he could register himself without listing any intermediary. The majority (89%) of automakers put at least one intermediary on their lists. The key characteristic of the registration list is that it contains information on the matched partnerships among automakers and intermediaries. That is, we know the suppliers for each intermediary and that intermediary's export records. But a drawback is that if an intermediary was listed by multiple automakers, we can not attribute his auto exports to a specific automaker.

The registration list also reveals unique information about the ownership linkages between automakers and intermediaries. Examined by orthography, about 17% of intermediaries share part of their firm names with automakers who listed them. They are defined as *linked* intermediaries for they tend to either be owned by the corresponding automakers or belong to the same Corporate Group as the automaker. For instance, First Automobile Works Import and Export (FAWIE) is a subsidiary of FAW Group and facilitates trade activities of other FAW subsidiary auto manufacturers such as FAW Tianjin Xiali.[5] Linked intermediaries account for about one third of total auto exports and are more specialized in auto products. The stylized facts described in this paper will take the special feature of ownership linkages into consideration.

This registration policy is designated for automobiles. Firms who export auto parts are not restricted by this regulation. To be specific, the Chinese government provided a product list which contains 83 CN 10-digit (covering 16 HS 6-digit) product varieties.[6] Table 1 shows China's automobile export by a more aggregated HS 4-digit product category.[7] Column (1) presents that

[2]Please refer to Appendix A for detailed descriptions of the regulation.

[3]The Customs ID number is available for automakers who export some or all of their products directly by themselves.

[4]The product categories include passenger cars, trucks, buses, and chassis.

[5]Hu et al. (2014) also observes the existence of big corporate groups in Chinese automobile industry. But instead of export intermediaries, they focus on passenger vehicles and the competition structure of the industry.

[6]The Chinese Customs use CN10 standard which contains more detailed product specifications than HS 6-digit. Also, motorcycles are not included in this regulation.

[7]There are 5 HS 4-digit level product categories: tractor (HS8701), bus (HS8702), car (HS8703), truck (HS8704) and chassis (HS8706).

the total export value of regulated automobiles increased from 0.13 million USD in 2000 to over 8 million USD in 2011. Trucks account for about 50% of China's automobile exports followed by cars (26%) and buses (18%).

Table 1: Automobile export by HS4 product category

Year	TotVal (1)	Truck% (2)	Car% (3)	Bus% (4)	Tractor% (5)	Chassis% (6)
2000	0.13	0.48	0.23	0.23	0.01	0.05
2001	0.18	0.38	0.22	0.34	0.01	0.05
2002	0.17	0.48	0.18	0.23	0.01	0.10
2003	0.30	0.56	0.21	0.14	0.02	0.07
2004	0.57	0.49	0.30	0.14	0.03	0.04
2005	1.52	0.38	0.38	0.12	0.08	0.03
2006	2.83	0.42	0.34	0.15	0.07	0.02
2007	6.38	0.43	0.33	0.14	0.08	0.02
2008	9.19	0.46	0.33	0.12	0.07	0.02
2009	4.23	0.55	0.18	0.15	0.10	0.03
2010	5.51	0.48	0.19	0.19	0.13	0.02
2011	8.78	0.49	0.22	0.18	0.11	0.01

TotVal = total value of automobile exports in billion US dollars.

Firms on the registration lists are first combined with export data collected by the Chinese Customs Office using their Customs ID numbers. The transaction level Customs data contain information on firm name, export value, quantity, product at eight-digit level, destination country, indicator of processing trade, and etc. Then, characteristics of automakers are obtained from the Chinese Industrial Enterprises Survey database. It is collected by National Bureau of Statistics and covers all state-owned manufacturing firms and non-state-owned manufacturers above certain size thresholds. Firm level balance sheet information such as sales, employment, and capital investment are included.[8] Sales of automakers are extracted from this dataset to demonstrate assortative matching.

Now I turn to describing the empirical facts of automobile exporters in China and matching patterns among automakers and intermediaries.

[8]The Survey sample has a different firm identification system from the Customs records, and therefore, firms are matched by orthography when automaker characteristics are required.

2.1 Fact 1: Many intermediaries have zero or small auto export orders.

I start with the size distribution of registered intermediaries. There are a large number of intermediaries with small or even zero amount of auto export orders. Table 2 shows that on average 44% of intermediaries on the list do not have auto exports the following year and for around 29% of them, auto exports account for less than half of their total export values.

As Bernard et al. (2011) pointed out that intermediaries handle more product varieties than direct exporting manufactures, auto intermediaries on the registry also export other products such as auto parts or electronics. Patterns in Table 2 suggest that automobile is not the main product category for the majority of intermediaries in China. It is also consistent with anecdotal evidence that the business presence of intermediaries in a foreign country will attract local buyers with occasional demand.

There are 979 distinct intermediaries listed on the registry over the five years. About 40% of these intermediaries are only listed once and their chances of bringing positive orders is less than 30%.[9] This finding is consistent with what Ganapati (2016) observes from the other side of the relationship: smaller buyers predominantly deal with wholesalers instead of manufactures. Similarly, if we compare the size distribution of auto export orders between intermediaries and direct exporting automakers, only 3% of intermediaries export over 100 million USD in 2007 compared to 6.3% for automakers. At the same time, 43% of intermediaries have export orders below 1 million USD compared to 36% among automakers.

Table 2: Share of intermediaries with small auto exports

Year	#Intm	AutoExp=0	AutoShr<0.5
2007	294	0.31	0.36
2008	474	0.42	0.27
2009	510	0.55	0.26
2010	540	0.53	0.26
2011	389	0.41	0.28

There are 979 distinct intermediaries on the list over the five years.

In order to capture the highly skewed distribution of auto export orders, especially to ensure that intermediaries have a positive probability to receive zero orders, granularity is introduced

[9]There are 8 intermediaries listed throughout the period who never bring any orders.

into the model. That is, intermediaries are assumed to be endowed with heterogeneous qualities. These qualities can be considered as networks or business connections with potential customers. Intermediary-specific demand shocks are drawn based on their qualities. The granularity of export orders indicates that the order generating process follows a discrete distribution with high probability of receiving zero or small orders.

2.2 Fact 2: Net exit of intermediaries post regulation.

The second stylized fact is the decreasing number of auto intermediaries after the registration policy and describes the characteristics of those who exit. As presented in Figure 1, the number of intermediaries with positive auto exports peaked in 2006 and then dropped by almost a half and stabilized after 2009.[10] In order to demonstrate that the sharp decrease of auto intermediaries is not an effect of any macro economic shock to the global automobile market, Figure 1 also depicts the number of direct exporting automakers. The steady increase of direct exporting automakers before regulation and stable auto exporters post regulation form a stark contrast to the trend of intermediaries.[11]

Who are the exiting intermediaries? The first column of Table 3 compares the auto export quantity of surviving and exiting intermediaries before and after the registration policy.[12] Surviving intermediaries had four times the exports of exiting ones[13] and the gap increased post regulation. On average, intermediaries export around 70% more after the registration policy. The remaining columns report results from a discrete hazard model which focuses on the probability of exit. Column (2) and (3) of Table 3 show that intermediaries with fewer auto exports are more likely to

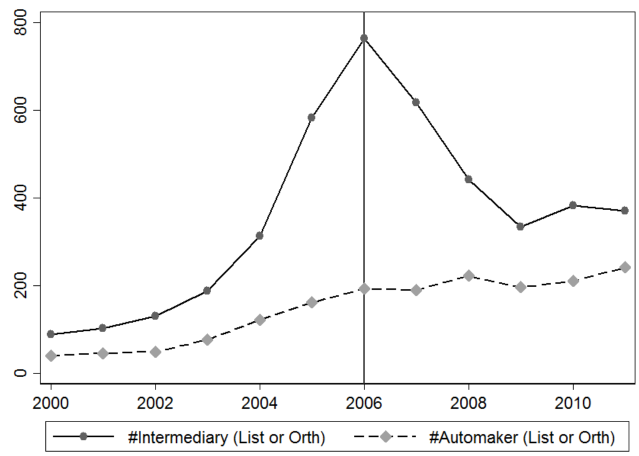
[10]How to identify intermediaries before policy? The cleanest way is to use the registration list. However, intermediaries shaken out by the policy can not be found on the list. Therefore, orthography provides additional information to identify intermediaries. We worry that orthography is not precise and might generate errors. In oder to make the numbers comparable pre and post regulation, orthography is also used to identify intermediaries in addition to the list after the registration policy. To remain consistence of the comparison, the same method is used to identify automakers as well. In sum, the number of automakers and intermediaries available in Figure 1 are identified by both registration list and orthography.

[11]The increasing number of intermediaries before 2006 mainly results from the deregulation of export trading rights. That is, before 1999 SOE intermediaries have monopoly trading rights. From 1999 to 2000, manufacturing firms were allowed to set up privately owned intermediaries if they exported more than 10 million USD in the previous year. Since 2001, domestic manufacturers were allowed to set up trade intermediaries as long as its registered capital was over 3 million RMB. (5 million RMB for non-manufacturers.) Details of the policy can be found in Chen and Li (2014).

[12]Other aspects of intermediary characteristics—not directly related with model predictions—are also compared and the results are presented in Appendix B.

[13]$q_{\text{stay}}/q_{\text{exit}} = e^{1.417} = 4.12$

Figure 1: Number of auto exporters



exit especially in the post policy period. However, the exit probability does not change significantly post regulation. The last two columns include additional control variables such as price, number of destination markets, number of products, and auto export share and their interactions with the *post* dummy. Intermediary's order size remains negatively related to exit while the scale of the effect becomes smaller.

2.3 Fact 3: Automakers are more likely to list same province intermediaries.

Figure 2 displays the geographic locations of automakers (top) and intermediaries (bottom) on the 2011 registry. There are two clusters of automakers around Hubei and Shandong provinces. Meanwhile, a slightly higher share of intermediaries are also found close to these clusters.[14]

Among the matched pairs on the registry, automakers are more likely to list intermediaries that are located in the same region.[15] Figure 3(a) illustrates that 38.16% of matched pairs are from the same province. And it is rare for automakers to list intermediaries located five or more provinces away. Although linked pairs are more likely to locate close to each other, as Figure 3(b) shows that the large share of same province match is not driven by linked pairs.[16]

[14] The northwest province Xinjiang turns out to be exceptional in hosting intermediaries. The reason is that the top destinations of auto exports from China are Russia, Iran, and Ukraine. Intermediaries choose to located in Xinjiang to get close to their customers. Similar fact is also described in Ganapati (2016) where wholesalers are found to ship products mainly to nearby destinations.

[15] Location information of automakers and intermediaries are extracted from their Customs IDs (i.e., first 2 digits for provinces and first 4 digits for cities). 88% of automakers and all intermediaries on the list have Customs IDs.

[16] As a reference point, random matches lead to less than 5% same province pairs (assuming intermediaries can be re-drawn). Prob(same prov) $= \sum_j \frac{N_{mj}}{N_m} \times \frac{N_{ij}}{N_i}$.

