

# Understanding Regional Price Convergence Clubs in China

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December 24, 2022

## Abstract

This paper aims to explore the existence of price convergence clubs for various goods in China and understand the determinants of their formation. The study uncovers novel empirical patterns in the domestic cross-city price mechanism using individual goods retail price data for 36 major cities in China. Employing a nonlinear factor model, the paper shows that there is no evidence of national price convergence across Chinese cities for more than half of the goods in the sample (52 out of 102 goods), yet cities may form regional convergence clubs. These clubs emerge due to the regional differences in the cost and share of traded and non-traded inputs used in the production of goods. The data show that China has been moving towards a nationally integrated market up until the early 2010s, while in the last decade China's domestic market has become more fragmented. Thus, further economic reforms may be needed to reinforce the process of domestic market integration.

**Keywords:** Micro prices, Convergence clubs, Integration, China, Log-t test.

**JEL Classification:** O18, O53.

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## **1 Introduction**

China has expanded greatly economic cooperation and integration with other countries. Existing studies show a significant positive effect of these efforts on China's involvement in the world market, but their impact on the domestic market integration is unclear. During the last decade, many studies assessed domestic integration in China for various product markets. Ma and Oxley (2012) studied the behavior of China's energy sector; Bernhofen et al. (2015) focused on the historical evolution of price convergence for grain prices; Huang and Rozelle (2006) assessed the integration of agricultural markets such as rice, maize, and soybeans; Chow et al. (2016) explored house price convergence in Chinese cities. This paper contributes to the literature by investigating the extent of domestic market integration in China and the existence of local convergence clubs for more than 100 goods and services using monthly micro price data across 36 major Chinese cities during the period 1997-2018.

One approach to measuring the degree of market integration relies on the law-of-one-price (LOP), which asserts that, as a result of arbitrage, identical goods sold in different locations will have identical prices. LOP deviations can capture the degree of market integration present across any two places at a point in time. Empirical evidence in favor of the LOP in China is mixed. Earlier studies showed that China's markets have become less integrated due to the political reforms. This includes Young (2000) who showed that China's economic reform resulted in the fragmentation of domestic markets, Poncet (2005) who measured China's domestic market disintegration and argued that China is a 'fragmented economy', Li et al. (2003) who showed that China's regional markets are highly fragmented due to interregional protection. However, these findings were countered by other scholars such as Fan and Wei (2006), Lan and Sylwester (2010), and Li et al. (2018). For example, Fan and Wei (2006) studied price convergence amongst 96 commodities and found that prices had converged in China for an overwhelming majority of goods and services. Lan and Sylwester (2010) examined a panel of monthly prices of 44 products from 36 cities in China from

1990 to 1999 and found that prices in China converge to relative parity extremely quickly. Li et al. (2018) have shown significant evidence of price convergence in China during 1997-2012. The literature suggest that the effect of China's reforms on the internal market integration still remains inconclusive. This paper contributes to the literature by observing long-term changes in China's domestic price integration for the period 1997-2018, and by recording recent changes in the degree of market integration that took place during the period 2012-2018. The results show that China has become more integrated over time, but there is a lower pace of convergence between 2008-2018 compared to the earlier period.

While panel unit root tests are widely used in price literature to estimate the speed of price convergence, they do not study the transitory dynamics of the time series. These tests do not distinguish between locations that have already converged and locations that are converging. Moreover, they ignore threshold-like structures of price convergence suggested by Dumas (1992) and Sercu et al. (1995). This paper assumes that the convergence within the country is nonlinear, and some cities might form separate convergence clubs. Therefore, the study contributes to the literature by re-examining price integration of the domestic markets by allowing for the existence of regional convergence clubs and using the nonlinear time-varying heterogeneous factor model proposed by Phillips and Sul (2007). Importantly, the Phillips and Sul (PS) methodology allows to distinguish between locations that have converged and locations that are converging by explicitly addressing the question of invariance of the time-series process for prices. Moreover, this methodology overcomes various problems associated with the validity of conventional price convergence tests, such as cross-sectional dependence and heterogeneity issues.

The results show that for 55 out of 102 items there is no evidence of price convergence across cities; however, when a study cannot find significant evidence of price convergence at the national level, it does not necessarily mean that there is no convergence across some locations. Since China is a large country, the patterns of price convergence may vary across regions. Some cities may exhibit closer movement of prices due to geographical proximity, regional development zone policies, and

production linkages. The paper, therefore, investigates the existence of regional price convergence clubs across Chinese cities.

The original methodology to find regional convergence clubs is documented in Phillips and Sul (2007). This methodology has been adopted in many subsequent studies to analyze convergence clusters in income and prices. For example, Zhang et al. (2001) studied the existence of income convergence clubs in China and the US, respectively; Nagayasu (2011) investigated regional inflation convergence in Japan; Ma and Oxley (2012) explored the evolution of price convergence clubs for energy products in China; Barrios et al. (2019) studies convergence in innovation activity across European regions; Maynou et al., (2021) investigated house price convergence in Europe; Glushenkova et al. (2018) used the method to study evidence of national and local price convergence for different products across the globe. Yet, this is the first paper to study the existence of regional price convergence clubs in China for a large set of individual goods and services. The only similar study was performed by Ma and Oxley (2012), who identified convergence clubs for the energy market in China during 1995-2005 and found no evidence of national market integration in China. This paper further explores the existence of convergence clubs for more than 100 products from different industries, including agriculture, food, household appliances, daily-use chemical products, real estate, and services.

The results suggest that cities form various regional convergence clubs, and their formation varies significantly across goods. Furthermore, the results of the club convergence tests at the industry level are in line with those obtained at the good-level analysis. Specifically, the null hypothesis of national convergence cannot be rejected for agricultural products, perishable food products, non-perishable food products, and services, supporting the hypothesis of national integration for these markets. In contrast, there is no evidence of national convergence across Chinese cities for household appliances, alcohol, cigarettes, real estate, and daily-use chemicals, yet the cities form regional convergence clubs.

Finally, the literature on China's domestic market integration mainly focuses on recording the convergence speed for different product markets while it is silent about the factors that may explain it. This paper contributes to the field by exploring the factors that may affect the formation of price convergence clubs. The study follows the retail price model of Crucini, Telmer and Zachariadis (2005), which suggests that the price of any final good is determined by traded and non-traded factor components. The implication of this theory is that price differences between any two locations can be explained by the share and cost of the traded component used in the production of a good and the share and cost of the non-traded component. This paper investigates the effect of the variables related to the traded and non-traded components on the formation of the regional convergence clubs in China.

The results show that traded factors such as physical distance and tradeability of goods, as well as non-traded factors such as wages and the share of the local input components can determine the formation of the convergence clubs. In particular, the markets for less traded goods tend to be more segregated than markets for highly traded goods, i.e., they tend to have a larger number of regional convergence clubs. Similarly, there is a high likelihood of observing a larger number of regional convergence clubs for industries utilizing a large share of non-traded inputs in the production. Considering characteristics of the cities that form regional convergence clubs, the study shows that cities located further away from the core club would more likely form other regional convergence clubs than cities located close to the core club, which emphasizes the key role of trade cost in determining price differences between cities and is in line with the studies that underline the importance of distance in determining price differences (e.g., Kano et al. (2021), Yilmazkuday (2018), and Crucini et al. (2015)). Finally, the analysis reveals that cities with large local market sizes and high wages form the first convergence club, characterized by the highest prices, more often than cities with small market sizes and low wages.

The rest of the paper is organized as follows. Section 2 describes the data used for the analysis. Section 3 presents the nonlinear factor model of prices used to test for domestic price convergence

and for the existence of price convergence clubs. Section 4 reports the results of the convergence test. Section 5 briefly concludes.

## **2 Data**

The paper utilizes a panel of monthly retail prices collected by the China Price Information Centre (CPIC). These price data are used to calculate official CPI and PPI in China, and therefore, the government and CPIC maintain a high quality of the data. Moreover, this price data set has been widely used in previous literature (e.g., Li et al. (2018), Young (2000), Fan and Wei (2006), and Lan and Sylwester (2010)). Li et al. (2018) discuss extensively several issues related to the sample selection and reliability of this dataset and conclude that this is one of the best available sources of the desegregated price data in China.

The data cover more than 180 goods and services in 165 cities for the period January 1997-December 2018. However, the availability of the data varies a lot over time and across cities. For the purpose of comparability, a set of restrictions is applied to the data. First, the goods with erroneous price movements are excluded, i.e., if there is a rise or fall in prices by more than 300%. The study also controls for outliers by eliminating individual prices that are at least five times bigger or smaller than the cross-city median price for that item in that month. Data for food products are collected from two types of markets - supermarkets and bazaars. To alleviate possible measurement errors, the prices are averaged across stores where possible, and one representative price per item is obtained. Since the availability of the data varies a lot across cities, the analysis is focused on 36 cities, presented in Table A3 of the Online Appendix, as these are major cities in China with the least number of missing observations.

Only a few cities and goods are available in the early months of 1997; therefore, the paper focuses on the sub-sample of prices available between 1997.11 and 2018.12. The data have no time gaps as it is required to apply the Phillips and Sul (2007) convergence test. Finally, the data contain only

items available in more than two-thirds of the cities to ensure sufficient cross-city variation. The final sample covers 102 goods and services available in 36 cities from November 1997 to December 2018<sup>1</sup>. A list of the items is available in Table 1.

### 3 Method

Phillips and Sul (2007, PS) *log t* test is employed to test domestic price convergence in China. According the PS method the logarithm of prices for each good  $j$  in city  $i$  at time  $t$ ,  $p_{ijt}$ , could be expressed as combination of price growth component,  $\mu_{jt}$ , which is common for all locations, and a time varying factor-loading,  $\delta_{ijt}$ , that captures both city and goods specific transition:

$$p_{ijt} = \delta_{ijt}\mu_{jt}. \quad (1)$$

The method relies on the idea of relative convergence, which assumes that two series share the same stochastic or deterministic trend elements in the long run so that their ratio eventually converges to unity.  $p_{ijt+k}/p_{ljt+k} \rightarrow 1$  as  $k \rightarrow \infty$  for any pair of cities  $i \neq l$  or equivalently  $\delta_{ijt+k} = \delta_j$  as  $k \rightarrow \infty$ . To capture transition dynamics in the price data the relative transition curve,  $h_{ijt}$ , is calculated as:

$$h_{ijt} = \frac{p_{ijt}}{\frac{1}{N_j} \sum_{i=1}^{N_j} p_{ijt}} = \frac{\delta_{ijt}}{\frac{1}{N_j} \sum_{i=1}^{N_j} \delta_{ijt}}, \quad (2)$$

where  $N_j$  is the number of cities where each good  $j$  is available. Relative convergence is allied to standard  $\sigma$ -convergence<sup>2</sup> widely used in the growth literature. The relative convergence can be tested by estimating coefficients on the logarithm of time in the following regression:

$$\log \left( \frac{D_{1j}}{D_{tj}} \right) - 2 \log \log t = \alpha_{0j} + \alpha_{1j} \log t + \epsilon_{tj}, \quad (3)$$

for  $t = [rT], [rT] + 1, \dots, T$  with some trimming percentage  $r > 0^3$ , and  $D_{jt} = \frac{1}{N} \sum_{i=1}^N (h_{ijt} - 1)^2$  is the sample transition distance, which captures price dispersion across cities. The null of national

<sup>1</sup>The data for real estate and daily-use chemicals are reported only since 2004 and 2012, respectively.

