Understanding Urban-Rural Price Differences in China: The Role of Infrastructure Development

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Abstract

We study evolution of price differences between urban and rural areas across 25 Chinese provinces over the period 1985-2018. While there is an evidence of convergence separately for urban markets and for rural markets in China, the gap between urban and rural price levels within each province remains large and persists over time. We also record notable differences in urban-rural price gaps between provinces, yet, there is evidence of regional convergence of these price gaps. Using spatial econometric analysis, we find that road and railway construction has strong negative effect on the urban-rural price divide, indicating that infrastructure development is conducive to market integration between urban and rural areas in China.

Keywords: Price level, Convergence, Urban-Rural gap, Infrastructure, Spatial econometric analysis.

JEL Classification: P25, O18, O53.

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1 Introduction

Urban and rural imbalance has been an important issue during the development process of many countries, especially during the process of industrialization and urbanization (Kibriya et al. (2019) and Azam (2019)). China is not an exception. Although its growth performance has been remarkable over the last forty years, urban and rural imbalance in China contributes a large portion of overall inequality and has become one of the major constraints for further growth (Fan & Zhang (2004), Molero-Simarro (2017), Luo et al. (2020)).

China's urban-rural duality is deeply rooted in its early centrally planned strategies that favored heavy industry development over agriculture (Yang (1999), Liu et al.(2019)). The government controlled agricultural production and prices in the sector while also restricting migration from rural to urban area. The extracted agricultural surplus was then directed for urban capital accumulation, as capital was mainly concentrated in urban area and a large share of rural labor was constrained in the agricultural sector prior to 1978 (before the beginning of liberalization reforms). This policy caused large imbalances in the development of the urban and rural markets. The urban-rural duality take different forms in China. For instance, the wide gap in productivity of urban and rural labor leads to a noticeable urban-rural income inequality (e.g., Yang (1999) and Gao et al. (2019)). The literature documents a greater urban-rural income gap in China than in other developing countries. Moreover, historical segregation of the urban and rural markets in China resulted in wide differences in terms of social welfare, access to basic public services and living standard (Ye (2009) and Ma et al. (2019)).

Majority of papers document the urban rural gap from the perspective of urban rural income differences. For instance, Su et al. (2019) studies the role of financial development on urban rural income gap in China's provinces; Huang et al.(2020) investigate the city level urban rural income gaps. While our paper develops in the similar vein, we differ from previous literature by approaching the urban-rural divide from the perspective of the differences in the cost of living between urban and rural areas in China. This not only accounts for demand side factors such as income differences that influence the price level, but also supply side factors that embody in the regional price indicators. Study of the price differences can contribute to understanding of the actual living standards in regions in terms of nominal urban-rural inequality and real inequality (Li & Gibson (2014)), and can provide useful insights for policymakers to promote regional integration.

Although, urban rural price difference is an important subject, a very limited number of papers explored this topic. For instance, Gong & Xin (2008) study the regional price differences only in urban China; Brandt & Holz (2005) estimate the spatial price differences in China including urban and rural price gap. While these papers tried to refine the regional comparison of income inequality by disentangling the price factor, our paper focuses on price integration of urban and rural markets in China and determinants of urban-rural price differences.

This study is closely related to Zhang (2010), who studies price differences in China using urban-rural inflation gap based on CPI indexes. However, inflation differences provide no insights about the actual cost of living in the urban and rural areas but rather the pace of price changes. Our paper instead uses the actual estimated prices for a representative basket of goods and services to measure the differences in urban and rural cost of living. Moreover, this is the first paper to focus on urban-rural price differences across individual provinces in China instead of studying the aggregate national urban-rural price gap.

First, we study evolution of urban-rural price gap in China and its persistence. We find that the gap has been increasing significantly between 1985 and the late 1990s, and started to shrank in the late 1990s providing some evidence of the price convergence between the rural and urban areas after the beginning of the 2000s. This is consistent with recent studies on domestic market integration that find evidence of an overall convergence of prices across Chinese cities (Lan & Sylwester (2010) and Li et al.(2018)) in recent years. However, the existing literature is silent to whether this convergence appears due to higher degree of integration for same-type markets (e.g. urban markets) or due to higher degree of integration for different types of markets (i.e. urban and rural area), or both. Our paper contributes to the analysis of the domestic market integration by looking at the urban-rural price differences and intra-provincial price integration. We record price convergence for the same types of markets consistent with the results of the above mentioned papers. Nevertheless, applying Augmented Dickey-Fuller unit root tests we reveal that the price differences between urban and rural areas are persistent in majority of provinces, suggesting that the urban-rural market segmentation is still prominent and hinders further integration of domestic markets.