Table 3: Exiting vs surviving intermediaries

	Y=ln(q)	Y=Prob(exit)			
	(1)	(2)	(3)	(4)	(5)
	OLS	Hzd_LP	Hzd_Logit	Hzd_LP	Hzd_Logit
exit	-1.417^a				
	(0.111)				
post	0.567^a	-0.028	0.097	0.068	0.541
	(0.121)	(0.025)	(0.126)	(0.104)	(0.591)
exit×post	-0.663^a				
	(0.142)				
ln(q)		-0.073^a	-0.324^a	-0.040^a	-0.178^a
		(0.004)	(0.023)	(0.007)	(0.035)
post×ln(q)		-0.020^a	-0.189^a	-0.023^b	-0.175^a
		(0.006)	(0.038)	(0.010)	(0.053)
Control		N	N	Y	Y
N	4197	4197	4197	4197	4197
R^2	0.160	0.161		0.240	

Standard errors in parentheses. ^{c} $p < 0.1$, ^{b} $p < 0.05$, ^{a} $p < 0.01$.
Firm-year level regression with firm clusters.
Appendix B presents the regression results with the coefficients on control variables as price, the number of products, the number of markets, auto export share as well as their interactions with the *post* dummy.

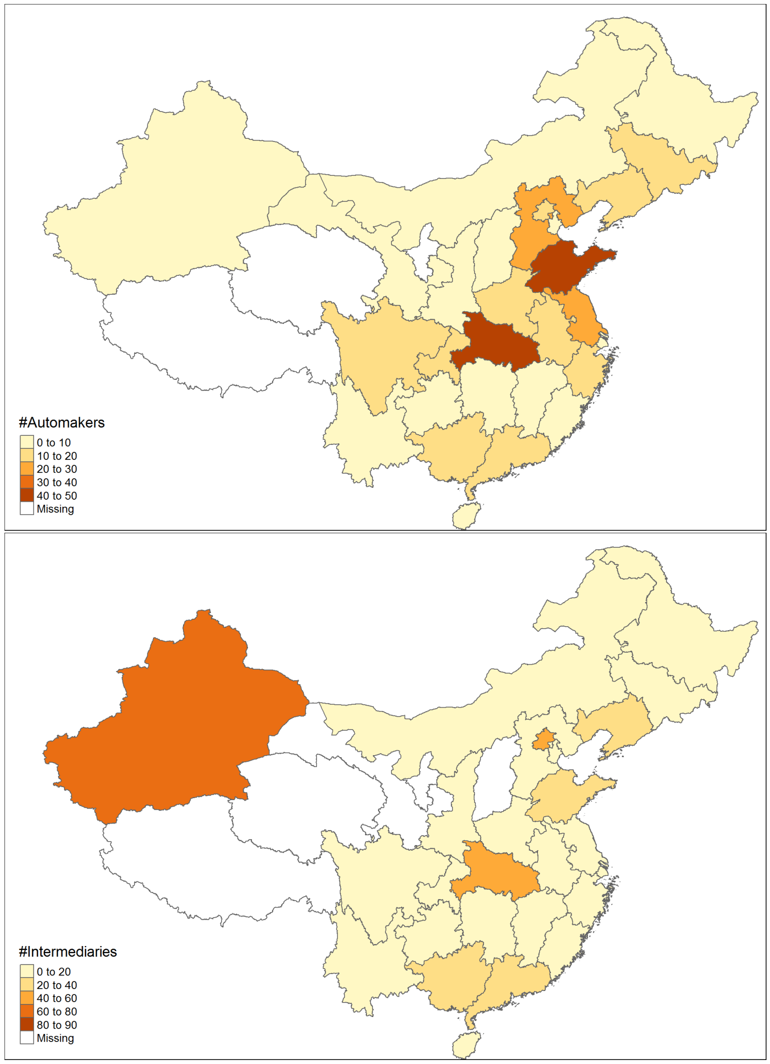
In addition, Figure 4 shows that long-term relationships tend to be local. That is, almost 60% of those pairs who maintain their relationships throughout the sample period are from the same province. On the contrary, hit-and-run relationships—automaker only list an intermediary once—present fewer same province matches.

Next, I investigate to what extent does locating in the same province or same city affect the probability of automaker-intermediary matches.[17] The first two columns of Table 4 show OLS regression results of distance in terms of same city, same province, and number of provinces apart dummies on the probability of automaker-intermediary matches. Automaker and intermediary fixed effects capture all the characteristics that affects the attractiveness of a firm. Being in the same province increases the probability of match by 5.3 percentage points while being in the same city further boosts the matching probability by 14.2 percentage points. The effects decay as the two partners become further apart. Coefficients from logit regressions suggest similar results. The odds ratio of pair match is 6.8 times larger if they locate in the same city.[18]

The model incorporates cost advantage of same region matches. The marginal cost of supplying

[17]For simplicity, I focus on the initial year of the registration list. According to the model, subsequent adjustments to the registration lists only result from updating the expectation of intermediary qualities. Robustness checks show

Figure 2: Geographic locations of automakers (top) and intermediaries (bottom) in 2011



an intermediary located in a different province is higher by τ compared with selling to same province intermediaries. To what extent same province is valued depends on the relative size of τ and differences in production costs.

similar patterns for other years.

[18]The scale of same city effect ($exp(1.918) = 6.8$) is much smaller than the same province effect due to the reason that same city effect is in addition to the same province effect. The OLS coefficients also suggest a larger odds ratio for same province dummies. That is, the OLS predicted same province odds ratio $= \frac{0.062/(1-0.062)}{0.009/1-0.009} = 7.3$ (where $0.062 = 0.009 + 0.053$) and same city odds ratio $= \frac{0.204/(1-0.204)}{0.062/(1-0.062)} = 3.9$ (where $0.204 = 0.062 + 0.142$).

Figure 3: Distance in terms of number of provinces apart

(a) All matched pairs (b) Non-linked pairs

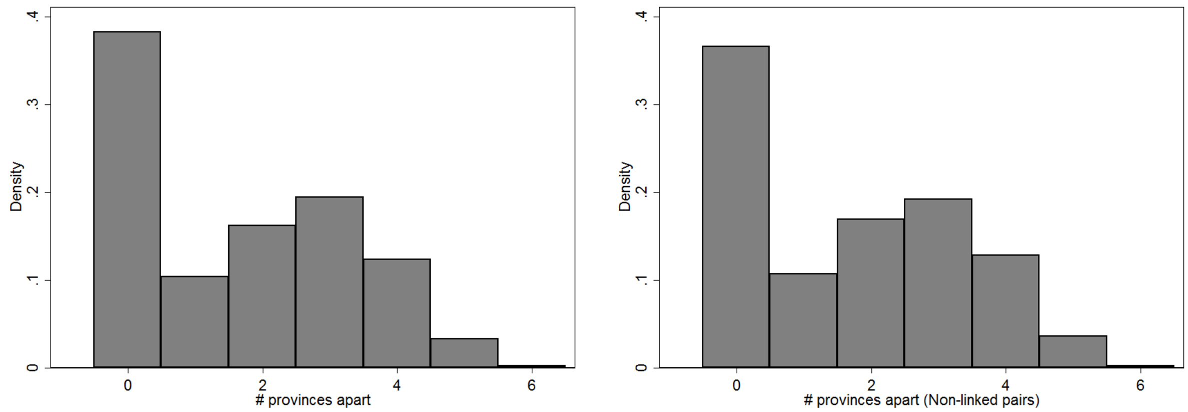
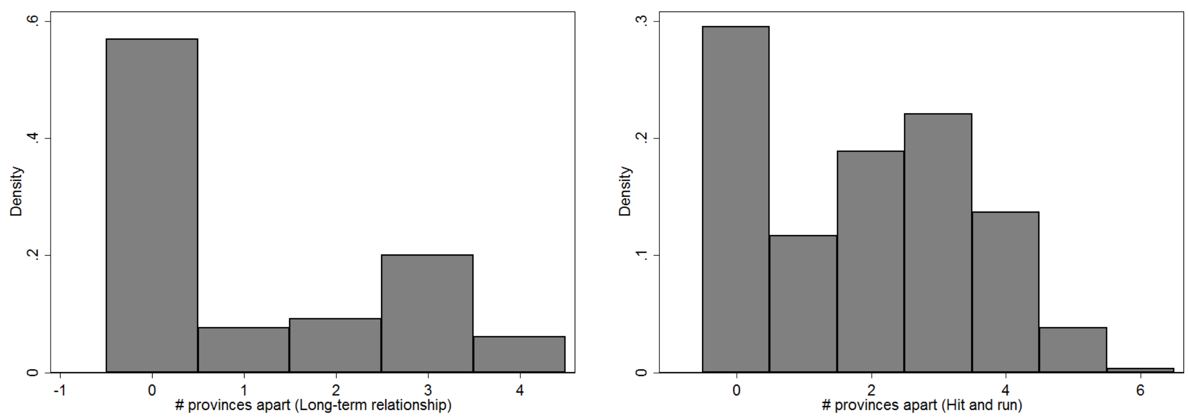


Figure 4: Long-term (left) vs Hit-and-run (right) relationships



2.4 Fact 4: Automakers rarely share intermediaries on the list.

In this subsection, the matching pattern among automakers and intermediaries on the registration list is examined. Most automakers list three (the maximum allowed by the regulation) intermediaries with the registry and their lists rarely overlap. Figure 5 depicts the number of automakers per intermediary and shows that 70% of intermediaries are listed by one automaker (instead of multiple automakers). In other words, each automaker generally lists a different set of intermediaries from other automakers.[19] This pattern is similar to what Blum et al. (2009) found with Chilean exporter and Colombian importer pairs. Blum et al. (2009) shows that most importers source from

[19]Those listed by multiple automakers tend to be linked intermediaries—subsidiaries of the automaker or the Corporate Group.