<sup>2</sup>The concept of  $\sigma$ -convergence implies that the cross-regional dispersion falls if regions become more integrated, while when markets diverge from each other, the dispersion is typically rising.

<sup>3</sup>Following Phillips and Sul(2007) paper,  $r = 0.3$  is chosen based on the size of the sample.

convergence holds if the coefficient of  $\log t$ ,  $\alpha_{1j} \geq 0$ . The magnitude of the coefficient  $\alpha_{1j}$  measures the convergence speed of  $p_{ijt}$ ; if  $0 \leq \alpha_{1j} < 2$  there is evidence of growth convergence, and if  $\lambda_{1j} \geq 2$  one can conclude that there is level convergence in log prices.

The  $\log t$  test is applied to each product to check whether there is evidence of price convergence across all cities. However, the absence of convergence across all cities in China, i.e., national convergence, does not exclude the possibility of convergence within some clubs of cities or regions. The club convergence could be analysed using log-t regression and PS clustering procedure. First, cities must be ordered according to the final period prices, and the  $\log t$  test is applied to identify the ‘core group’ of cities against which other cities will be compared. Then, cities are added to the ‘core group’ one at a time, and the  $\log t$  test is run to check for their possible membership of the convergence club. These steps are repeated to check for the existence of other convergence clubs. If there is no evidence of further clubs, one can conclude that the remaining observations have divergent behavior, i.e., the cities do not converge with any of the uncovered clubs. One limitation of the PS test is that it may find more convergence clubs than the true number. To avoid such overidentification, the study uses log-t regression tests across the clubs to check whether identified clubs can be merged into larger clubs. A detailed description of the clustering process is presented in Phillips and Sul (2007) paper.

## 4 Results

### 4.1 Domestic convergence clubs

First, the  $\log t$  test is applied to each product to test the null of the national convergence. Table 1 presents the results of the convergence test. There is evidence of national convergence for almost half of the items (47 out of 102 goods), mainly agricultural products, food, and drinks (e.g., apples, beer, and sugar), as well as some services (e.g., taxi, tuition fee, and water usage). Yet, the null of national convergence is rejected for 55 items that belong to various industries, such as daily-use



chemicals, household appliances, real estate, food, and services.

Rejecting the null of national convergence leaves open the possibility of regional convergence, i.e., convergence within a group of cities. Therefore, the existence of regional convergence clubs is further tested for the 55 items for which the null of national convergence was rejected. The results presented in Table 2 reveal the existence of up to five convergence clubs depending on the good. The appearance of the fifth club is rare and exists only for four items: “Bicycle Phoenix QE-65”, “Rent of property, 2-class”, “Rent of property, suburb”, and “Women’s cotton sweater, YOUR SUN cotton”. For the majority of goods, the test identifies the existence of two to three convergence clubs. For some goods, there is a set of cities that do not form any club, so these cities are labeled as a divergent group. For two goods (“Gas stove” and “Soy sauce”) there is only one large convergence club and a few locations that diverge from the national price level. It is possible to conclude that there is weak evidence of national convergence for these items once divergent cities are excluded. For the majority of goods, the size of the convergence coefficient is less than 2,  $0 \leq \alpha_{ij} < 2$ , suggesting price growth convergence within clubs rather than price level convergence. Price-level convergence occurs only for “Imported cigarettes” within the first club, for “Bicycle female” within the third and fourth clubs, and for “Second-hand commercial housing, 3-class location” within the third club.

Table A1 of the Online Appendix presents average prices by good across cities within each club. The first club is typically characterized by the highest price level, the second club by the second-highest price, and so on.

## 4.2 Industry level analysis

### 4.2.1 Long run convergence

As noticed above, price convergence at the goods level is closely related to the industry to which the good belongs. This sub-section focuses on exploring the behavior of aggregated prices at the

Table 1: Log t test for National Convergence

Item	$\alpha$	T-stat	Item	$\alpha$	T-stat
Air conditioner 1.5 horse power	-1.56	-18.31	Instant noodles (110 grams/pack)	-0.74	-55.01
Apple, red Fuji	1.64	24.36	Laundry detergent (1kg)	-1.02	-166.99
Bananas local	2.12	50.94	Leek	2.48	14.63
Beans, fresh	0.97	27.80	CT plain scan of the skull	-0.84	-466.43
Beer canned, 350ml	-1.24	-88.76	Men's cotton vest, YOUR SUN cotton	-1.85	-19.16
Beer, 630ml	0.13	1.62	Microwave oven, Mechanical	-0.99	-56.19
Bicycle female 26	-1.07	-62.04	Milk (500 ml)	2.50	53.48
Bicycle Phoenix QE-65	-1.15	-162.1	Mineral water (550 ml)	0.05	2.34
Brown sugar (packaged)	0.48	19.22	Mobile phone fee, China Mobile, local call	-1.21	-87.56
Bus trip (one ticket)	0.82	4.32	Mobile phone fee, China Telecom, local call	-0.41	-14.61
Cabbage, fresh	2.99	1.79	Mobile phone fee, China Unicom, local call	-0.29	-18.60
Cable TV (monthly fee)	0.96	22.19	Mono-sodium Glutamate (1 bag)	-0.93	-68.09
Carbonated beverages, 2.5L	-0.45	-30.78	Mung bean	1.35	7.21
Carrot	6.15	6.20	Oranges	1.62	98.34
Celery	3.63	6.27	Peanut oil (barrel)	-1.42	-48.68
Chicken (white, gutted)	0.08	4.45	Pear	0.39	3.00
Chinese Lettuce	3.23	7.11	Polished rice, second class	1.83	5.88
Chinese cabbage	0.98	0.94	Potato	4.97	5.81
Color TV, 25 inch	-1.46	-25.67	Radish	2.48	1.31
Commercial housing, Second-class	-1.05	-748.14	Refrigerator, 210-250 dm3	-1.59	-73.09
Computer, mainstream brand	-0.96	-69.12	Rent of Low-cost House	-0.38	-235.29
Cookies (100 gram/bag)	-0.31	-21.79	Rent of property, city centre	-0.79	-588.13
Corn flour	2.41	32.59	Rent of property, 2-class	-0.95	-104.67
Cucumber	3.11	71.01	Rent of property, suburb	-1.00	-110.11
Digital camera (3 mln pixel, 3x zoom)	-1.85	-19.39	Salt iodized	6.72	10.97
Dish-washing liquid (500g)	-0.91	-102.57	Second-hand commercial housing, 2-class	-0.87	-160.02
Domestic call fee, within network	0.56	25.06	Second-hand commercial housing, 3-class	-0.66	-19.01
Domestic cigarette (high-end)	-2.50	-108.27	Shampoo (750 ml)	-0.58	-1533.10
Eggplant	1.73	104.95	Shower gel (750 ml)	-1.17	-53.10
Eggs	0.59	7.65	Small red bean	2.12	32.75
Electric hot water heater 50L	-1.04	-48.92	Soap (125 gr)	-1.08	-65.68
Electricity 220v	-0.56	-9.58	Soy sauce (500 ml)	-0.32	-6.92
Fish, carassius live (350 gram)	-0.45	-22.37	Soybean	1.84	19.65
Fish, grass carp live (1kg)	0.64	19.82	Soybean blend oil (barrel)	-2.19	-19.52
Flour, first class	1.61	22.60	Soybean oil, 500ml	-0.68	-10.42
Flour, standard class	1.85	126.43	Taxi (per km)	0.43	6.17
Fresh beef boneless	0.32	22.41	Tofu	6.62	7.67
Fresh beef tendon meat	-0.59	-181.44	Tomato	2.92	38.16
Fresh mutton boneless	0.48	8.10	Toothpaste (120 gr)	-0.52	-46.85
Fresh pork lean	0.29	1.51	Vinegar (500 ml)	0.11	5.54
Fresh pork without bones	-0.41	-6.89	Washing machine, front load (5kg)	-0.76	-54.77
Fresh pork ribs	-0.55	-38.52	Washing machine, top load (5kg)	-0.72	-43.68
Fresh pork skinned hind leg meat	-0.63	-14.61	Water usage not incl. sewage	1.96	55.43
Garlic moss	0.47	5.13	White granulated sugar (packaged)	0.72	7.67
Gas stove	-0.24	-7.27	Women's cotton sweater, YOUR SUN cotton	-3.03	-17.74
Green pepper	1.21	90.13	Women's cotton trousers, YOUR SUN cotton	-2.33	-19.14
Hairtail frozen (250 gr)	-0.09	-38.03	Dormitory fee for college students, 4 ppl	0.19	36.95
Hot pepper	1.26	84.25	Sewage treatment fee	-3.54	-7.26
Imported cigarettes, 84mm	-0.88	-9.65	University tuition, artistic college	-0.50	-85.72
Infant formula domestic. (400 gr)	-1.24	-62.12	University tuition, comprehensive university	0.13	1.67
Infant formula imported (400 gr)	-0.87	-72.66	University tuition, teachers college	0.26	4.93

Notes: This table presents estimates of the convergence coefficient  $\lambda$  and its t-statistics using the *log t* test of Phillips and Sul (2007). The null of price convergence cannot be rejected at the 5% significance level if test statistic (T-stat) takes value larger than -1.65.