Furthermore, we investigate existence of convergence clubs in the provincial price differences using the nonlinear time-varying heterogeneous factor model proposed by Phillips & Sul (2007) in order to understand whether price gap vary significantly across Chinese regions. We find no evidence of overall convergence in price gaps at the national level (for all provinces), however the test suggests existence of convergence within a group of provinces. The largest convergence club includes 19 out of 25 provinces under study implying that that these provinces are characterized by similar dynamics of the urban-rural price gaps.

Finally, we try to understand the importance of various factors in narrowing urban-rural price gap in China. Using urban-rural income inequality, we examine whether provinces with smaller income gaps between the urban and rural areas enjoy smaller price gap as suggested by Balassa-Samuelson hypothesis (Balassa 1964; Samuelson 1964). Interestingly, we find that the relationship between urban-rural price gap and income inequality is characterised by the inverted U-shape, that is, price gap first rises with the increase in inequality and then decreases. To our best knowledge, this has not been discussed in the price literature before, and so we contribute to the field by providing new insights into the effect of income inequality on price gaps at the intra-regional level.

Then, using transportation-related variables, we study if provinces with better access to transport infrastructure exhibit relatively smaller urban-rural price differences as suggested by the trade theory. According to the existing literature, infrastructure development may reduce transportation cost and prices (Cosar & Demir (2015), and Donaldson (2018)), improve productivity (Fan & Zhang (2004), Teruel & Kuroda (2005), Wan & Zhang (2018)), stimulate the formation of urban agglomerations, reduce poverty, inequality and promote growth (Roberts et al.(2019) and Medeiros et al.(2022)), and through spillover effects enhance regional integration (e.g., Song et al. (2012) and Börjesson et al. (2019)). Our findings show that provinces with better transport infrastructure, such as road and railroad, exhibit smaller urban-rural price divide. The development of transport infrastructure helps to narrow price gap mainly via the trade-related channel, i.e. due to the increasing flow of goods and reduction in the cost of trade. Interestingly, railway construction has two simultaneous opposite effects on the price gap - it promotes flow of goods which leads to price convergence, and at the same time it stimulates migration, which is found to be conducive to price divergence via widening the urban-rural income inequalities. Overall, the development of both transportation modes help to narrow price gap via the trade-related channel, i.e. due to the increasing flow of goods and reduction in the cost of trade.

The integrated development of urban and rural areas has become an increasingly important concern for policymakers in China. Chinese government has realized that urban-rural divide become a major obstacle for further growth in China and has carried out a series of reforms to address these imbalances. In 2017 China proposed the rural revitalization policy aiming at narrowing the gap between urban and rural areas, promoting balanced development and realizing the equivalent life quality between urban and rural residents. Therefore, the findings of this paper should be of interest to policymakers, as they show how urban-rural divide has evolved throughout the last forty years from the perspective of price differences and implicitly evaluate the efficiency of the reforms in reducing urban-rural market segregation and promoting price integration. In particular, the massive transport infrastructure development in the last few decades is found to be conducive to urban-rural price convergence. Thus, further improvement of infrastructure can promote the process of urban-rural economic integration within Chinese provinces, and this could become a main focus of China's rural revitalization strategy. Although this paper is mainly focused on China's story, it also has large policy implications for other countries with a significant urban-rural divide.

The remainder of this paper is organized as follows. In the next section, we describe the data we use. Section 3 analyses the urban and rural price convergence across Chinese provinces and the inta-provincial price gap, as well as tests for persistence and regional convergence of the price gaps. Section 4 explores the effect of the infrastructure development on the urban-rural price divide in China. Section 5 briefly concludes.

2 Data

The data used in this paper come from two main sources, CSMAR, which gathers information from China Statistical Yearbooks, China State Information Center and the China National Bureau of Statistics, and the price level data from Brandt & Holz (2005). The scope of the paper is to assess evolution of the gap in the cost of living between urban and rural area in China and the role of transport infrastructure development in narrowing this gap. For this purpose we calculate intra-provincial urban and rural differences in the cost of living, which requires information on urban and rural CPIs as well as estimated price of the basket of goods in the base year in both areas of each province. We obtain the base-year[1] price of the urban and rural baskets from Brandt & Holz (2005). Then, we supplement the price data with data on CPIs for urban and rural area across provinces in China[2] in order to obtain the estimated cost of living in the urban and rural areas within each province in China for the period 1985-2018. Since the quality and availability of the data varies across provinces, we apply a number of restrictions to our dataset. Specifically, we exclude the four municipalities in China, namely Beijing, Tianjin, Shanghai, and Chongqing, from comparison as there is no data on rural area in these regions. Moreover, following Brandt & Holz (2005) suggestion, Tibet and Hainan are excluded from the sample because of the poor quality of estimated prices. After applying these restrictions, we end up with price level data available for urban and rural areas in 25 provinces for the period 1985-2018.