Table 4: Probability of automaker-intermediary matches 2007 (Y=1 if match)

	(1) OLS	(2) LI=0	(3) Logit	(4) LI=0
Same city	0.142^a	0.129^a	1.918^a	1.788^a
	(0.019)	(0.020)	(0.214)	(0.228)
Same province	0.053^a	0.057^a	14.006^a	14.365^a
	(0.006)	(0.007)	(0.464)	(0.670)
Adjacent province	0.010^a	0.013^a	11.369^a	11.790^a
	(0.004)	(0.004)	(0.507)	(0.738)
1-province apart	0.009^b	0.011^b	11.011^a	11.368^a
	(0.004)	(0.004)	(0.598)	(0.676)
2-provinces apart	0.008^b	0.010^b	10.908^a	11.144^a
	(0.004)	(0.004)	(0.535)	(0.715)
3-provinces apart	0.006^c	0.008^b	10.742^a	11.095^a
	(0.003)	(0.004)	(0.529)	(0.722)
4-provinces apart	0.005	0.007^c	10.536^a	10.940^a
	(0.004)	(0.004)	(0.560)	(0.743)
N	45746	40158	45746	40158
$\bar{Y}$	0.009	0.009	0.009	0.009
R^2	0.052	0.045		

Standard errors in parenthesis. ^{c} $p<0.1$, ^{b} $p<0.05$, ^{a} $p<0.01$
Automaker and intermediary fixed effects included. The longest distance between any two of Chinese provinces is 5 provinces apart and that is the omitted group in the regressions. Column (2) and (4) restrict the sample to non-linked (LI=0) pairs.

one exporter while only a few importers buy from multiple exporters.[20]

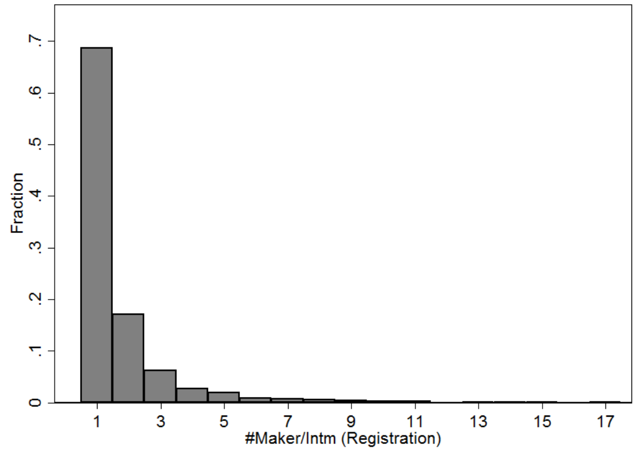
This matching result—each automaker listing a different set of intermediaries—is consistent with predictions of the proposed model. Intuitively, Bertrand competition among automakers gives advantage to the lowest cost automaker. A pair-specific search cost ensures that each intermediary has his lowest cost supplier which may be different from other intermediaries. Having in mind each intermediary's preference, automakers avoid listing intermediaries listed by other lower-cost automakers. This leads to the result that automakers rarely share intermediaries.

2.5 Fact 5: High drop rate and relationship to previous order size.

This subsection examines the persistence of automaker-intermediary partnerships over time and explores the importance of previous orders brought by an intermediary on his chances of being listed again. Table 5 shows that the pair-level drop rate ranges from 48% to 59% indicating frequent

[20] In Blum et al. (2009), the mean of Exporters per Importer is 1.6 and the median is 1.

Figure 5: # Automaker per Intermediary



churning of automaker-intermediary partnerships on the registry. Tybout et al. (2016) discovered similar patterns of non-trivial probability of eliminated connections when investigating the transitional relationship between wholesale exporters worldwide and Colombia footwear importers.

Table 5: No. of automaker-intermediaries pairs

Year	New	Continue	Dropped	Total	DropRate
2007	.	.	245	490	0.50
2008	566	245	391	811	0.48
2009	481	420	437	901	0.49
2010	463	464	550	927	0.59
2011	250	377	.	627	

I hypothesize that intermediaries are more likely to be dropped when they have lower quality, draw zero demand and fail to bring orders in the previous year. In other words, intermediaries with higher realized demand shocks previously are more likely to bring larger orders and stay on the list. Table 6 shows that an intermediary's probability of being listed by *any* automaker is positively affected by his previous order size. Columns (3) and (4) take the linkage between automakers and intermediaries into account. As expected, linked intermediaries are more likely to be listed and their previous performances in bringing orders play a smaller role in automakers' choice decisions compared with non-linked intermediaries. As a robustness check, the last two columns restrict the sample to non-linked intermediaries only. The results confirm that among non-linked intermediaries the impact of previous order sizes on chances of being listed is larger than the whole sample.

The model allows uncertainty in intermediary order draws each period. Specifically, since qualities of intermediaries are not observed, automakers are allowed to update their expectations of intermediary quality μ_i following a Bayesian updating process based on previous realized demand shocks of each intermediary. As a result of the uncertainty aspect of the model, substantial churning in the sets of intermediaries listed by automakers is observed. Higher order sizes in the previous years reflect intermediary quality and are valued by automakers when they choose whom to put on their lists.

Table 6: Probability of being listed again by any automaker

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	Logit	Logit	Logit	OLS LI=0	Logit LI=0
q_{it-1}	0.030^a	2.044^b	1.870^b	4.373^a	0.034^a	4.365^a
	(0.005)	(0.901)	(0.862)	(1.471)	(0.009)	(1.470)
LI			0.781^a	1.302^a		
			(0.265)	(0.280)		
$q_{it-1}\times$LI				-4.094^a		
				(1.480)		
N	1823	1823	1823	1823	1664	1664
R^2	0.036				0.032	

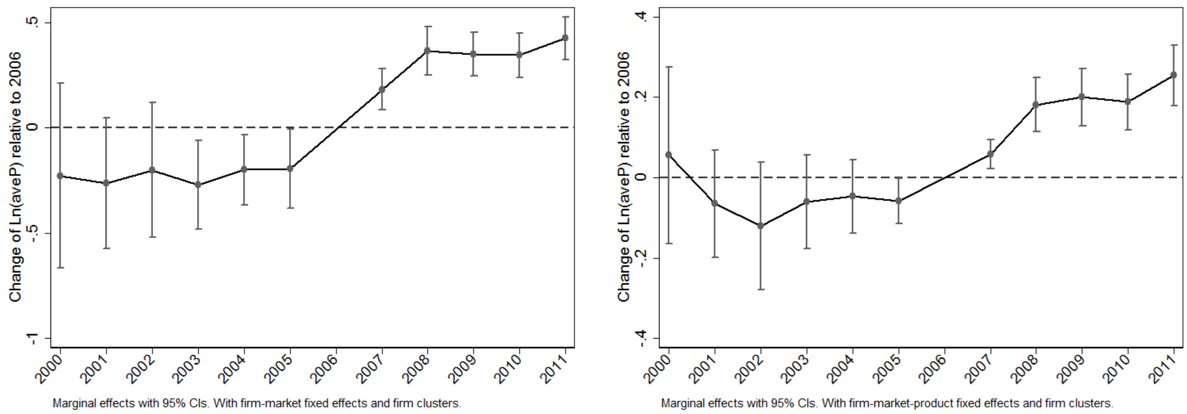
Standard errors in parentheses. ^{c} $p < 0.1$, ^{b} $p < 0.05$, ^{a} $p < 0.01$.
Intermediary-year level regression with year fixed effects and intermediary clusters.

2.6 Fact 6: Export prices of intermediaries rise post regulation.

Export prices of intermediaries are investigated with firm-market and firm-market-product fixed effects respectively. Figure 6(a) traces the average price of intermediaries at destination market level over time. With firm-market fixed effect, it demonstrates that the same intermediary would charge on average 50% (i.e., $e^{0.4}$=1.49) more post policy in markets he previously exported to. And this price increase is not fully driven by changes in product composition as shown in Figure 6(b) when an additional product layer is taken into consideration. In other words, when firm-market-product dummies are controlled in the regressions, the price increase post policy could possibly reflect higher unit cost, higher quality or higher markup rather than extensive margin effects. The model proposed in the next section predicts cost changes channeled through matching mechanism and structure of competition while holding product quality unchanged.

Figure 6: Average price changes of intermediaries

(a) Firm-market-year level (b) Firm-market-product-year level



2.7 Fact 7: Positive assortative matching among automakers and intermediaries.

The last stylized fact describes the characteristics of the matched partners. Positive assortative matching is observed from Table 7. That is, automakers with larger overall sales are matched with intermediaries who generate larger amount of auto export orders. Note that the overall sales of automakers include a variety of products, especially auto parts, besides completely assembled automobiles. One issue is that the sales of automakers may contribute to the export volume of their matched intermediaries. In order to partly address this issue, the lagged export value of intermediary i ($\ln(Q_{i0})$) right before he matches with any automaker is used as the dependent variable. Similarly, the pre-match sales $\ln(Sale_{s0})$ is used to represent the size of automakers.

Columns (2) & (3) take automaker-intermediary linkages into consideration. Linked pairs by nature are more likely to be matched with each other. Despite of shrinking slightly in scale, positive assortative matching still exists when the sample is restricted to non-linked pairs. Distance controls in terms of *Same city* and *Same province* dummies are included in the regressions. They no longer have significant effects because only matched pairs are taken into consideration.

Moreover, sales of intermediaries might be correlated with automakers sales over time when matches are permanent. To eliminate this built-in relationship, I restrict the sample to newly matched pairs. Results are shown in the last three columns of Table 7 and positive assortative matching remains strong. The scale of the coefficients become slightly smaller suggesting the existence of carried over sales between matched pairs over time. Linked pairs tend to have stable long-term relationships and are largely excluded from the new match sample. Bernard et al. (2014), in contrast, find negative assortative matching in terms of connectivity among Norwegian exporters and importers from other countries. That is, a well connected exporter has on average buyers with very few connections to other sellers. This paper focuses on matching in terms of firm size instead of connections since the latter is restricted by the registration policy.

Table 7: Assortative matching Y = $\ln(Q_{i0})$

	(1) All	(2) All	(3) LI=0	(4) NewMatch	(5) NewMatch	(6) LI=0
$\ln(Sale_{s0})$	0.481^a	0.411^a	0.436^a	0.406^a	0.396^a	0.397^a
	(0.045)	(0.044)	(0.044)	(0.060)	(0.060)	(0.060)
Same province	0.261	0.248	0.369	0.118	0.111	0.120
	(0.225)	(0.222)	(0.240)	(0.285)	(0.285)	(0.298)
Same city	0.291	0.103	0.133	0.502	0.484	0.545
	(0.290)	(0.290)	(0.314)	(0.428)	(0.427)	(0.434)
LI_{is}		1.676^a			0.466	
		(0.277)			(0.602)	
N	1348	1348	1169	494	494	469
R^2	0.126	0.179	0.118	0.102	0.104	0.098

Standard errors in parentheses. ^{c} $p < 0.1$, ^{b} $p < 0.05$, ^{a} $p < 0.01$.
The dependent variable Y = $\ln(Q_{i0})$ stands for the order size of intermediary i before he matches with any automaker in the next period. Similarly, $\ln(Sale_{s0})$ represents the size of automaker s pre-match.
Automaker-intermediary-year level regression with year fixed effects and pair clusters.

Table 8 summarizes the stylized facts and relates each of them to a brief description of modeling features. The model developed in the next section is motivated by institutional information (i.e., timing of the registration and realization of export orders) and Fact 1 (granular orders received by intermediaries). In particular, intermediaries are endowed with heterogeneous quality μ_i. Intermediary-specific shock, A_i, is distributed Poisson[21] with parameter μ_i and can be zero. An intermediary with a demand shock of zero will not bring any export orders. The other facts are consistent with model predictions.