Table 2: Club convergence coefficients at the good level

Item	club 1	club 2	club 3	club 4	club 5	divergent group
Air conditioner 1.5 horse power	-0.638	-0.587	0.611	0.088		
Beer canned, 350ml	0.183	0.426	0.623			
Bicycle female	-0.022	0.319	2.113	5.261		
Bicycle Phoenix QE-65	0.603	0.255	-0.036	1.346	1.787	
Carbonated beverages, 2.5L	-0.032	0.546	-0.305			
Color TV, 25 inch	-0.128	0.017				
Commercial housing, Second-class	0.096	0.412	-0.027			
Computer, mainstream brand	0.007	0.560	0.409	0.302		-1.635*
Cookies (100 gram/bag)	-0.022	0.032				
Digital camera (3 mln pixel, 3x zoom)	0.279	0.070	0.231			
Dish-washing liquid (500g)	0.363	-0.054	0.048			
Domestic cigarette (high-end)	0.089	0.267	1.970			-4.140*
Electric hot water heater 50L	-0.032	0.718	-0.853			
Electricity 220v	0.088	0.232	-0.120	0.997		-0.122**
Fish, carassius live (350 gram)	-0.007	0.267				-0.773*
Fresh beef tendon meat	0.018	0.607				
Fresh pork without bones	-0.010	0.565				
Fresh pork ribs	-0.038	0.154				
Fresh pork skinned hind leg meat	-0.100	0.548				
Gas stove	-0.015					-0.736*
Hairtail frozen (250 gr)	0.337	-2.034				
Imported cigarettes, 84mm	2.411	0.627				
Infant formula domestic. (400 gr)	0.266	0.013	0.278	0.573		-0.305*
Infant formula imported (400 gr)	-0.048	-0.016	0.583			
Instant noodles (110 grams/pack)	-0.009	0.495	1.350			
Laundry detergent (1kg)	-0.010	0.044				
CT plain scan of the skull	0.182	0.640	0.336			
Men's cotton vest, YOUR SUN cotton	0.367	0.192	0.003	-0.114		
Microwave oven, Mechanical	0.751	-0.068				
Mobile phone fee, China Mobile, local call	0.149	-0.137				
Mobile phone fee, China Telecom, local call	1.942	0.038				
Mobile phone fee, China Unicom, local call	0.092	0.958				
Mono-sodium glutamate (1 bag)	1.003	0.233				
Peanut oil (barrel)	0.072	-0.051	0.440			
Refrigerator, 210-250 dm3	0.009	-0.234	0.720			
Rent of Low-cost House	0.079	0.008	0.233			-0.488*
Rent of property, city centre	0.259	0.153	0.566			-3.022*
Rent of property, 2-class	1.679	0.263	0.286	0.043	-0.225	-6.810*
Rent of property, suburb	-1.606	0.520	-0.005	0.553	0.691	-1.714*
Second-hand commercial housing, 2-class	0.258	-0.006	0.348			
Second-hand commercial housing, 3-class	0.510	0.008	2.918			
Shampoo (750 ml)	0.144	0.040	0.043			-0.752*
Shower gel (750 ml)	1.412	0.108	0.019			
Soap (125 gr)	0.372	0.077	0.450	0.056		
Soy sauce (500 ml)	0.603					-4.277*
Soybean blend oil (barrel)	0.148	0.796	0.393	2.612		
Soybean oil, 500ml	-0.049	0.691				
Toothpaste (120 gr)	0.052	0.073				
Washing machine, front load (5kg)	-0.366	0.105	0.297	3.066		
Washing machine, top load (5kg)	0.058	-0.080				
Women's cotton sweater, YOUR SUN cotton	1.329	0.514	1.099	0.831	-0.010	
Women's cotton trousers, YOUR SUN cotton	0.162	0.011	0.302	1.748		
Sewage treatment fee	-1.443	-0.280	0.464			-3.060*
University tuition, artistic college	0.617	0.320				-2.421*

Notes: This table presents estimates of the club convergence coefficients. The last column presents coefficient estimates of the divergent group. Asterisks indicate a significance level of \*1% and \*\*5% at which the null of convergence is rejected. The table presents the final club classification after testing for potential existence of large convergence clubs and merging small clubs into larger ones where possible in accordance with Phillips and Sul (2009) club merging procedure

industry level as a way to summarize the information across various goods. This type of analysis will allow us to discern whether convergence patterns observed at the individual good level carry over to the industry level. The goods are organized into sectors, and the average price across goods is calculated in each sector for every city. Then, as in the good-level analysis, national and regional club convergence is tested for each industry.

Table 3: Convergence coefficients at the industry level

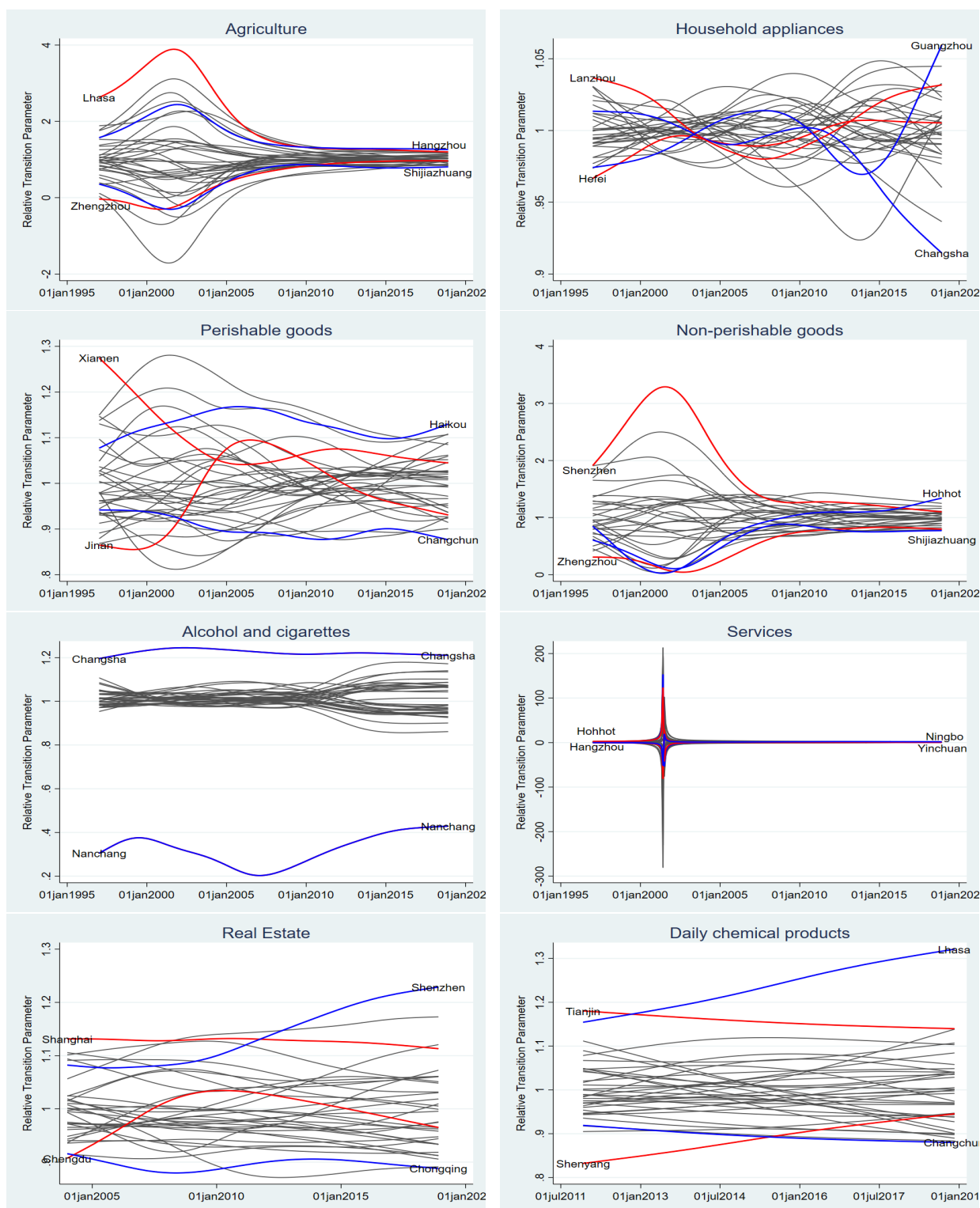
<b>Industry</b>	<b>Convergence coefficients</b>						
	national	club1	club2	club3	club 4	club 5	Diverg.
Agriculture	2.866						
Alc&Cig	-0.230*	0.09	0.09				-3.450*
Household App	-2.069*	-1.73	-0.60	0.58	0.14	-1.48	-6.722*
Perishable goods	0.640						
Non-Perishable goods	1.865						
Services	1.249						
Real Estate	-0.801*	0.23	0.03	0.70			
Daily-use chemicals	-0.999*	-0.01	0.29				

Notes: This table presents estimates of the national convergence coefficient and club convergence coefficients at the industry level of analysis. Column 2 presents the national convergence coefficients. The next five columns present estimates of the five club convergence coefficients. The last column presents coefficient estimates of the divergent group. Asterisks indicate a significance level of \*1% at which the null of convergence is rejected. The table presents the final club classification after testing for the potential existence of large convergence clubs and merging small clubs into larger ones where possible in accordance with Phillips and Sul (2007) club merging procedure.

Table 3 shows results of the convergence test for different industries. The results at the industry level are in line with the good-level analysis. Specifically, the null hypothesis of national convergence cannot be rejected for agricultural products, perishable food products, non-perishable food products, and services. For household appliances, alcohol and cigarettes, real estate, and daily chemicals, the null of convergence is rejected, suggesting no evidence of overall convergence and the possibility of club convergence. Moreover, for the industries with no evidence of national convergence, the clustering procedure identified up to five convergence clubs.

Figure 1 presents the transition curves  $h_{iht}$  for all cities for the overall period 1997.11-2018.12 for each industry. The idea of the transition curve is similar to the concept of sigma-convergence. In

Figure 1: Relative transition curves by industry



the case of national convergence, one should expect monotonic convergence of the transition curves to unity for all cities.

As is apparent in Figure 1 there is a strong convergence pattern of prices for agricultural products and non-perishable food products. Also, there is some evidence of convergence in the latter period for services and perishable food products. For household appliances, price dynamics change significantly over time, with some evidence of convergence in the early years and divergent behavior in the most recent period. Similar patterns are observed for alcohol and cigarettes. No convergence of transition paths is recorded for the real estate market and daily-use chemical products.