In Section 4 we utilize data on total road mileage (including all types of roads) and railway operating mileage from 1985 to 2018 to estimate the role of transport infrastructure in explaining urban-rural price differences. We also use turnover of passengers and freight by road and railway in order to capture the effect of resource flow on price divide. Among other control variables we use urban-rural income gap, openness, and industrial structure of the provinces. All data are obtained from CSMAR website and discussed in Section 4.

[1]Following Brandt & Holz (2005), we use 1990 as the base-year for pricing the basket, due to the limited availability of the price data over time.

[2]The data on CPIs originate from the China Statistical Yearbooks and have been retrieved from CSMAR website at `http://us.gtadata.com/SingleTable/DataBaseInfo?nodeid=23`.

3 Price convergence

3.1 Relative cost of living in China

In our analysis we refer to the Purchasing Power Parity theory, which is a generalized form of the Law of One Price[3], and suggests that identical basket of goods sold in different locations will have identical prices. So we first calculate differences in the cost of living between province i and j at time t for urban and rural area as

$$q_{ijt}^{k} = P_{it}^{k}/P_{jt}^{k}, \tag{1}$$

where P_{it}^{k} is the price of a fixed basket of goods in the area k (either urban area or rural area) of province i at a specific time t. This measure is informative about the relative cost of living across various provinces in China, and the degree of their price integration. Convergence in the cost of living for a pair of provinces ij is observed when $q_{ij,t+l}^{k} \to 1$ as $t \to \infty$. In addition, we are interested in the estimation of the urban-rural price gap calculated as

$$q_{it} = P_{it}^{urban}/P_{it}^{rural}. \tag{2}$$

We start our analysis by comparing difference in the cost of living across Chinese provinces for urban area, q_{ijt}^{U}, and rural area, q_{ijt}^{R}. Figure 1 shows the kernel density estimates of pairwise differences pooling all years together separately for urban area and rural area in China. As evident from Figure 1, the distribution of price differences for urban area is more highly peaked at unity than the distribution of price differences for rural area, suggesting that the urban area in China is characterised by a higher degree of integration than the rural area.[4]

[3]The Law of One Price states that a good must sell for the same price in all locations if there are no barriers to trade. It implies that convergence of prices across locations appears due to the existence of arbitrage opportunities. Difference in prices of an identical good between any two locations creates an opportunity for sellers to buy the product in a cheaper location and sell it in a more expensive location. This leads to an increase of the demand for the product in the cheap location, and therefore pushes prices up. At the same time the price of the good in the expensive location tends to fall due to the growing supply. Therefore, prices in two locations converge over time thanks to this process of arbitrage.

[4]We check that the distributions of the price differences for urban and rural area are statistically different using the Kolmogorov-Smirnov test of the equality of distributions. The test shows that the null of equality can be rejected at the 1% level. Moreover, we calculate kurtosis values for the urban and rural price difference as a measure of peakedness of the distribution. We find that the kurtosis values for the distribution of price difference for urban area and rural area are 5.79 and 3.53, respectively, which supports our finding that urban markets in China are more integrated than rural markets.