[21]The Poisson distribution can generate frequent zero and small discrete order sizes. That is, the order generation process can be modeled by a binomial distribution with two parameters capturing the probability of obtaining positive foreign orders and number of intermediaries in the market. It converges towards the Poisson distribution as the number of intermediaries becomes large while the probability of receiving positive orders remains low. The heterogeneous quality μ_i predicts more skewed right distribution than the Poisson with homogeneous quality. This is consistent with Figure 7.

Table 8: Summary of stylized facts and model features

Stylized facts	Model features
Fact 1 Granular orders (2.1)	Poisson process with intermediary quality μ_i.
Fact 2 Small firms exit (2.2)	Automakers pick stronger intermediaries.
Fact 3 Same province match (2.3)	Higher probability to list same province intermediaries.
Fact 4 1:m match (2.4)	Market partition arises endogenously from the model.
Fact 5 High drop rate (2.5)	Uncertain intermediary quality with Bayesian updates.
Fact 6 Price increase (2.6)	Policy reduces match efficiency and induces double marginalization.
Fact 7 Assortative matching (2.7)	Assortative matching always characterizes some equilibrium and with certain parameters it captures all equilibria.

3 A model of automaker-intermediary matches

A model featuring the matching process among automakers and intermediaries is developed in this section. I start with the basic setup and assumptions of the model. Pre-regulation order allocation and pricing strategies are discussed next. Then I introduce the matching and pricing game with registration requirements. Results based on Nash Equilibrium are analyzed.

3.1 Model setup and assumptions

Automakers (or sellers) with production cost c_s^0 are assumed to produce homogeneous products. The marginal cost of automaker s selling to an intermediary i depends on the geographic locations of the pair, i.e.,

$$c_s = c_s^0 + \tau D_{is}$$

where D_{is} equals 0 if they locate in the same region and 1 if in different regions. There is no capacity constraint for automakers. The market structure is assumed to be Bertrand competition among automakers for orders brought by intermediaries. That is, automakers make simultaneous offers to each intermediary i and intermediaries always favor the lowest price offered by automakers.[22]

Intermediaries are endowed with quality μ_i which is higher if an intermediary has a larger business network or is better connected to potential automobile buyers abroad. A_i is an intermediary-

[22]Automakers do not compete with each other by offering price-quantity menu contracts to intermediaries. The lowest cost automaker could always offer the second lowest price to intermediaries with any quantity they bring pre-regulation, making other offers unattractive to intermediaries. Such menu competition has not been observed practically, suggesting it is not used. It might be too complicated to make the offers and too difficult to enforce the contracts.

specific demand shock that depends on μ_i and it is randomly drawn from the Poisson distribution, i.e.,

$$A_i \sim \text{Poisson}(\mu_i).$$

Intermediaries are monopolistic competitors with CES demand in the foreign market.[23] Suppose the price intermediary i offers to foreign buyers is $p_i(s)$, then the demand for that intermediary becomes

$$q_i(s) = A_i \cdot p_i(s)^{-\sigma} \cdot X\mathbb{P}^{\sigma-1}$$

where $\mathbb{P} = [\sum_i A_i \cdot p_i(s)^{1-\sigma}]^{1/(1-\sigma)}$ and X is the total expenditure of automobiles in the foreign market. The realization of intermediary-specific demand shock A_i introduces randomness so that demand is not pre-determined by price (which is a function of production cost). Intermediaries could receive zero export orders purely because of a bad demand shock rather than sourcing from a high cost producer. This implication is in line with Eaton et al. (2012).

Maximizing its profit, intermediary i will price at

$$p_i(s) = \frac{\sigma}{\sigma - 1} \cdot p_s$$

That is, intermediary i charges a constant markup to its marginal cost—price offered by automaker s, p_s.[24]

Export transactions in this model are initiated by foreign buyers and automakers are unaware of the occasional demand abroad. Intermediaries are the ones who connect with foreign buyers and receive the demand shocks modeled by A_i. They secure the demand and then contract with the automaker offering the lowest cost of filling the order. Therefore, intermediaries play an active role in bringing orders to automakers rather than passively serving producers and economize on fixed costs of exporting as modeled in previous studies.[25] Given little brand recognition of Chinese auto-

[23] Intermediaries and direct exporting automakers serve different consumers and they each fit a different niche in the export market. Since the main emphasis of this paper is the matching among automakers and intermediaries, I will focus on indirect exports of intermediaries only and assume away its interactions with direct exporters.

[24] No fixed cost of entry is assumed for intermediaries because cost associated with business presence in a foreign market is usually country-specific rather than product-specific. Moreover, even if the fixed cost is product-specific, for the majority of intermediaries the share of auto exports is very low (as shown in Section 2.1) which indicates a rather small fixed cost easy to be covered.

[25] For example, in Ahn et al. (2011) firms could choose to pay a fixed cost to match with an intermediary and get access to all foreign markets. Intermediaries are assumed to be homogeneous in their model.

mobiles and a large number of automakers, it is reasonable for foreign buyers to hire intermediaries to help with finding the best supplier.[26]

Consistent with the pre-regulation environment, the number of intermediaries is assumed to be at least three times larger than the number of automakers, i.e., $N > 3M$. If s is the only automaker who competes for intermediary i, that automaker sets the monopoly price. If multiple automakers compete for the same intermediary, the automakers engage in Bertrand competition and set the price at the minimum between the second lowest and monopoly price. The following two scenarios analyze demand, pricing strategies, and profits for both automakers and intermediaries in the above two situations.

Scenario 1: s is the only automaker who deals with i. (Monopoly)

In this situation, automaker s maximizes its profit and sets monopoly price for i:

$$p_s = \frac{\sigma}{\sigma - 1} \cdot c_s$$

Given p_s, the price intermediary i charges to foreign buyer is:

$$p_i(s) = \frac{\sigma}{\sigma - 1} \cdot p_s = \left(\frac{\sigma}{\sigma - 1}\right)^2 \cdot c_s$$

Demand received by intermediary i is:

$$q_i(s) = A_i \cdot \left(\frac{\sigma}{\sigma - 1} \cdot c_s\right)^{-\sigma} \cdot \kappa M = A_i \cdot c_s^{-\sigma} \cdot \kappa^2 M$$

where $\kappa = (\frac{\sigma}{\sigma-1})^{-\sigma}$ and $M = X\mathbb{P}^{\sigma-1}$. This means that foreign orders received by intermediary i depends on its realized quality A_i as well as the efficiency (or cost) of its matched automaker. The multiplicative demand consists of both A_i and c_s also indicates that high quality intermediaries bring more demand for automakers and especially those with low costs. The profit of automaker s

[26] Anecdotal evidence is provided by agents working in Chinese trading firms. The role of intermediary tends to be agents hired by foreign buyers in search of qualified suppliers. This type of business model is not uncommon in China and Midler (2010) records a rich variety of illustrations.

decreases with its cost c_s and increases with intermediary quality A_i, i.e.,

$$\pi_s(i) = (p_s - c_s) \cdot q_i(s) = \frac{1}{\sigma - 1} \cdot c_s^{1-\sigma} \cdot A_i \cdot \kappa^2 M.$$

Similarly, the profit of intermediary i becomes

$$\pi_i(s) = \frac{1}{\sigma - 1} \cdot p_s \cdot q_i(s) = \frac{\sigma}{(\sigma - 1)^2} \cdot c_s^{1-\sigma} \cdot A_i \cdot \kappa^2 M.$$

Scenario 2: intermediary i deals with multiple automakers. (Bertrand)

If multiple automakers favor the same intermediary i, they engage in Bertrand competition. If automaker s has the lowest cost, it will set price to the cost of that intermediary i's next lowest cost automaker s', i.e.,

$$p_s = c_{s'}.$$

Consider the situation where $c_{s'}$ is large enough to exceed the monopoly price which generates the most profit for automaker s. In that case, automaker will set the price at whichever is lower. That is,

$$p_s = \min\{c_{s'}, \frac{\sigma}{\sigma - 1} \cdot c_s\}.$$

If seller s sets the monopoly price, then the following analysis will be the same as in Scenario 1. If cost differences are relatively small compared to automaker's monopoly power, price will be set at the cost of s'. Given p_s, the price intermediary i charges to foreign buyer is:

$$p_i(s) = \frac{\sigma}{\sigma - 1} \cdot p_s = \frac{\sigma}{\sigma - 1} \cdot c_{s'}.$$

Demand received by intermediary i becomes

$$q_i(s) = A_i \cdot c_{s'}^{-\sigma} \cdot \kappa M.$$

The lowest cost automaker s makes profit

$$\pi_s(i) = (c_{s'} - c_s) \cdot q_i(s) = (c_{s'} - c_s) \cdot A_i \cdot c_{s'}^{-\sigma} \cdot \kappa M.$$

There is a trade-off for automaker's profit: on the one hand, automaker s would prefer its competitor s' to have a high cost so that the markup will be high; on the other hand, $c_{s'}$ has to be low enough to bring enough demand. Profit is always lower in Bertrand competition (with the same intermediary) where $p_s = c_{s'} < \frac{\sigma}{\sigma-1} \cdot c_s$. Finally, the profit of intermediary i is

$$\pi_i(s) = \frac{1}{\sigma - 1} \cdot c_{s'} \cdot q_i(s) = \frac{1}{\sigma - 1} \cdot c_{s'} \cdot A_i \cdot c_{s'}^{-\sigma} \cdot \kappa M.$$

3.2 Pre-regulation: pricing and order allocation

Timing of the pre-regulation game is as follows:

1. Intermediaries draw idiosyncratic demand shifter A_i.
2. Automakers offer prices p_s to supply intermediaries (based on Bertrand competition).
3. Intermediaries distribute orders to automakers.

Before the regulation, Bertrand competition leads to a Nash equilibrium where each intermediary matches with his lowest cost automaker. The lowest cost automaker may be within the region or outside the region, depending on the cost of procurement across regions, τ. This pre-regulation matching is efficient in the sense that intermediaries all source from their lowest cost producer(s).

3.3 Post-regulation: pricing and order allocation

The introduction of registration requirements restricts the maximum number of matches to three for each automaker and changes the sequence of decision making. The timing of post-regulation game is as follows:

1. Automakers observe previous demand shocks of intermediaries and form expectations about their quality.
2. Automakers list at most three intermediaries with the registry.
3. Intermediaries draw demand shifters A_i as before.
4. Automakers offer prices to supply intermediaries.
5. Intermediaries distribute orders to automakers.[27]

[27] Intermediaries can only source from automakers who list them with the registry.

The post-regulation equilibrium concept is perfect Bayesian for both the listing and pricing game. In equilibrium, each automaker lists three intermediaries and no lists contain common intermediaries. In other words, market division arises endogenously from the regulation. Automakers will not list the same intermediary because if they do, they engage in Bertrand competition and automakers with higher costs get nothing. It is subgame perfect in the sense that intermediaries will always turn to the lower cost automakers if they are listed by multiple ones. Backward induction predicts that automakers will avoid listing the same intermediary.