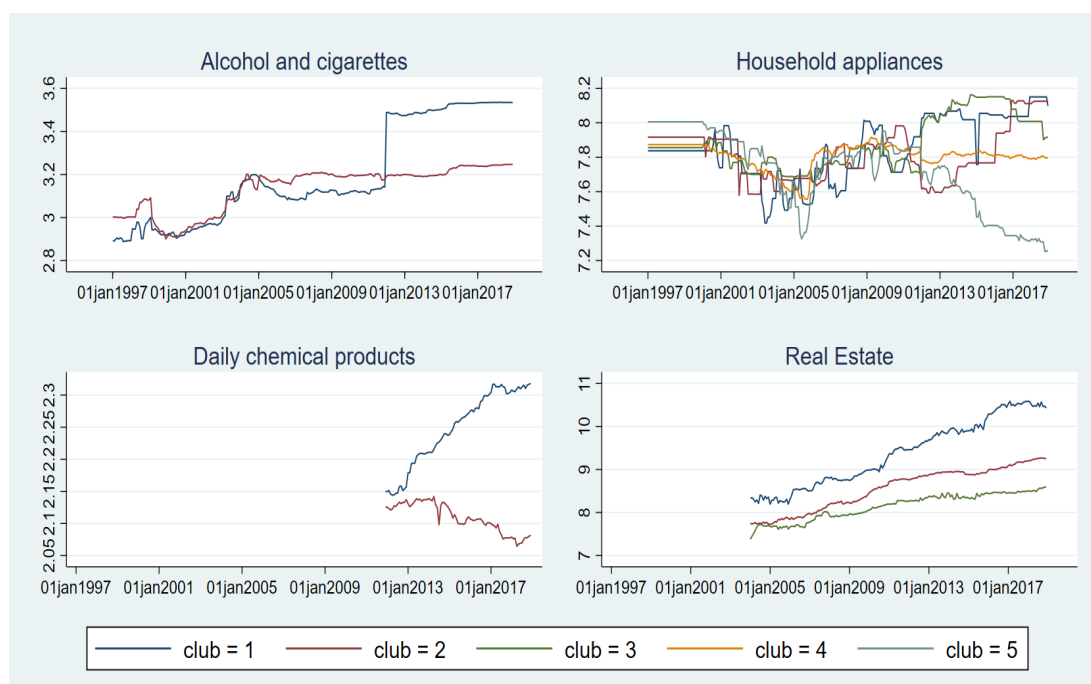
Figure 2 presents the dynamics of average prices for each club<sup>4</sup>. The behavior of prices in each club varies across industries. For instance, in the alcohol and cigarettes market, average prices for club 1 and club 2 moved in the same direction and were almost identical up until 2005, but thenceforth there is a divergence between the clubs with prices in the second club remained stable over the recent period while the average price of the first club jumped up. Similarly, prices in the market for daily-use chemicals were close to each other in club 1 and club 2 in the end of 2012, but hereafter diverged up until the end of 2018. Interestingly, the average price of household appliances remained unchanged between 1997 and 1999 in all three clubs and started to change after that, with the most apparent divergence between clubs observed after 2012. Overall, the study records significant changes in the dynamics of average prices over time in all three clubs, with the most apparent divergence patterns observed after 2012 in all markets; this might be associated with the new wave of economic reforms in China.

While transition curves presented in Figure 1 capture convergence behavior in the long run, they are also informative about cross-city heterogeneity in the short run. As recorded in Figure 2, trends in average prices changed a lot over time, therefore one might be interested in the short-run price dynamics. In what follows, the paper will focus on price changes that took place in different sub-periods, namely 1997-2000, 2001-2004, 2005-2011, and 2012-2018. These periods correspond to the

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<sup>4</sup>Average price is calculated as the arithmetic average of log prices over locations that belong to each club.

Figure 2: Average price in convergence clubs by industry



various stages of economic reforms in China.

#### 4.2.2 Short run convergence

Table 4 presents results of the convergence test for four sub-periods. As can be seen there, convergence patterns change significantly over time for different industries. The convergence test shows that after price liberalization reform in 1997, prices were mainly diverging<sup>5</sup>. However, these patterns change a lot over time, e.g., prices of services started to converge during the period 2001-2004 and this trend held in the following period of 2005-2012 as well. Divergent behavior is observed in agriculture products prices till 2005, but later on between 2005-2012 the prices converge at the national level. Interestingly, there is no evidence of national convergence for any groups of products during the most recent period of 2012-2018.

Figure A1 of the Online Appendix shows relative transition curves for different industries and

<sup>5</sup>Between 1997 and 2000, there is evidence of national convergence only for household appliances.

Table 4: Convergence test for different sub-periods

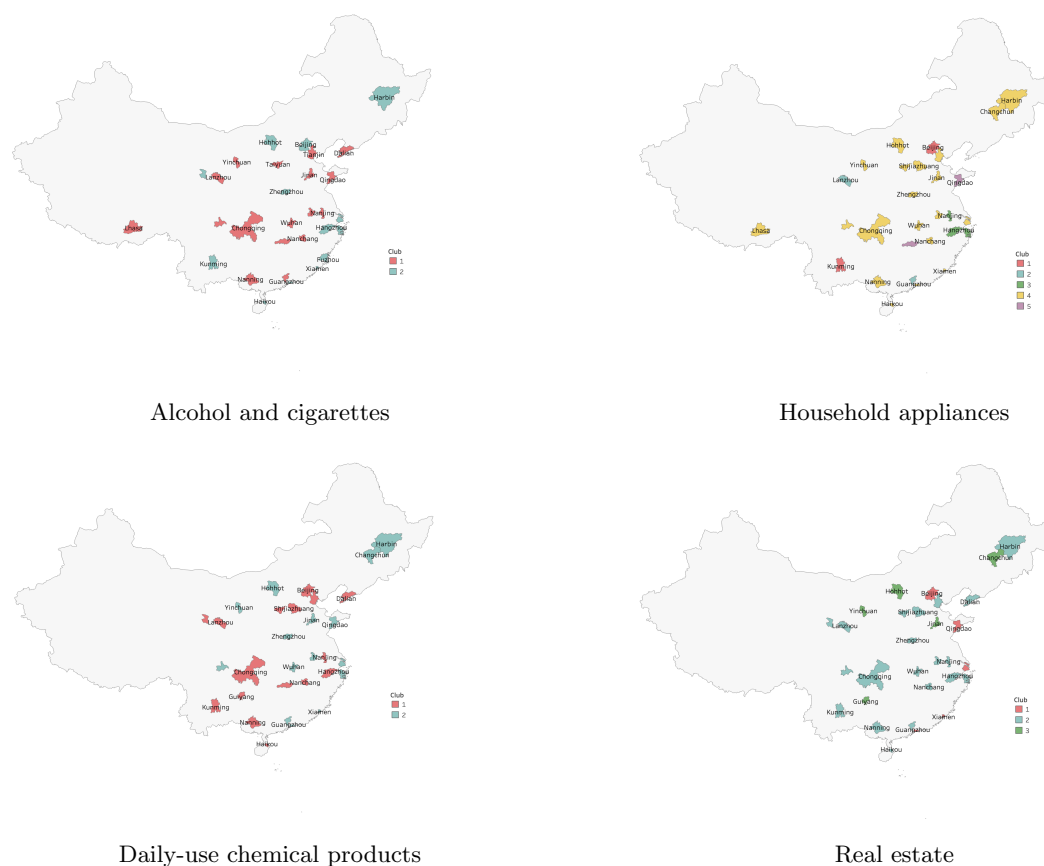
Industry	1997-2000		2001-2004		2005-2012		2012-2018	
	$\alpha$	T-stat	$\alpha$	T-stat	$\alpha$	T-stat	$\alpha$	T-stat
Household App	0.05	3.86	-1.24	-12.68	-1.14	-41.31	-0.56	-10.29
Agriculture	-2.09	-60.14	-0.43	-43.87	0.70	33.06	-0.19	-8.77
Alc&Cig	-0.28	-29.76	-0.36	-24.62	-0.16	-8.32	-0.41	-80.48
Services	-5.00	-5.54	0.65	46.01	0.05	2.66	-0.11	-30.96
Real Estate	NA		-1.11	-156.18	-0.73	-602.92	-0.82	-709.21
Perishable food	-1.16	-62.98	-0.68	-54.88	-0.39	-21.97	-0.93	-34.55
Non-Perishable food	-1.79	-63.84	0.44	11.10	-0.14	-10.99	-0.13	-8.56
Daily-use chemicals	NA		NA		NA		-0.99	-140.67

different sub-periods to demonstrate convergence patterns graphically.<sup>6</sup> Finally, Table A2 of the Online Appendix presents the results of the club convergence test for different industries for each period. The paper shows that the number of regional convergence clubs formed in each sector changes over time. For instance, for agricultural goods, there are five clubs in 1997-2000, three clubs in 2001-2004, and two clubs in 2012-2018. Interestingly, for some industries, such as real estate, alcohol and cigarettes, and perishable food products, the number of convergence clubs was the same in 2001-2004 and 2012-2018, while it dropped between 2005-2012, suggesting that there were some forces bringing prices in different cities closer to each other during 2005-2012, but they were not in place in the latter period of 2012-2018. Moreover, one might be interested in whether the same cities form the convergence clubs in different periods. To help answering this question, Table A3 presents the cities that form convergence clubs in each period. Also, the paper shows geographic maps with cities forming convergence clubs in different industries in the short and long run. The maps for the long-run convergence clubs are presented in Figure 3, while maps for various sub-periods are included in the Online appendix (see Figure A2). Geographic maps may help understand how the formations of clubs evolved over time and what factors may determine this.

<sup>6</sup>Only three sub-periods are presented for real estate as the data for this market has been available only since 2004.



Figure 3: Long run convergence clubs by industry



Firstly, Figure A2 provides more evidence in favor of national convergence than was recorded using the  $\log t$  test. Specifically, since 2001 for services, there is only one convergence club, which includes almost all locations except for two cities (Changchun and Yinchuan) that present divergent behavior in 2012-2018. So the  $\log t$  test rejects the null of national convergence because of several locations that significantly diverge from other cities. Similarly, for household appliances, only one large convergence club is identified in 2012-2018, covering all cities except for Changsha and Qingdao that form a divergent group. For non-perishable food, the PS test confirms overall convergence in 2001-2004 and identifies one large convergence club in 2005-2011, which includes most cities except for Lhasa and Haikou that form a divergent group. Therefore, in 2012-2018 there is evidence of convergence across most locations (except a few cities) in the market for household appliances and

services.

Secondly, the clubs become larger over time with the smallest number of clubs and the largest size of clubs observed in 2005-2011. In 1997-2000, the PS test identified five small clubs in the markets of non-perishable food products and agricultural goods, four clubs in the market of perishable food products, and three clubs for services. Then, between 2005 and 2011, there was evidence of national convergence for agricultural products, services, and non-perishable products, and the PS test identified only two large clubs for perishable goods. Similarly, the number of convergence clubs recorded for the real estate market in 2005-2011 is smaller than in the preceding and the following periods. The results suggest that the maximum degree of market integration in different product markets was observed between 2005 and 2012.

Finally, as Figure 3 shows, the formation of clubs varies across product markets. For instance, two convergence clubs are observed for daily-use chemicals and alcohol and cigarettes, but different cities form these clubs. Interestingly, while the real estate market has three convergence clubs, the majority of the locations belong to the second club, which is characterized by a middle level of prices as presented in Figure 2. The first club consists of only five cities (Beijing, Shanghai, Qingdao, Shenyang, and Xiamen), and the third club consists of six cities (Changchun, Guiyang, Hohhot, Jinan, Shenyang, and Yinchuan). Such formation of clubs may be highly associated with income and the development level of the cities that form each club.