The pricing game is (trivially) part of a perfect Bayesian equilibrium. Specifically, this game leads to monopoly pricing in the pricing stage since prices are set after matching by which time market has already been divided and intermediaries do not have alternative automakers to source from. Given an arbitrary partition of intermediaries, an automaker changing its list (to compete with a rival for a better intermediary) would be trading a monopoly profit for a Bertrand profit. If a Bertrand profit with a higher quality intermediary is larger than the current monopoly profit with a lesser intermediary, the automaker with the lower cost would deviate and enter the weaker rival's market to compete for the high quality intermediary.

For some parameter values, the model generates the positive assortative matching equilibrium where the lowest cost automakers match with the intermediaries expected to generate the highest orders. It also yields a large number of equilibria where assortative matching does not obtain. Conditions under which assortative matching is supported are discussed below. Assortative matching always characterizes some of the equilibria and under certain parameters, it is the only equilibrium.

Conditions for assortative matching

Suppose the current arbitrary market division is converse to positive assortative matching: automaker s matches intermediary 2 with A_2 and automaker s' matches intermediary 1 with A_1, where $A_1 > A_2$ and $c_s < c_{s'}$. The question is whether automaker s wants to deviate from the current monopoly situation with intermediary 2 to engage in Bertrand competition with s' for the higher quality intermediary 1. If automaker s stays with current market division, it will get

$$\pi_s(2) = \frac{1}{\sigma - 1} \cdot c_s^{1-\sigma} \cdot A_2 \cdot \kappa^2 M.$$

If automaker s deviates to compete with s' for A_1, its profit would be

$$\pi_s(1) = (c_{s'} - c_s) \cdot A_1 \cdot c_{s'}^{-\sigma} \cdot \kappa M.$$

The first case to consider is when Bertrand competition posits a binding restriction, i.e., $p_s = c_{s'} < \frac{\sigma}{\sigma-1} \cdot c_s$. Non-sssortative matching is ruled out if

$$\pi_s(1) > \pi_s(2),$$

i.e.,

$$\underbrace{\frac{A_1}{A_2}}_{>1} \cdot \underbrace{\frac{(c_{s'} - c_s)}{\frac{1}{\sigma-1} \cdot c_s}}_{<1} \cdot \underbrace{\frac{c_{s'}^{-\sigma}}{(\frac{\sigma}{\sigma-1} \cdot c_s)^{-\sigma}}}_{>1} > 1.$$

This condition is satisfied if variation in quality is large and the second lowest cost gets closer to the monopoly price.

A second case occurs when Bertrand price is not binding, i.e., $p_s = \frac{\sigma}{\sigma-1} \cdot c_s < c_{s'}$ and automaker s becomes better off to charges monopoly price. The profit of automaker s will always increase by switching from intermediary 2 to higher quality intermediary 1.

This discussion shows that non-assortative matching may not be equilibria whereas assortative matching is always an equilibrium. Also, we could get partial assortative matching if the above conditions are met by some pairs but not by the others.

3.4 Post-regulation: welfare analysis

Automakers. The lower cost automakers favored by intermediaries pre-regulation will likely be worse off post-regulation because although they charge weakly higher prices, some lose intermediary business due to the registration that limits relationships to three. But if the distribution of intermediary quality is very skewed and those being dropped would not bring many orders anyway, their elimination will not have a large effect on the profit of the low cost sellers. Whether or not the lower cost automakers become worse off depends on the trade-off between higher markup and fewer orders. Some high-cost automakers who did not receive business prior to the policy and now serve intermediaries are better off.

Intermediaries. Intermediaries of lowest qualities are not listed by any automaker. The regulation mechanically cut the number of intermediaries from N to $3M$. The remaining intermediaries are worse off as well since they are faced with higher costs for two reasons: 1) all but three lose access to the low-cost automaker and 2) they face monopoly rather than Bertrand prices. Therefore, the total profits for intermediaries are decreasing post-regulation.

Aggregate profit. Since the downstream intermediaries engage in monopolistic competition (MC) for foreign buyers and the upstream competition among automakers changes from Bertrand to MC, the integrated market structure for Chinese automobile exporters to compete for foreign buyers is subject to double marginalization post-regulation (rather than the one layer markup pre-regulation). This acts to reduce aggregate profits.

Let us imagine the special case of perfect competition among automakers pre-regulation (i.e., zero cost variation). Buying from the lowest cost automaker with price set at the second lowest cost is the same as buying from any automaker (with second lowest cost $c = c_{s'}$). Intermediaries are the only ones who mark up the prices to foreign buyers. Total profit π^{Pre} generated by each automaker-intermediary pair with cost c and quality A is

$$\pi^{Pre}(c) = \frac{1}{\sigma - 1} \cdot A \cdot c^{1-\sigma} \cdot \kappa \cdot M.$$

With market division post-regulation, automakers with cost c price at $\frac{\sigma}{\sigma-1} \cdot c$ and total profit of the same automaker-intermediary pair becomes

$$\pi^{Post}(c) = \left[\left(\frac{\sigma}{\sigma - 1}\right)^2 - 1\right] \cdot A \cdot c^{1-\sigma} \cdot \kappa^2 \cdot M.$$

Therefore, the profit difference $\Delta\pi$ is

$$\Delta\pi = \pi^{Post}(c) - \pi^{Pre}(c) = A \cdot c^{1-\sigma} \cdot \kappa \cdot M \cdot \left(\rho\kappa - \frac{1}{\sigma - 1}\right) < 0$$

where $\rho = (\frac{\sigma}{\sigma-1})^2 - 1$.

Next, we move on to consider the case where automaker costs are heterogeneous and they charge

$p_s = \frac{\sigma}{\sigma-1} \cdot c'$ where $c' \geq c$. The total profit of an automaker-intermediary pair becomes

$$\pi^{Post}(c') = \rho \cdot A \cdot (c')^{1-\sigma} \cdot \kappa^2 \cdot M.$$

The ratio between post and pre regulation profits can be expressed as

$$\frac{\pi^{Post}(c')}{\pi^{Pre}(c)} = \left(\frac{c}{c'}\right)^{\sigma-1} \cdot (\sigma - 1) \cdot \rho\kappa < 1.$$

Thus, total profits for all the newly formed automaker-intermediary pairs are decreasing. For the already existing partnerships including the lowest cost automakers, total profits stay the same if monopoly prices are lower than Bertrand prices (i.e., $\frac{\sigma}{\sigma-1} \cdot c_s < c_{s'}$) and decrease if Bertrand prices are binding (i.e., $c_{s'} < \frac{\sigma}{\sigma-1} \cdot c_s$).

Inefficiencies also arise from non-assortative matching equilibrium where a high cost automaker is matched with a high quality intermediary who otherwise generates more profits with a lower cost automaker. In addition, intermediaries who are weeded out by the regulation no longer generate profits. Aggregate profit decreases post-regulation.

3.5 Bayesian updating process

The model allows uncertainty in intermediary demand shock (A_i) based on its quality μ_i, Bayesian updating process is introduced to facilitate the formation of intermediary quality expectations. To fully describe the updating process, a prior distribution of model parameters needs to be specified. Usually a conjugate prior will be chosen due to algebraic convenience, providing a closed-form expression for the posterior. Given that intermediary qualities are assumed to follow a Poisson distribution with parameter μ_i, a natural prior choice is the Gamma distribution,

$$\mu_i \sim \text{Gamma}(\alpha_0, \beta_0), \forall i.$$

Then the sampling model given μ_i can be specified as

$$A_i^t | \mu_i \sim \text{Poisson}(\mu_i).$$

Although automakers do not observe μ_i, they know these parameters are drawn from a Gamma distribution with hyper-parameters (α, β). Therefore, automakers could use realizations of previous demand shocks (A^1, A^2, A^3) to estimate (α, β) based on the assumption that A_i^t are i.i.d.[28] and

$$\begin{cases} \alpha = v - m \\ \beta = \frac{v}{m} - 1 \end{cases}$$

where $m = \text{Mean}(A^{pre})$, $v = \text{Var}(A^{pre})$, and $A^{pre} = \{A^1, A^2, A^3\}$.[29]. $A^t = \{A_1^t, A_2^t, \cdots, A_n^t\}$ is used to summarize observed demand shocks of intermediaries in each period. And $t = 1, 2, 3$ indicates pre-regulation periods while $t = 4, 5, 6$ stands for post-regulation years.

Once the estimated priors (α, β) are obtained, automakers are able to update the expected quality of each intermediary (μ_i) based on *its* previous realized demand shocks $\{A_i^1, A_i^2, A_i^3\}$,

$$E(\mu_i^t | A_i^{t-1}) = (\alpha + \sum_{t=1}^{t-1} A_i^t)/(\beta + t - 1)$$

where $t = 4, 5, 6$.

Two assumptions worth mentioning are implicitly incorporated into the model. First, automakers are assumed to share the same expectation of intermediary qualities. Common expectations help simplify the model solution while preserving key features of the matches. Second, the model assumes that realized demand shocks of intermediaries who were not listed by any automaker on the registry cannot be observed. Automakers only use the last observed realized sales to form expectations.

4 Simulation

In this section, I simulate the model to see if it delivers results that are consistent with stylized facts of the industry described in Section 2. The simulation follows the order of steps shown in

[28] Although qualities are not directly observed by automakers, costs of automakers, general market conditions, matches among automaker and intermediaries and orders generated by intermediaries are common knowledge. Automakers can perfectly infer intermediary qualities based on these revealed information at the end of each period. For simplicity, I model automakers to update A_i directly.

[29] The equations used to estimate hyper-parameters (α, β) are derived from the predictive Negative-binomial distribution of A_i^t. Details of the deduction can be found in Appendix C.

Section 3.2 and Section 3.3. Specifically, each intermediary sources from the lowest cost automaker to him pre-regulation.[30]

In the post-regulation periods, automakers form common expectations about the orders that intermediaries will deliver based on previously observed orders and the Bayesian updating process. If the cost of selling across regions τ is zero, the ranking of automakers is shared by all the intermediaries. Then the lowest-cost automaker that has not filled its registry lists the three available intermediaries that are expected to bring the largest orders. Automakers do not list intermediaries that already are chosen by lower-cost automakers because Bertrand competition implies that they would not get the orders of this intermediary. Once the registry lists are established, intermediaries realize demand shifters, automakers offer prices to supply intermediaries, and final prices and profits are obtained.

If τ is large enough to make the lowest-cost automakers different across regions, the simulation procedure is slightly adjusted to incorporate τ. Specifically, intermediaries ranking from high to low based on their expected order sizes take turns to fill one of the three registration slots of his lowest cost automaker available. For example, if the first three intermediaries prefer the same automaker, that automaker is no longer available for other intermediaries to choose from. The registry is established once all the automaker slots are filled.

The simulations assume assortative matching for the following reasons. First, assortative matching always characterizes some equilibria and with certain parameters it is the only equilibrium. Second, it is natural to consider assortative matching since efficient automakers are more motivated to spend a little effort to list people early and they would match with the best intermediaries. Finally, it is the best case scenario for government policy in terms of total surplus.

I will begin with a brief discussion of parameter values chosen in the simulation and then move on to present the simulation results.

4.1 Choice of parameters

Table 9 presents a list of parameters used in the simulation and the values chosen for each of them.

The parameters governing the Gamma distribution of intermediary qualities (μ_i) are chosen to

[30] Due to the cost of selling across regions τ, intermediaries located in different regions may not share the same lowest cost automaker.

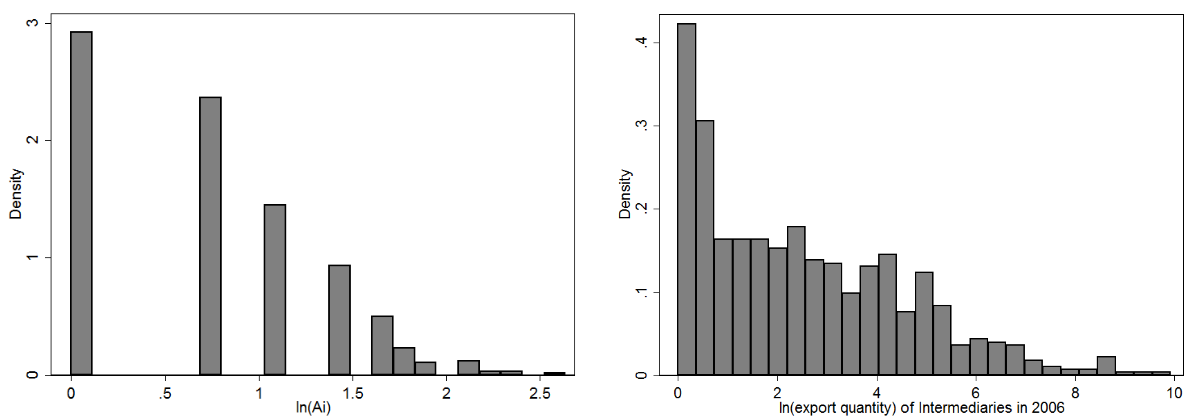
Table 9: Description of model parameters

Parameter	Description	Value
(α_0, β_0)	parameters of Gamma distribution	(2,1)
M	number of automakers	3, 3, 4[a]
N	number of intermediaries	16, 16, 18
c_s^0	automaker production cost	$c_s^0 \sim N(0.8, 0.01)$
τ	cost of selling across regions	$\tau = 2\% \times c_s^0$
σ	demand elasticity	3[b]

[a] It lists the number of automakers in each of the three regions.
[b] Broda and Weinstein (2006) estimate the demand elasticity for Motor Cars and Other Motor Vehicles in the US to be 3. κM is normalized to 1.

match the distribution of intermediary order sizes which is granular and highly skewed. However, one difficulty is that the intermediary demand shock A_i (based on μ_i) can not be directly observed. Recall that the orders brought by intermediary i pre-regulation is $q_i(s) = A_i \cdot c_s^{-\sigma} \cdot \kappa M$. Since in the pre-regulation period, intermediaries tend to choose the same automaker to fill their orders, variations in c_s is small and variations in A_i is required to explain variations in $q_i(s)$. Setting $\alpha_0 = 2$ and $\beta_0 = 1$ generates the necessary skewness and variation in A_i as shown in the left panel of Figure 7. The right panel of Figure 7 shows the real distribution of intermediary order size for comparison.[31]

Figure 7: Intermediary demand shock (simulation) vs order size (data)



The number of automakers and intermediaries are set to 10 and 50 respectively.[32] They are

[31] Appendix C provides a detailed explanation of how α_0 and $beta_0$ are associated with the skewness of the distribution and the relative importance of priors in the Bayesian updating process.

[32] Before registration is required for auto exporters, automakers and intermediaries do not identify themselves. This posits challenges for researchers to determine the ratio of automakers and intermediaries who would potentially handle auto exports. The registration lists provide some hints and when combined with firm name orthography,

randomly assigned to 3 different regions. Each region receives roughly the same number of automakers and intermediaries (shown in Table 9). Costs are generated from normal distribution $c_s \sim N(0.8, 0.01)$. In order to address the effect of intermediary quality, the costs of automakers are scaled down. The cost of selling across regions is assumed to be 2% the cost of production. That is, $\tau = 2\% \times c_s^0$. In the simulation, the pre-regulation same-region matches accounts for 36% while the share of same region matches ranges from 33% to 43% post-regulation. Elasticity of substitution σ is assumed to be 3 which represents a 50% monopoly markup.[33] The product of demand elasticity and total automobile expenditure in the foreign country, κM, is normalized to 1. As mentioned previously, three periods before and three after the policy are simulated.

4.2 Simulation results

Simulation results corresponding to model predictions and stylized facts described in Section 2 are presented in this subsection.

First, the number of intermediaries with positive orders and their probability of exiting are examined. Figure 8 presents the drop of intermediaries right after the policy. It is mainly driven by the limited number of intermediaries allowed to be listed by each automaker on the registration. The slightly increasing number of intermediaries post regulation results from the fact that automakers have more accurate information about intermediary qualities due to Bayesian updating process. It enables automakers to list intermediaries who are more likely to bring orders.

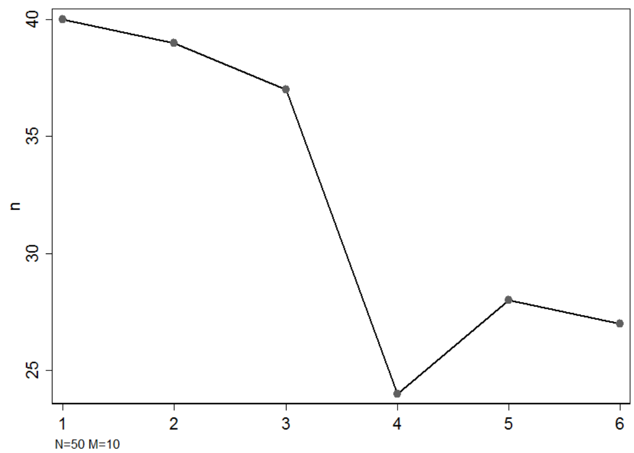
Consistent with the stylized facts, exiting intermediaries in the simulation have fewer automobile export orders both before and after the regulation (Table 10). Intermediaries post regulation on average bring fewer orders than their pre-regulation counterparts. This is caused by increases in wholesaler prices. The last three columns of Table 10 indicate that intermediaries with larger export sales are less likely to exit which is consistent to Fact 2 shown in section 2.2. However, in the simulation the disadvantage of smaller intermediaries is not getting worse post-regulation.

Table 11) provides information on the persistence of matches. The drop rate of automaker-intermediary relationships is as high as 57% according to the simulation which matches the observed

several implications could be made to estimate the boundaries of this ratio. To make the paper succinct, discussions regarding the ratio are presented in Appendix D.

[33] $\sigma = 3$ is borrowed from Broda and Weinstein (2006) which estimates the elasticity of substitution for Motor Cars and Other Motor Vehicles in the US.

Figure 8: Number of intermediaries



scale of drop rate in data. The matches dissolve as automakers update priors. High level of dissolution is mainly driven by the large number of small intermediaries who would bring orders occasionally and make it difficult for automakers to determine whom to put on the list.

Next, simulation results on prices received by intermediaries are analyzed. Since intermediaries charge a constant markup when they sell to foreign buyers, changes in intermediary exporting prices should share the same pattern with wholesale prices. Among the 30 intermediaries out of 50 listed in all periods, only 3 of them remain matched with their lowest cost automaker. All the other intermediaries will source from a less efficient automaker and prices will rise. Therefore, the first source of price increase comes from inefficiencies in matching. The second source of price increase comes from the structure of competition. Automakers shift from Bertrand competition pre-regulation to monopoly pricing post-regulation due to market division endogenously implemented by the regulation.

Figure 9 shows that on average prices received by intermediaries increase post-regulation. Specifically, wholesale prices are about 65% ($e^{0.6} - 1$=0.65) higher than before. Provided that cost variation is set small in the simulation, the margin of price increase is mainly driven by monopoly pricing with a 50% markup ($\sigma = 3$).[34]

[34]The 2% search cost is not high enough to prevent intermediaries from sourcing from the most efficient seller even if that seller locates in a different region. Since matches in pre-regulation periods do not change, there is no wholesale price variation for intermediaries then.

Table 10: Exiting vs surviving Intermediaries

	Y=ln(q)	Y=Prob(exit)		
	(1)	(2)	(3)	(4)
	OLS	Hzd_LP	Hzd_logit	Hzd_probit
exit	**-0.582**^{a}			
	(0.137)			
post	-1.359^a	-0.313^a	-2.710^a	-1.522^a
	(0.092)	(0.060)	(0.866)	(0.431)
exit×post	0.156			
	(0.214)			
ln(q)		**-0.223**^{a}	**-1.562**^{a}	**-0.882**^{a}
		(0.050)	(0.447)	(0.241)
post×ln(q)		0.129^c	0.309	0.184
		(0.067)	(0.670)	(0.358)
_cons	0.580^a	0.332^a	-0.785^a	-0.471^a
	(0.095)	(0.048)	(0.221)	(0.133)
N	169	169	169	169
R^2	0.508	0.130		

Standard errors in parentheses. ^{c} $p < 0.1$, ^{b} $p < 0.05$, ^{a} $p < 0.01$.
Intermediary-year level regression with intermediary clusters.

Table 11: # of Automaker-Intermediaries pairs

t	New	Continue	Dropped	Total	DropRate
4	.	.	17	30	0.57
5	17	13	13	30	0.43
6	13	17	.	30	

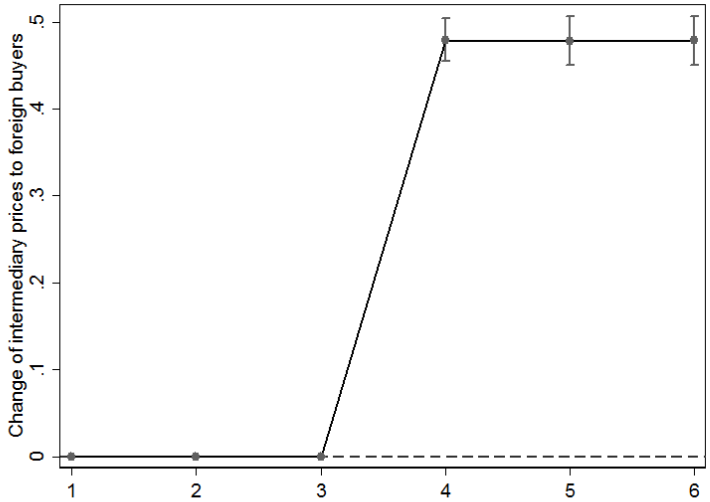
Welfare in terms of total industry profits.