The market for household appliances appeared to have the largest number of convergence clubs; however, the fourth club includes most cities (21 out of 32), while the remaining clubs consist of only several locations (2 or 3 depending on the club). Relatively high prices observed in the first three clubs (and documented in Figure 2) as compared to clubs 4 and 5 could be explained by high transportation cost for large-size appliances, which is in line with the arbitrage theory. Therefore, another potential explanation for the formation of clubs could rely on the transportation cost and arbitrage opportunities. The next section tries to explain the formation of clubs using various

variables related to traded- and non-traded factors.

### 4.3 Determinants of Club Convergence

This section investigates the factors that may affect the formation of the price convergence clubs using multinomial logit regression. Specifically, the formation of price convergence clubs for various industries could be explained by industry-specific variables, such as tradeability,  $\gamma_{ht}$ <sup>7</sup>, and the share of non-traded input used in the production of goods in the industry,  $\alpha_{ht}$ <sup>8</sup>, as well as by the city-specific explanatory variables such as wages, the average distance from other cities, and population density<sup>9</sup>. The industry-specific variables allow us to examine whether there is a higher probability of having only one convergence club and thus having a lower degree of market segregation for highly traded goods with low non-traded input share. The second set of city-level variables helps us understand regional factors that sort cities into convergence clubs.

The following model is estimated using the industry-level convergence club data for different sub-periods:

$$\log\left(\frac{\text{prob}(Y_{iht} = 2)}{\text{prob}(Y_{iht} = 1)}\right) = \beta_{0,2} + \beta_{1,2}\alpha_{ht} + \beta_{2,2}\gamma_{ht} + \pi_2'z_{it} + \epsilon_{iht,2} \quad (4)$$

$$\log\left(\frac{\text{prob}(Y_{iht} = 3)}{\text{prob}(Y_{iht} = 1)}\right) = \beta_{0,3} + \beta_{1,3}\alpha_{ht} + \beta_{2,3}\gamma_{ht} + \pi_3'z_{it} + \epsilon_{iht,3}, \quad (5)$$

where  $\text{prob}(Y_{iht} = k)$  is the probability that city  $i$  belongs to the club  $k$  for industry  $h$  in period  $t$ ;  $\alpha_{ht}$  is the share of the non-traded input required to produce goods in industry  $h$  in China;  $\gamma_{ht}$  is estimated tradeability of goods in industry  $h$  in China;  $z_{it}$  is a vector of city-level explanatory variables. Equation (4) is estimated using the multinomial logit model where club 1 is set as the reference group<sup>10</sup>. Table 5 reports the results.

<sup>7</sup>Tradeability of goods in industry  $h$  is calculated as sum of import ( $M_{ht}$ ) and export ( $X_{ht}$ ) over gross output ( $Y_{ht}$ ) of the industry in China,  $\gamma_{ht} = \frac{X_{ht} + M_{ht}}{Y_{ht}}$ . The data are obtained from Glushenkova (2020).

<sup>8</sup>Non-traded input shares required to produce goods in each industry are calculated using Input-Output tables of China that available for every five years between 1997-2017, accessible at <http://cdi.cnki.net/Titles/SingleNJ?NJCode=N2020040339>

<sup>9</sup>The data are obtained from EPS China and available at [www.epschinadata.com](http://www.epschinadata.com).

<sup>10</sup>Clubs 4 and 5 are excluded from the analysis as their appearance is rare in the sample.

Table 5: Determinants of regional convergence clubs

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Club 2						
Non-traded input	0.313 (0.603)	0.299 (0.619)	0.437 (0.628)	0.784 (0.643)	0.783 (0.643)	0.458 (0.627)
Tradeability	-1.801*** (0.670)	-1.966*** (0.695)	-1.592** (0.708)	-2.032** (0.727)	-2.037** (0.726)	-1.569** (0.707)
Wages			-0.046 (0.119)	0.007 (0.121)	-0.007 (0.121)	-0.052 (0.119)
Pop.Density			-0.343** (0.156)	-0.012 (0.156)		-0.270** (0.137)
Avg. Distance			-0.532 (0.530)			
Distance from club 1				1.628*** (0.429)	1.645*** (0.388)	
Constant	0.300 (0.269)	0.450 (0.589)	6.648 (4.405)	-11.29** (3.852)	-11.48*** (3.167)	2.448* (1.346)
Club 3						
Non-traded input	1.846*** (0.630)	1.817*** (0.653)	2.405*** (0.676)	2.831*** (0.703)	2.827*** (0.702)	2.432*** (0.675)
Tradeability	-3.070*** (0.889)	-3.349*** (0.923)	-2.376** (0.931)	-2.032*** (0.965)	-3.016*** (0.963)	-2.348** (0.930)
Wages			-0.392** (0.160)	-0.308* (0.163)	-0.307* (0.163)	-0.401** (0.159)
Pop.Density			-0.485** (0.206)	-0.048 (0.204)		-0.376** (0.178)
Avg. Distance			-0.752 (0.682)			
Distance from club 1				2.359*** (0.524)	2.299*** (0.464)	
Constant	-0.750** (0.316)	-0.879 (0.789)	11.31** (5.713)	-14.98*** (4.856)	-14.26*** (3.865)	5.341*** (1.777)
City FE		YES				
Observations	584	584	576	576	576	576

Notes: Standard errors presented in parenthesis. Asterisks indicate a significance level of the coefficients \*\*\*1%, \*\*5%, and \*10%. Distance from club 1 is correlated with population density with the correlation coefficient equal to 0.48. Thus, these variables are included in the model one at a time to avoid the multicollinearity problem.

The results show that tradeability plays an important role in explaining the formation of price convergence clubs. The industries producing highly traded goods tend to form a smaller number of convergence clubs, while the probability of having several clubs increases for the industries producing less traded goods. Therefore, markets for less traded goods tend to be more segregated than markets for highly traded goods. Similarly, the formation of price convergence clubs can be explained by the share of non-traded inputs used in the production of goods. There is a higher likelihood of observing more than two clubs for products with a larger share of non-traded input.

However, the non-traded input share cannot explain the formation of the second club as opposed to the first club, perhaps, because only industries with significantly large non-traded input share form more than two clubs.

To further investigate the importance of the local input cost, wages are included in the regressions (columns 3-6 of Table 5). The results suggest that cities with high average wages tend to form high-price convergence clubs (i.e., club 1 or club 2) with a higher probability than cities with low average wages. Therefore, both the share and the cost of the non-traded input may explain the degree of market (dis)integration.

The regressions also include population density as a proxy for the market size. Column 3 of Table 5 shows that the market size has a negative effect on the likelihood that the city belongs to the second or third convergence club. Cities with a large market size form the first convergence club (characterized by the highest price level) with a higher probability than cities with a small market size.

Finally, average distance between city  $i$  and other cities in the sample is used to estimate the effect of trade cost on formation of convergence clubs. As shown in column 3 of Table 5 the effect of average distance on club formation is not significant. This could be explained by the fact that there is no much variation in this parameter. However, the picture changes once a different distance proxy is used. The average distance between city  $i$  and cities belonging to club 1, i.e., the core convergence club, has significant positive effect on the formation of the second and the third clubs. Cities located further away from the core club would form other convergence clubs with a higher probability. Once again, this implies the key role of trade cost in determining price differences between cities.

In summary, the share and the cost of non-traded input used in the production of goods as well as tradeability and trade cost play an essential role in explaining the formation of regional convergence clubs.

## **5 Conclusion**

This paper assessed the extent of price integration across Chinese cities for different product markets and provided new insights into the changes of domestic convergences patterns that took place over time, especially in the recent period of 2012-2018.

First, the paper investigated the existence of the long-run domestic convergence clubs in China using data for 1997-2018. While the paper did not find evidence of national price convergence for almost half of product markets, strong evidence of regional convergence clubs was recorded. Further analysis at the industry level confirmed the findings that there is national convergence for products belonging to specific industries, such as agriculture, food, and services. At the same time, cities form regional convergence clubs for items belonging to the sectors, such as household appliances, daily-use chemicals, and real estate.

Second, the paper assessed the short-run changes in the domestic convergence by performing a convergence test for different sub-periods. The results show that after price liberalization reform in 1997, there was divergent behavior of prices across cities with evidence of national convergence only for household appliances. However, since the early 2000s, prices started to converge, and this trend held up until the beginning of the 2010s. Moreover, the clubs grow over time with the smallest number of clubs and the largest size of the clubs observed in 2005-2011, suggesting that the maximum degree of market integration in different product markets was achieved between 2005 and 2011.

Finally, the paper showed that the formation of price convergence clubs can be explained by the share and the cost of non-traded inputs into production, tradeability, distance, and differences in market size. The importance of non-traded inputs implies that policies which encourage liberalization in the labor market and mobility of workers could be crucial for enhancing domestic market integration in China.

The analysis has uncovered a set of new facts to be taken into account by policymakers. For example, the data shows that China has been moving towards a nationally integrated market up until the early 2010s, while in recent years, China's domestic market has become more fragmented. This trend could be associated with the housing boom or the consequences of the global financial crisis. Nevertheless, further economic reforms may be needed to reinforce the process of domestic price integration.

This study is just the first step to record patterns of regional price convergence. Further study is required to identify forces that caused price divergence in the recent period and assess the effect of China's economic reforms on domestic price convergence. One possible research direction is to explore the relationship between formation of the price convergence clubs and formation of the industrial clusters in China. As shown by Guo et al. (2020), the industrial clusters enhance economic growth and reduce inequality, which can be conducive to price convergence and result in more efficient resource allocation. Therefore, this future research could contribute to the knowledge on economic geography, price convergence, and the economic development of China.

## **Data availability statement**

The data that support the findings of this study are available from the China Price Information Center (<http://www.chinaprice.com.cn/>). The data cannot be made publicly available due to the license agreement.

## **Acknowledgement**

This work is supported by Natural Science Foundation of China with project code 71950410627.