As discussed before, the lower cost automakers who receive orders pre-regulation will likely be worse off post-regulation because of lost orders since the registration limits the relationships to a maximum of three. But if the distribution of intermediary quality is very skewed and those being dropped would not bring many orders anyway, dropping them will not have a large effect on the profit of the lowest cost seller. The grey dash line in Figure 10 shows profits of the lower cost automakers who receive orders pre-regulation.[35]The pre-regulation profits are determined by the quality draws of intermediaries. The post-regulation profit of the lowest cost automaker actually increased suggesting the effect of higher markups overcome the damage of lost orders.

The solid black line in Figure 10 presents the total profit of all automakers.[36] Some high-cost

[35]Under the assumed parameters in this simulation, only the most efficient automaker is used pre-regulation.
[36]Since the lowest cost automaker is the only one matched with all intermediaries and its profit represents the total

Figure 9: Price change of intermediaries



Marginal effects with 95% CIs. No price variation pre-regulation (t=1,2,3) due to single automaker.

automakers who did not receive business prior to the policy now serve intermediaries. The large increase in total profits post-regulation shows that they are better off. In addition, the total profit increase from period 4 to 5 can be attributed to the Bayesian updating process where automakers have better expectations of intermediaries and are more likely to list the ones who will bring orders.

Figure 10: Profit of automakers

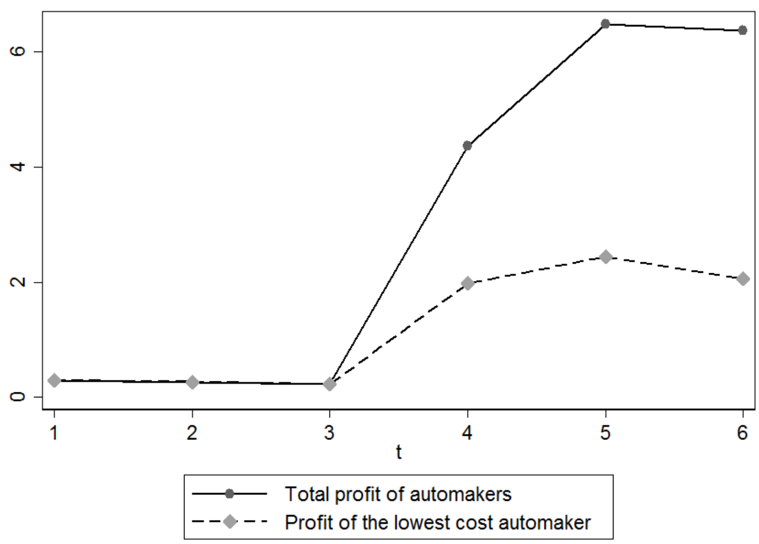
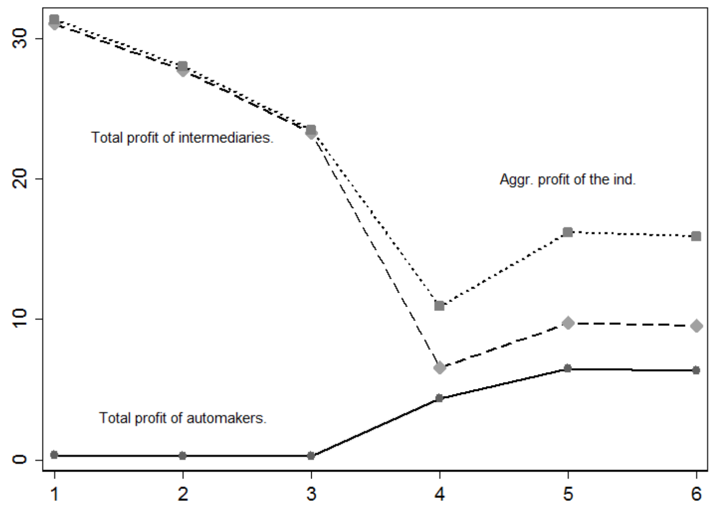


Figure 11 displays the total profit of intermediaries and the aggregate profit of the auto export

profit of automakers pre-regulation.

industry. The regulation mechanically reduce the number of intermediaries together with the profits. The remaining intermediaries are worse off as well due to higher wholesale prices as discussed above. The automobile industry as a whole becomes worse off post-regulation.

Figure 11: Total profit



Parameter values used in this simulation: M=10, N=50, $c_s^0 \sim N(0.8, 0.01)$, $\tau = 2\% \times c_s^0$, and $\mu_i \sim Gamma(2, 1)$.

Welfare in the foreign country will fall for two reasons based on this model. First, foreign buyers connected with intermediaries not being listed by any automaker will have to drop the order or find alternative sellers. Due to the regulation, intermediaries can only source from automakers who list them on the registry. Foreign consumer surplus is lost due to unfulfilled orders. Second, even if foreign buyers link with intermediaries on the registry, they are still worse off due to higher prices transferred from the monopoly pricing of automakers. Foreign buyers may potentially gain in the long run if the regulation pushes them to search and connect with direct exporting automakers. However, the interaction between direct and indirect exporting is assumed away in the current model.

Domestic consumers are hardly affected by this regulation. The large share of automobile sales in the Chinese market consists of passenger cars while the majority of China's auto exports is commercial vehicles such as buses and trucks. No direct interactions or spillovers are assumed between the domestic and foreign market in this paper. Therefore, export registration of automakers and intermediaries does not affect the production and sales in the domestic market.

Alternative rationales for the regulation

The model associates the registration policy with aggregate welfare loss. The winners are a subset of automakers. Therefore, the model can only provide a political economy explanation for the policy—politically powerful automakers pushed the policy through despite the costs inflicted on some automakers and all intermediaries.

A search of Chinese news reports reveal a couple of other explanations for the policy. One from the state media suggests the goal was to correct excess entry in the intermediated auto-export industry. Intuitively, if intermediaries incur fixed cost to enter the market and each additional entrant will dilute the market share of existing firms without lowering prices appreciably, there might be too many intermediaries. However, Dixit and Stiglitz (1977) show that with CES demand, the monopolistic competition equilibrium number of firms is the social optimum.[37] The social planner problem in this paper is slightly different from the standard Dixit-Stiglitz setting since the orders brought by intermediaries benefit automakers without additional cost.[38] If intermediaries are modeled as measureless firms who do not affect the price index and additional entry do not affect the current profits of other intermediaries, the socially optimal number of intermediaries should coincide with the free market equilibrium. Excess entry could be introduced into the model by allowing firms to have market power and additional entry to generate business stealing effects. A number of papers using different utility functions characterize the conditions under which excess entry exist (e.g., Anderson and Renault, 1999; Gu and Wenzel, 2009; Dhingra and Morrow, 2012).

The registration policy may reduce problems with after-sales services. First, it eliminates marginal intermediaries who arguably are more likely to offer inadequate after-sales service. Second, if the commercial dispute arises to government, a smaller number of intermediaries makes it easier for government to track down the source of the problem.

5 Conclusion

This paper takes advantage of the automaker-intermediary matching data to provide evidence on the economics underlying the linkages among domestic producers and export intermediaries. It

[37] Lump sum subsidies which transfer consumer surplus to producers are not allowed.

[38] Welfare of foreign consumers is not taken into consideration.

shows that large automakers are matched with intermediaries who bring more foreign orders. In addition, large skewness in intermediary qualities and Bayesian updating of automaker beliefs give rise to the substantial churning in the sets of intermediaries registered by the automakers. These findings are in line with studies examining seller-buyer matches in international markets.

The matching data is made available because of a trade policy initiated to monitor China's auto exports and potentially promote industry consolidation. This paper proposes a model to describe how this registration policy facilitated market division as an equilibrium outcome and led to inefficiency.

Predictions from the model and results of the simulation show that this regulation benefited automakers especially those relatively less efficient ones who were not used by intermediaries before. Intermediaries became worse off. The survivors faced higher wholesale prices and the lowest quality ones were not listed by any automaker and exit the market. Inefficiencies of the policy mainly came from endogenously risen market partition and double marginalization. Non-assortative matching equilibria also generated inefficiencies since low cost automakers benefited more from high quality intermediaries.

Welfare consequences discussed in this paper are drawn in light of the model. The question arises about why the government issued this regulation. A reading of media accounts does not reveal the rationale. Based on the model, a political economic argument can be constructed where automakers lobbied to reduce competition. Other potential rationales such as reducing fixed costs and extracting more foreign consumer surplus require additional modeling.

Information on manufacturer-intermediary provides a unique opportunity to model matching between firms. Future research is required to fully understand the Chinese government rationale for the regulation.

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A Registration policy

In **2007** version of the registration policy, requirements for automakers include (1) makers should be enlisted in "Automakers and Auto Products Bulletin" published by National Development and Reform Commission; (2) hold effective product certificates (CCC certificate); (3) have export compatible after-sales maintenance ability and sales network in major markets. For export intermediaries: (1) should obtain authorization from automakers and only export vehicles from authorized makers; (2) automakers and listed intermediaries should share the legal responsibility of product quality and after-sales services. Note that firms located in export processing zones and export 100% of their products are not restricted by this policy.[39]

B Comparing staying and exiting intermediaries

In this section, a full range of aspects are compared between staying and exiting intermediaries. Those who are dropped from the market are of smaller size, sell at lower prices, have fewer market access, handle fewer product varieties and less specialized in the auto industry. Intermediaries post-regulation are in general better than their pre-regulation counterparts in every aspect listed above. However, exitors post-regulation are even smaller in size and market coverage while slightly inferior in terms of product variety handled and knowledge of the auto industry (indicated by the share of auto exports).

Table 12: Exiting vs staying Intermediaries

	(1)	(2)	(3)	(4)
	ln(ExpVal)	ln(q)	ln(AveP)	ln(MedP)
exit	-1.876^a	-1.417^a	-0.526^a	-0.452^a
	(0.113)	(0.111)	(0.068)	(0.068)
post	1.717^a	0.567^a	1.148^a	1.150^a
	(0.119)	(0.121)	(0.070)	(0.072)
exit×post	-0.717^a	-0.663^a	-0.069	-0.063
	(0.151)	(0.142)	(0.095)	(0.096)
N	4197	4197	4197	4197
R^2	0.290	0.160	0.174	0.165

Standard errors in parentheses. ^{c} $p<0.1$, ^{b} $p<0.05$, ^{a} $p<0.01$
Intermediary-year level regression with intermediary clusters.

[39] That's why the empirical analysis of this paper only include ordinary exports.

Table 13: Exiting vs staying Intermediaries

	(1) ln(nMkt)	(2) nMkt	(3) ln(nProd)	(4) nProd	(5) autoShr	(6) HS87Shr
exit	-0.556^a	-1.050^a	-0.458^a	-0.692^a	-0.107^a	-0.175^a
	(0.050)	(0.095)	(0.038)	(0.069)	(0.016)	(0.018)
post	0.243^a	0.397^a	0.152^a	0.139^a	0.233^a	0.222^a
	(0.060)	(0.096)	(0.039)	(0.053)	(0.018)	(0.020)
exit×post	-0.272^a	-0.423^a	-0.096^b	-0.042	-0.083^a	-0.063^b
	(0.063)	(0.129)	(0.044)	(0.063)	(0.023)	(0.026)
N	4197	4197	4197	4197	4197	4197
R^2	0.150		0.155		0.140	0.149

Standard errors in parentheses. ^{c} $p < 0.1$, ^{b} $p < 0.05$, ^{a} $p < 0.01$

Intermediary-year level regression with intermediary clusters.

Table 14 illustrates similar comparisons from a different perspective. It shows the probability of intermediary exit is negatively correlated with its export size and smaller intermediaries are more likely to exit post-regulation. The predictions on exit decisions that correspond with prices and foreign market coverages do not change much with the regulation. The effect of product variety suggests that intermediaries with smaller number of products are more likely to exit. However, this factor becomes less important post-regulation. Similar pattern is shown for the share of auto exports intermediaries handle.

C Notes for Bayesian statistics and quality distribution

The following bullet points are drawn from Gelman et al. (2014). They explain a general rule of Bayesian updating process and provide intuitions of the parameters (e.g., effective sample size).

- **Data**: $Q = \{q_1, q_2, \cdots, q_n\}$
- **Sampling model**: $q_i|\mu \sim Poisson(\mu)$, where q_i are i.i.d. and μ is the population parameter which is unknown and random.
- **Prior**: $\mu \sim Gamma(\alpha, \beta)$ and prior mean $\mathrm{E}(\mu) = \alpha/\beta$
- **Posterior**: $\mu|Q \sim Gamma(\alpha + \sum q_i, \beta + n)$ and posterior mean

$$\mathrm{E}(\mu|Q) = (\alpha + \sum q_i)/(\beta + n) = \frac{\alpha}{\beta}\frac{\beta}{\beta + n} + \frac{\sum q_i}{n}\frac{n}{\beta + n}$$

Table 14: Discrete hazard model

	(1) LP	(2) Probit	(3) Logit	(4) LP	(5) Probit	(6) Logit
$post$	-0.086	-0.029	0.007	0.068	0.289	0.541
	(0.095)	(0.326)	(0.564)	(0.104)	(0.345)	(0.591)
$\ln(q)$	-0.090^{a}	-0.263^{a}	-0.436^{a}	-0.040^{a}	-0.109^{a}	-0.178^{a}
	(0.004)	(0.015)	(0.026)	(0.007)	(0.021)	(0.035)
$post \times \ln(q)$	-0.002	-0.053^{b}	$\mathbf{-0.099}^{b}$	-0.023^{b}	-0.099^{a}	$\mathbf{-0.175}^{a}$
	(0.006)	(0.023)	(0.040)	(0.010)	(0.031)	(0.053)
$\ln(P)$	-0.088^{a}	-0.256^{a}	-0.428^{a}	-0.057^{a}	-0.168^{a}	-0.279^{a}
	(0.006)	(0.021)	(0.035)	(0.008)	(0.023)	(0.039)
$post \times \ln(P)$	0.012	0.022	0.035	-0.007	-0.023	-0.040
	(0.010)	(0.033)	(0.056)	(0.011)	(0.036)	(0.061)
$\ln(nmkt)$				-0.078^{a}	-0.332^{a}	-0.578^{a}
				(0.016)	(0.055)	(0.092)
$post \times \ln(nmkt)$				0.019	-0.073	-0.213
				(0.020)	(0.088)	(0.146)
$\ln(nprod)$				-0.126^{a}	-0.454^{a}	-0.758^{a}
				(0.021)	(0.067)	(0.112)
$post \times \ln(nprod)$				0.097^{a}	0.375^{a}	0.659^{a}
				(0.029)	(0.099)	(0.166)
$HS87Shr$				-0.115^{a}	-0.338^{a}	-0.556^{a}
				(0.032)	(0.092)	(0.152)
$post \times Shr$				0.057	0.231^{c}	0.391^{c}
				(0.045)	(0.131)	(0.218)
_cons	1.519^{a}	2.952^{a}	4.931^{a}	1.243^{a}	2.184^{a}	3.625^{a}
	(0.057)	(0.200)	(0.343)	(0.067)	(0.214)	(0.362)
N	4197	4197	4197	4197	4197	4197
R^2	0.217			0.240		

Standard errors in parentheses. ^{c} $p<0.1$, ^{b} $p<0.05$, ^{a} $p<0.01$

Intermediary-year level regressions with intermediary clusters.

Note that the posterior mean is a weighted average of prior mean and sample mean. And the relative weight is determined by β (effective sample size) and n.

- **Predictive distribution**: $q \sim$ Neg-bin$(\alpha, 1/(\beta+1))$. Also, E$(q) = \alpha/\beta$ and Var$(q) = \alpha(\beta+1)/\beta$. These are the moments we use to generate priors in the simulation.

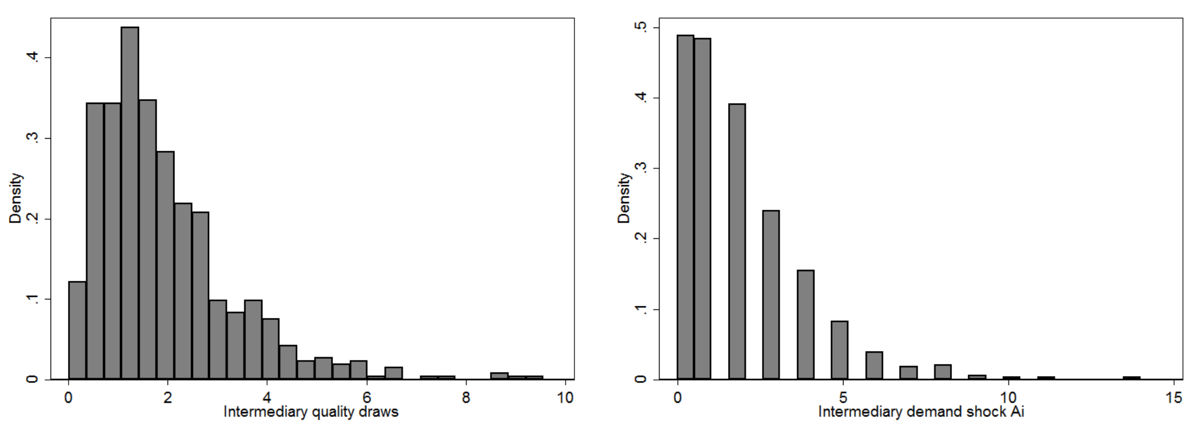
Based on the above analysis, two justifications can be made for the rather arbitrary choice of $\alpha_0 = 2$ and $\beta_0 = 1$ which govern the distribution of intermediary quality draws.

First, as demonstrated in the stylized fact 2 that the majority of intermediaries receive zero or only a small amount of auto export orders. The average size of intermediary demand shock is associated with the mean of μ which is determined by α_0/β_0.

The second benchmark rests on the weight allocated between priors and data. In Bayesian updating process, the expectation of μ_i conditional on observed A_i is a weighted average of prior mean and sample mean. In reality, firms usually have little information on the prior distribution. Therefore, more weight is assigned to the realization of intermediary demand shocks in previous periods (i.e., sample mean). This will be achieved by choosing a small β_0 which is the effective sample size compared to the observations used for belief updating.

Together, they provide a very skewed distribution of μ_i and the Poisson A_i (Figure 12).

Figure 12: $\mu_i \sim Gamma(2,1)$ and $A_i \sim Poisson(\mu_i)$



D Intermediary/automaker ratio

Suggestive evidence on the number of intermediaries per automaker before policy.

Figure 1 indicates that intermediary-automaker ratio in 2006 was $iAv/mAvDir = 746/142 = 5.2$ where automakers and intermediaries available are identified by both orthography and post-policy list.[40] And Figure 13 suggests that the ratio between direct exporting automakers and those who list at least one intermediary with the registration is $mRgDir = 1.05mSlot$. In other words, about 82% of automakers on the registration use intermediaries, $mSlot = 0.82mRg$. Then, what we're interested in is the number of intermediaries available in 2006 and the number of automakers who potentially need intermediaries.

$$\frac{iAv}{mSlot} = \frac{iAv}{mRgDir/1.05} = \frac{iAv}{mAvDir/1.05} = 1.05 \times 5.2 = 5.46$$

The above method relies on the credibility of iAv and $mAvDir$ which are calculated partially based on orthography. We could use another more restrictive measure by predicting the number of automakers and intermediaries who would be on the registration list in 2006 based on iAv and $mAvDir$. Figure 14 shows that on average the number of auto-exporters identified are larger than those registered on the list. That is, $mAvDir = 1.38mRg$ and $iAv = 2.24iRg$. Then,

$$\frac{iRg}{mSlot} = \frac{iRg}{0.82mRg} = \frac{iAv/2.24}{0.82mAvDir/1.38} = \frac{5.2 \times 1.38}{2.24 \times 0.82} = 3.9$$

It is restrictive in the sense that the number of automakers on the list is more likely to cover the universe of automakers who intends to export than intermediaries.

[40] How to identify intermediaries before policy? The cleanest way is to use the registration list. However, intermediaries shaken out by the policy can not be found on the list. Therefore, orthography provides additional information to identify intermediaries. We worry that orthography is not precise and might generate errors. In oder to make the numbers comparable pre and post policy, orthography is also used to identify intermediaries beyond the list after policy. Also since we're interested in the number of intermediaries per automaker, I use the same method to identify automakers. In sum, the number of automakers and intermediaries available in Figure 1 are identified by both registration list and orthography.

Figure 13: Direct export automaker/Automakers who list intermediaries (mDir/mSlot)

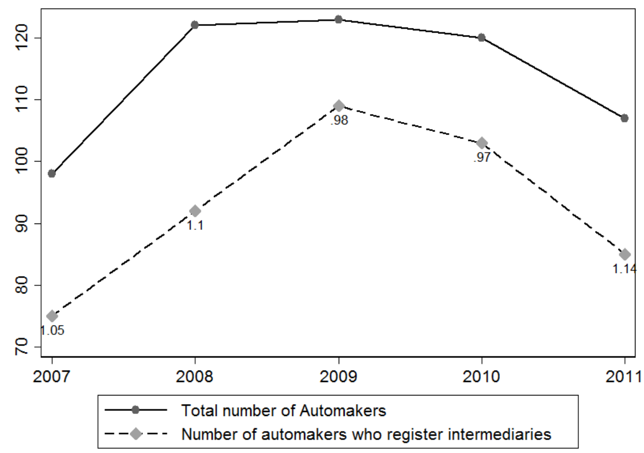


Figure 14: Number of auto-exporters: Available vs Registration