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## Online Appendix

Table A1: Average price in clubs for different goods

Item	club1	club2	club3	club4	club 5
Air conditioner 1.5 horse power	3749.61	3756.98	3174.12	2864.97	
Beer canned, 350ml	4.25	3.56	3.30		
Bicycle female	449.16	370.00	324.44	249.74	
Bicycle Phoenix QE-65	441.22	393.42	365.81	359.63	322.69
Carbonated beverages, 2.5L	6.66	6.51	6.42		
Color TV, 25 inch	1704.79	1584.56			
Commercial housing, Second-class	15848.77	9055.55	5136.87		
Computer, mainstream brand	4261.84	3710.91	3594.32	3200.83	
Cookies (100 gram/bag)	3.69	2.14			
Digital camera (3 mln pixel, 3x zoom)	2175.28	1667.17	1306.94		
Dish-washing liquid (500g)	5.84	4.46	4.12		
Domestic cigarette (high-end)	49.07	43.90	41.70		
Electric hot water heater 50L	1836.18	1425.03	917.18		
Electricity 220v	0.53	0.48	0.45	0.43	
Fish, carassius live (350 gram)	11.47	9.16			
Fresh beef tendon meat	36.42	31.27			
Fresh pork without bones	12.27	11.15			
Fresh pork ribs	21.62	16.84			
Fresh pork skinned hind leg meat	13.26	11.92			
Gas stove	1632.84				
Hairtail frozen (250 gr)	10.36	7.00			
Imported cigarettes, 84mm	21.34	16.45			
Infant formula domestic. (400 gr)	83.56	65.97	62.26	50.50	
Infant formula imported (400 gr)	118.46	77.30	71.07		
Instant noodles (110 grams/pack)	2.85	2.55	2.41		
Laundry detergent (1kg)	14.07	11.76			
CT plain scan of the skull	234.67	149.35	127.68		
Men's cotton vest, YOUR SUN cotton	19.00	17.98	16.93	15.44	
Microwave oven, Mechanical	909.60	648.51			
Mobile phone fee, China Mobile, local call	0.46	0.32			
Mobile phone fee, China Telecom, local call	0.39	0.23			
Mobile phone fee, China Unicom, local call	0.42	0.30			
Mono-sodium glutamate (1 bag)	11.11	9.18			
Peanut oil (barrel)	111.30	101.67	98.50		
Refrigerator, 210-250 dm3	3345.43	2709.69	2529.73		
Rent of Low-cost House	4.44	2.27	1.76		
Rent of property, city centre	65.00	34.63	24.80		
Rent of property, 2-class	76.89	53.23	28.96	20.68	19.13
Rent of property, suburb	44.43	34.88	22.70	15.11	11.26
Second-hand commercial housing, 2-class	23069.81	8008.73	3888.87		
Second-hand commercial housing, 3-class	12520.18	5072.29	2738.88		
Shampoo (750 ml)	73.33	53.45	34.02		
Shower gel (750 ml)	47.84	33.39	30.32		
Soap (125 gr)	5.47	5.21	4.76	4.51	
Soy sauce (500 ml)	5.18				
Soybean blend oil (barrel)	60.61	58.34	55.75	48.74	
Soybean oil, 500ml	4.66	4.59			
Toothpaste (120 gr)	8.96	5.28			
Washing machine, front load (5kg)	3427.13	3087.64	2694.64	2668.73	
Washing machine, top load (5kg)	1846.04	1630.10			
Women's cotton sweater, YOUR SUN cotton	57.62	40.32	37.98	37.21	35.83
Women's cotton trousers, YOUR SUN cotton	54.20	37.79	35.13	34.96	
Sewage treatment fee	0.86	0.62	0.56		
University tuition, artistic college	8131.55	5062.61			

Table A2: Club formation by industry for different periods

Industry	1997-2000					2001-2004						
	club1	club2	club3	club4	club5	Diverg.	club1	club2	club3	club4	club5	Diverg.
Agriculture	0.04	0.11	0.61	1.45	-0.36	-4.590*	0.12	0.61	2.81	club4	club5	-2.246*
Alc&Cig	0.37	0.62				-0.205*	0.03	0.58	-0.05	2.97		
Household App							0.29	0.16	0.16			
Non-Perishable goods	0.07	0.00	-0.42	0.58	1.42	-2.273*	-0.01	0.21	3.35	-0.72		
Perishable goods	0.05	0.15	0.15	0.95		-2.159*						
Services	-1.08	0.00	3.77				0.41	0.09	0.22	1.96		-1.374*
Real Estate				NA						NA		
Daily-use chemicals				NA								
Industry	2005-2012					2012-2018						
	club1	club2	club3	club4	club5	Diverg.	club1	club2	club3	club4	club5	Diverg.
Agriculture	0.01	0.40	0.04				-0.02	1.02				
Alc&Cig	0.45	0.16	0.32	0.32	0.32		0.03	0.11	0.02	0.39		-0.355*
Household App							0.12					-4.461*
Non-Perishable goods	0.17						0.19	0.10				
Perishable goods	0.25	0.01				-2.678*	0.33	0.12	0.46	0.60		
Services							-0.01	-0.50				
Real Estate	0.08	0.14	0.28				0.42	0.65	0.04	0.33		
Daily-use chemicals				NA			-0.02	0.28				

Notes: This table presents estimates of the club convergence coefficients. The last column presents coefficient estimates of the divergent group. Asterisks indicate a significance level of \*1% and \*\*5% at which the null of convergence is rejected. The table presents the final club classification after testing for potential existence of large convergence clubs and merging small clubs into larger ones where possible in accordance with Phillips and Sul (2007) club merging procedure.

Table A3: Formation of convergence clubs by industry

Cities	Agriculture			Alcohol & Cigarettes			Household appliances			Non-perishable goods					
	L.R.	97-00	01-04	05-11	12-18	L.R.	97-00	01-04	05-11	12-18	L.R.	97-00	01-04	05-11	12-18
Beijing	0	0	3	0	2	3	1	1	2	1	0	4	1	1	2
Changchun	0	1	1	0	2	4	4	1	2	4	0	4	1	1	2
Changsha	0	3	3	0	1	1	5	1	3	5	0	1	1	1	2
Chengdu	0	3	1	0	1	2	4	1	2	4	0	3	1	1	2
Chongqing	0	3	1	0	1	1	4	1	3	4	0	3	NA	1	2
Dalian	0	2	2	0	1	2	4	1	NA	4	0	5	1	1	1
Fuzhou_FJ	0	2	1	0	2	3	4	1	3	4	0	1	1	1	2
Guangzhou	0	2	1	0	1	3	2	1	2	2	0	2	1	1	1
Guiyang	0	2	1	0	1	3	4	1	1	1	0	2	1	1	2
Haikou	0	4	1	0	1	3	4	1	3	4	0	1	1	1	1
Hangzhou	0	2	1	0	1	3	4	1	1	3	0	2	1	1	1
Harbin	0	3	1	0	2	4	4	1	1	4	0	1	1	1	2
Hefei	0	1	1	0	2	3	4	1	3	4	0	1	NA	1	1
Hohhot	0	5	2	0	2	3	4	1	2	4	0	5	1	1	2
Jinan	0	5	1	0	1	3	4	1	2	4	0	1	1	1	1
Kunming	0	5	1	0	1	3	2	1	3	1	0	1	1	1	1
Lanzhou	0	5	1	0	2	3	2	1	3	2	0	1	1	1	1
Lhasa	0	1	1	0	1	3	2	1	3	2	0	1	1	1	1
Lhassa	0	1	1	0	2	4	4	1	1	4	0	1	1	1	2
Nanchang	0	1	3	0	1	3	4	1	2	4	0	3	1	1	2
Nanjing	0	3	1	0	1	1	3	1	1	3	0	2	1	1	2
Nanning	0	5	1	0	1	3	4	1	1	4	0	2	1	1	2
Ningbo	0	2	1	0	1	2	4	1	1	4	0	1	1	1	2
Ningbo	0	2	1	0	1	4	3	1	3	3	0	1	1	1	1
Qingdao	0	2	2	0	1	1	5	1	1	5	0	1	1	1	1
Shanghai	0	2	1	0	2	3	4	1	2	4	0	2	1	1	2
Shenyang	0	4	2	0	1	3	4	1	NA	4	0	1	NA	1	1
Shenzhen	0	1	1	0	1	2	4	1	3	4	0	4	1	1	2
Shijiazhuang	0	5	1	0	2	4	4	1	3	4	0	4	1	1	2
Shijiazhuang	0	5	1	0	2	3	4	1	3	4	0	4	NA	1	2
Taiyuan	0	5	1	0	1	2	4	1	3	4	0	4	NA	1	2
Tianjin	0	5	3	0	1	2	4	1	3	4	0	2	1	1	2
Urumqi	0	3	1	0	2	1	4	1	NA	4	0	2	1	1	2
Wuhan	0	4	1	0	1	2	4	1	3	4	0	2	1	1	1
Xiamen	0	3	1	0	1	3	4	1	3	4	0	2	1	1	2
Xiamen	0	5	D	0	2	2	4	1	3	4	0	2	1	1	2
Xian	0	5	2	0	1	2	3	1	3	1	0	2	1	1	1
Xining	0	2	1	0	2	3	4	1	NA	4	0	2	1	1	1
Xining	0	3	1	0	2	2	4	1	4	4	0	1	1	1	2
Yinchuan	0	3	1	0	2	2	4	1	4	4	0	1	1	1	2
Zhengzhou	0	5	1	0	2	2	4	1	1	4	0	1	1	1	2

Notes: This table presents formation of convergence clubs in each industry. The first column in each industry presents long run (L.R.) clubs, i.e. clubs existing between 1997-2018. The remaining columns in each industry present short run (ShR) clubs, i.e. clubs formed in different sub-periods. 0 means there is strong evidence of national convergence and thus we do not apply club convergence test.

Table A3 (cont.): Formation of convergence clubs by industry

Cities	Perishable goods			Services			Real Estate			Daily-use chemicals					
	L.R.	97-00	01-04	05-11	12-18	L.R.	97-00	01-04	05-11	12-18	L.R.	97-00	01-04	05-11	12-18
Beijing	0	2	2	1	2	0	1	1	1	1	1	1	1	1	1
Changchun	0	2	2	2	4	0	1	1	1	1	3	1	2	2	2
Changsha	0	2	2	1	2	0	1	1	1	1	2	1	1	1	1
Chengdu	0	2	2	2	2	0	1	1	1	1	2	4	1	3	2
Chongqing	0	2	1	2	1	0	1	1	1	1	2	3	4	1	1
Dalian	0	3	1	2	4	0	1	1	1	1	2	3	1	1	1
Fuzhou_FJ	0	2	2	1	1	0	1	1	1	1	2	3	2	2	2
Guangzhou	0	1	1	1	1	0	2	1	1	1	2	2	2	2	2
Guiyang	0	1	1	1	1	0	2	1	1	1	3	3	2	4	1
Haikou	0	1	1	1	1	0	1	1	1	1	2	4	2	3	1
Hangzhou	0	2	1	1	2	0	1	1	1	1	2	1	1	1	1
Harbin	0	2	2	1	4	0	2	1	1	1	2	2	3	4	2
Hefei	0	3	2	1	3	0	1	1	1	1	2	3	2	2	2
Hohhot	0	3	1	1	1	0	2	1	1	1	3	3	3	4	2
Jinan	0	4	1	1	4	0	2	1	1	1	3	2	2	4	2
Kunming	0	2	1	1	4	0	1	1	1	1	2	2	2	3	1
Lanzhou	0	2	2	1	2	0	1	1	1	1	2	2	2	3	1
Lhasa	0	1	1	2	4	0	2	1	1	1	2	NA	2	2	1
Nanchang	0	2	3	2	4	0	2	1	1	1	2	3	2	3	1
Nanjing	0	3	2	2	3	0	1	1	1	1	2	1	2	3	1
Nanning	0	2	1	1	2	0	1	1	1	1	2	2	2	3	1
Ningbo	0	2	1	2	2	0	1	1	1	1	2	2	2	3	2
Qingdao	0	4	1	2	3	0	2	1	1	1	1	3	1	1	2
Shanghai	0	2	1	1	2	0	1	1	1	1	1	1	2	1	2
Shenyang	0	2	2	1	4	0	1	1	1	1	3	3	3	4	1
Shenzhen	0	2	1	1	1	0	1	1	1	1	1	1	2	2	2
Shijiazhuang	0	2	1	1	4	0	2	1	1	1	2	3	2	2	1
Taiyuan	0	2	1	1	2	0	2	1	1	1	2	2	2	4	1
Tianjin	0	2	1	1	3	0	1	1	1	1	2	2	2	2	1
Urumqi	0	3	2	1	2	0	1	1	1	1	2	2	3	1	1
Wuhan	0	2	2	1	1	0	3	1	1	1	2	2	2	2	2
Xiamen	0	1	2	1	1	0	1	1	1	1	1	2	2	1	2
Xian	0	3	1	2	2	0	2	1	1	1	2	2	3	3	2
Xining	0	2	2	1	2	0	3	1	1	1	2	3	3	1	1
Yinchuan	0	3	1	2	2	0	3	1	1	1	3	2	3	4	2
Zhengzhou	0	4	3	1	2	0	1	1	1	1	2	3	2	2	2

Notes: This table presents formation of convergence clubs in each industry. The first column in each industry presents long run (L.R.) clubs, i.e. clubs existing between 1997-2018. The remaining columns in each industry present short run (ShR) clubs, i.e. clubs formed in different sub-periods. 0 means there is strong evidence of national convergence and thus we do not apply club convergence test.

Figure A1: Relative transition curves by industry

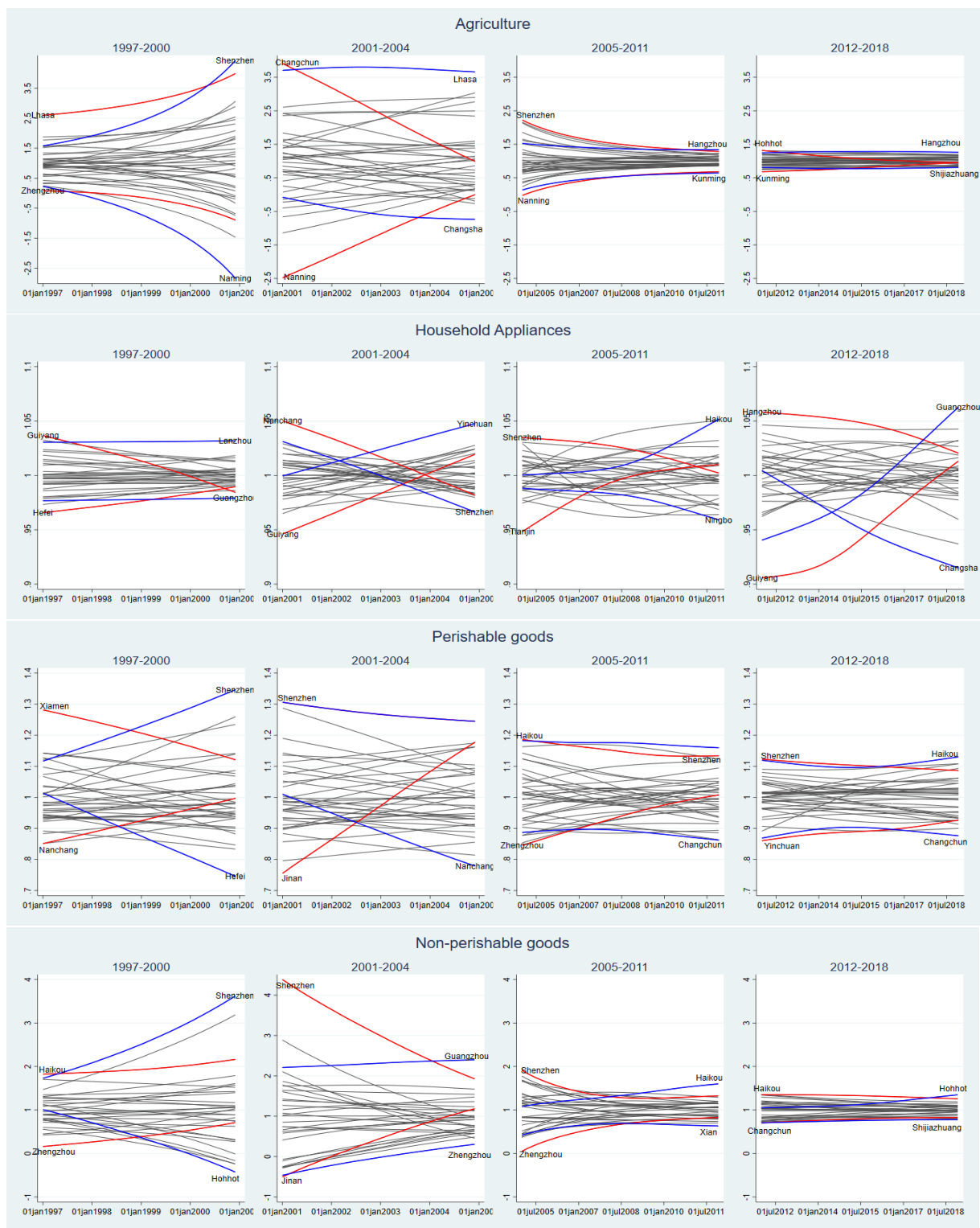


Figure A1 (cont.): **Relative transition curves by industry**

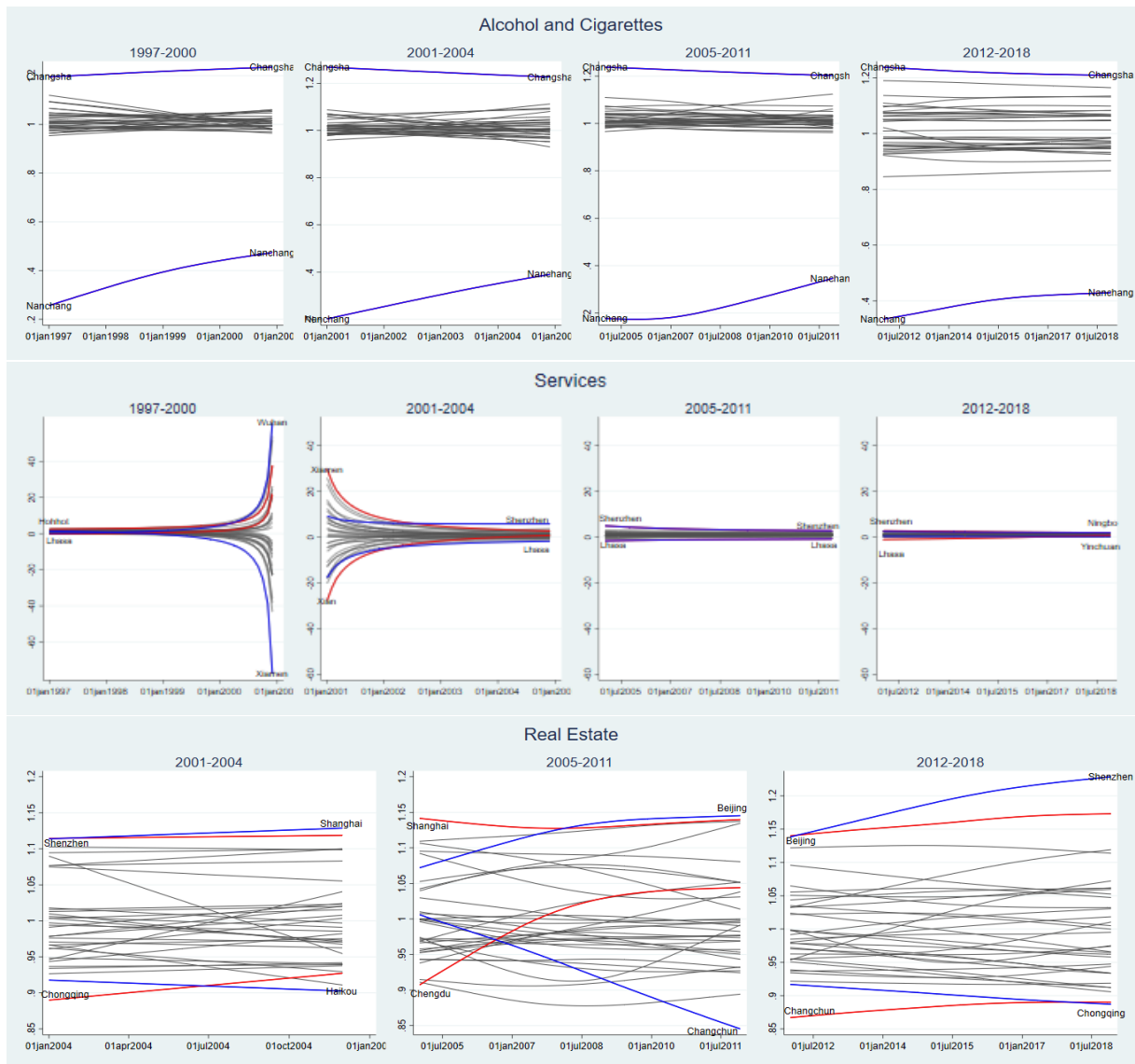
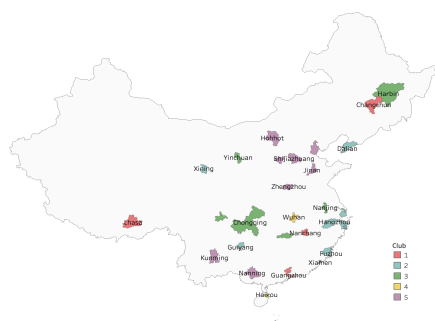
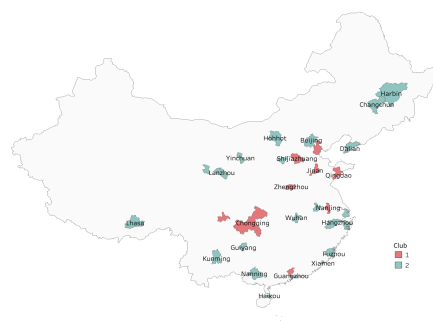


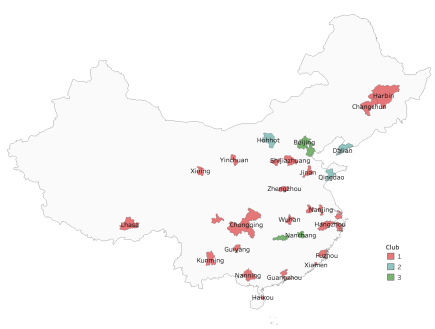
Figure A2: Evolution of the price convergence clubs



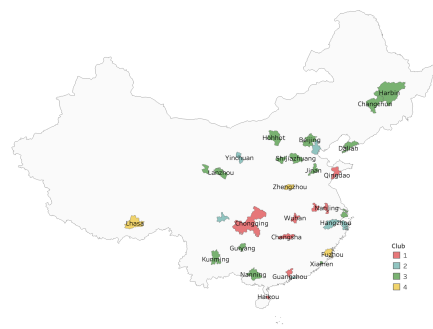
Agriculture, 1997-2000



Alcohol and cigarettes, 1997-2000



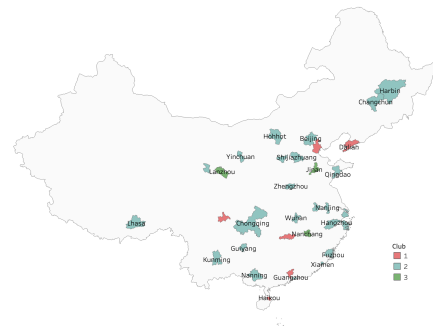
Agriculture, 2001-2004



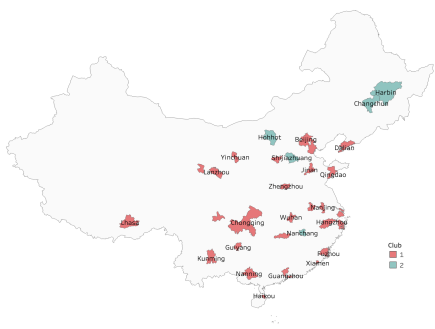
Alcohol and cigarettes, 2001-2004



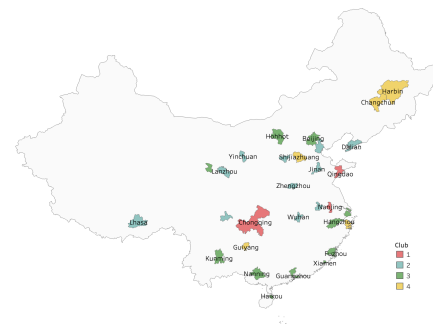
Agriculture, 2005-2011



Alcohol and cigarettes, 2005-2011



Agriculture, 2012-2018



Alcohol and cigarettes, 2012-2018



Figure A2 (cont.): Evolution of the price convergence clubs



Non-perishable goods, 1997-2000



Perishable goods, 1997-2000



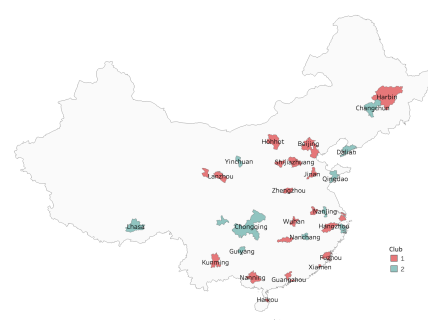
Non-perishable goods, 2001-2004



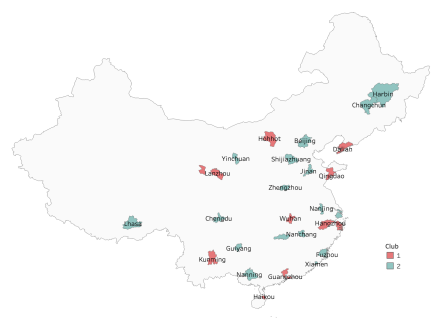
Perishable goods, 2001-2004



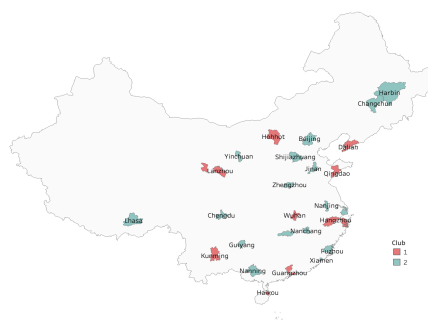
Non-perishable goods, 2005-2011



Perishable goods, 2005-2011



Non-perishable goods, 2012-2018



Perishable goods, 2012-2018

Figure A2 (cont.): Evolution of the price convergence clubs

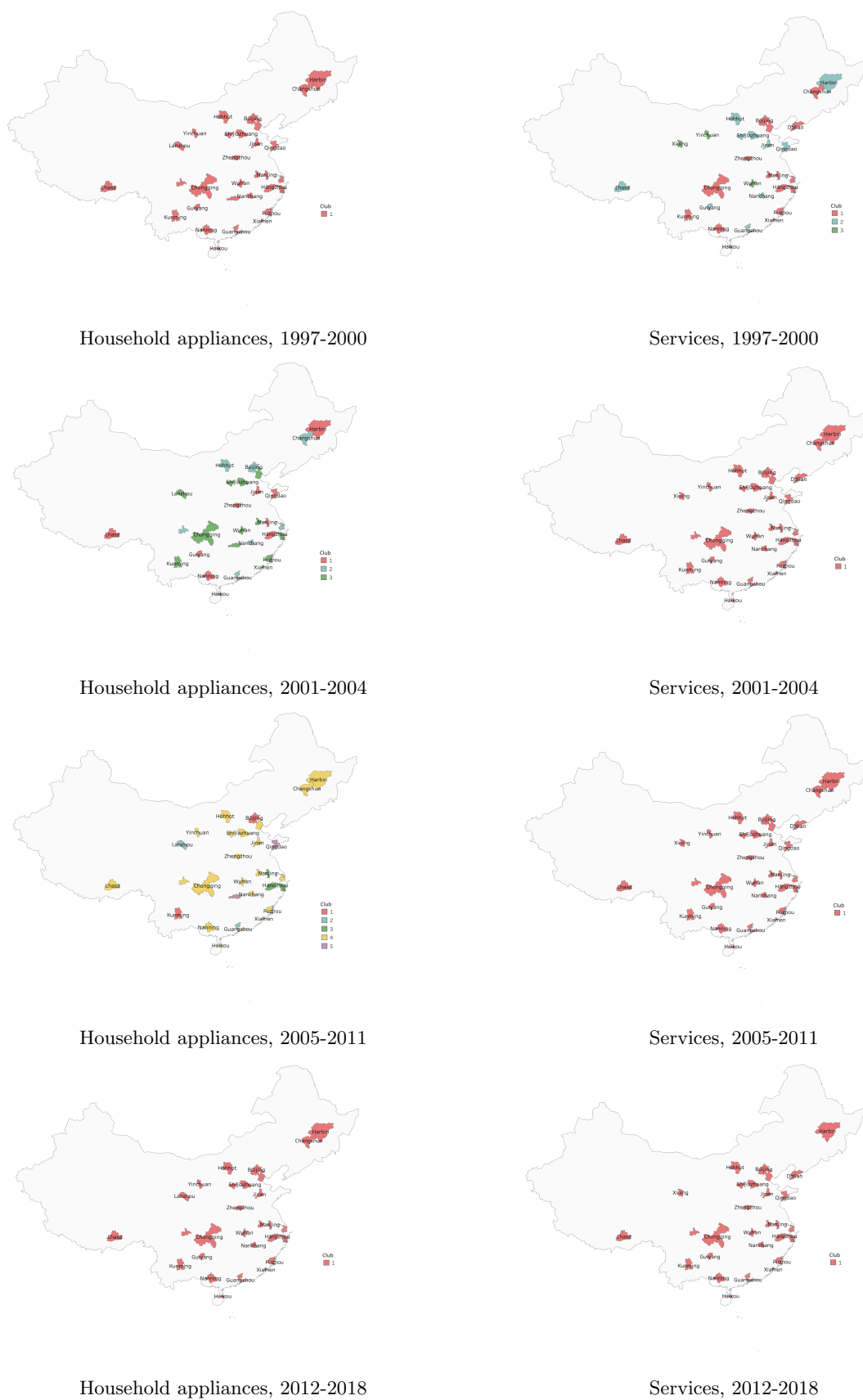
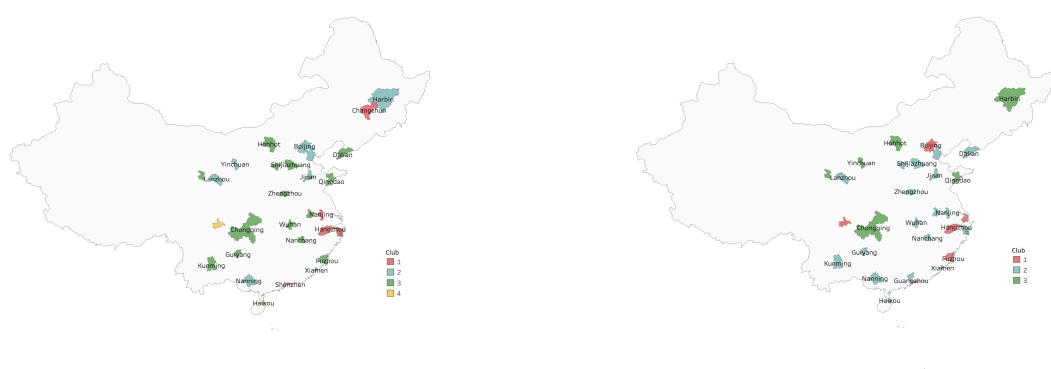


Figure A2 (cont.): Evolution of the price convergence clubs

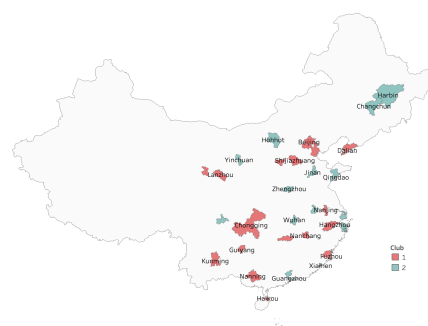


Real estate, 2001-2004

Real estate, 2005-2011



Real estate, 2012-2018



Daily-use chemical products, 2012-2018