Figure 1: **Empirical Distributions of Relative Cost of Living**

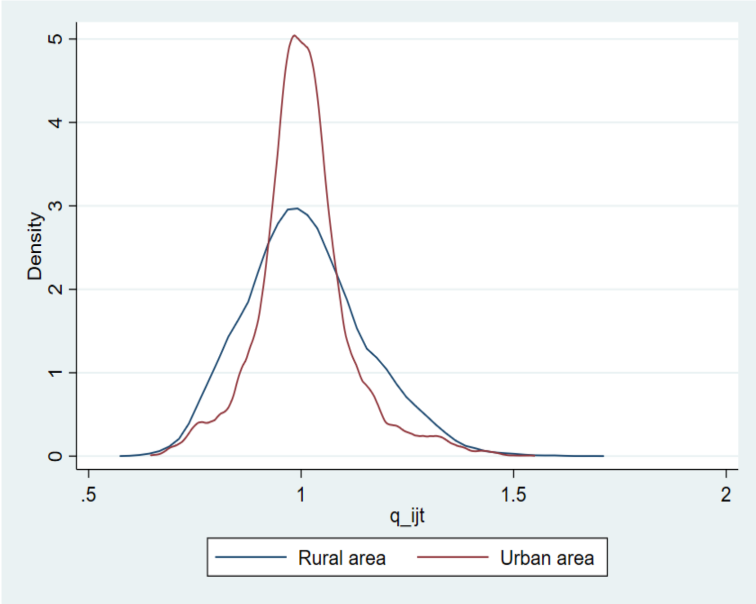


Table 1: Average price differences and urban-rural price gap

Province	Urban price differences ($\overline{q}_{it}^{U}$)				Rural price differences ($\overline{q}_{it}^{R}$)				Urban-rural gap (q_{it})			
	1988	1998	2008	2018	1988	1998	2008	2018	1988	1998	2008	2018
Anhui	0.946	0.950	0.951	0.927	0.924	0.942	0.911	0.892	2.336	2.452	2.405	2.376
Fujian	1.086	1.033	1.026	0.999	1.161	1.021	0.974	0.929	2.140	2.461	2.424	2.454
Gansu	0.991	0.987	0.978	1.002	0.983	1.052	1.129	1.171	2.300	2.289	2.010	1.971
Guangdong	1.395	1.252	1.221	1.206	1.438	1.328	1.212	1.175	2.217	2.297	2.323	2.348
Guangxi	1.019	0.941	0.969	0.957	0.988	1.051	1.027	1.005	2.352	2.187	2.181	2.184
Guizhou	0.970	0.964	0.980	0.970	1.026	1.140	1.200	1.136	2.163	2.071	1.899	1.968
Hebei	0.968	0.921	0.917	0.903	1.013	0.879	0.861	0.866	2.187	2.542	2.452	2.382
Heilongjiang	1.004	1.016	0.973	0.960	1.033	0.998	0.941	0.977	2.221	2.474	2.384	2.252
Henan	0.988	0.885	0.895	0.892	0.963	0.873	0.861	0.864	2.340	2.463	2.395	2.360
Hubei	1.005	1.062	1.072	1.069	0.894	0.981	0.972	0.982	2.554	2.625	2.534	2.484
Hunan	0.991	1.021	1.046	1.042	1.007	1.061	1.138	1.102	2.247	2.343	2.128	2.170
Jiangsu	1.020	1.060	1.032	1.044	1.082	1.012	0.995	1.003	2.157	2.544	2.391	2.379
Jiangxi	1.001	0.982	0.992	0.990	0.977	0.945	0.885	0.888	2.338	2.524	2.573	2.541
Jilin	0.980	0.925	0.892	0.894	1.027	0.936	0.920	0.933	2.182	2.405	2.241	2.198
Liaoning	1.009	1.019	0.971	0.965	1.033	0.930	0.952	0.942	2.233	2.654	2.351	2.342
Neimenggu	1.014	0.963	0.977	0.975	0.972	0.920	0.962	0.942	2.378	2.541	2.342	2.368
Ningxia	0.961	0.980	1.014	1.029	0.919	0.963	0.985	1.021	2.383	2.474	2.373	2.308
Qinghai	0.925	1.015	1.095	1.218	0.925	0.945	1.066	1.152	2.283	2.605	2.368	2.416
Shaanxi	0.970	1.043	1.008	1.007	1.014	1.106	1.092	1.126	2.188	2.298	2.136	2.056
Shandong	0.964	0.958	0.939	0.926	0.986	0.942	0.929	0.917	2.234	2.472	2.332	2.310
Shanxi	1.041	1.018	1.072	1.037	1.005	0.993	1.055	1.024	2.362	2.492	2.343	2.317
Sichuan	0.942	1.009	1.041	1.048	0.839	0.895	0.906	0.892	2.551	2.729	2.637	2.675
Xinjiang	0.960	1.027	1.022	1.047	0.919	1.077	1.085	1.174	2.382	2.324	2.179	2.049
Yunnan	0.991	1.007	0.993	1.009	1.048	1.208	1.198	1.175	2.164	2.040	1.926	1.978
Zhejiang	0.999	1.067	1.027	1.024	1.062	1.034	0.990	0.973	2.153	2.507	2.391	2.405

Table 1 portrays the information on the average relative cost of living in the urban and rural areas[5] and the urban-rural price gap. As can be seen from Table 1, the minimum relative cost of living in urban (rural) area equals 0.88 (0.84) and the maximum relative cost of living in urban (rural) area equals 1.39 (1.44), suggesting that the maximum cross-provincial price difference for urban (rural) area is about 39% (44%). The changes over time in the urban (rural) price differences indicate that there is an evidence of regional convergence in the cost of living for the same types of markets (either urban or rural). However, a different story appears when we look at the last four columns of Table 1. The size of the urban-rural price gap varies across provinces from 1.90 to 2.73 with the average gap within a province being equal to 133%. Moreover, there is no evidence of decline over time in this urban-rural price gap within Chinese provinces.

Table 1 further shows that for some provinces there are similar patterns in both urban and rural markets. For instance, prices in Anhui, Hebei, Henan, Jiangxi, Neimenggu, and Shandong, are typically cheaper than other provinces in both urban and rural areas, while prices in Guangdong, Hunan, Shaanxi, Shanxi, Xinjiang, and Yunnan, are more expensive than other locations for both urban and rural markets. For another group of provinces, such as Gansu, Guangxi, and Guizhou, we observe that urban prices are on average cheaper than in other regions, while rural prices are on average more expensive. Similarly, in Fujian, Heilongjiang, Hubei, and Qinghai, rural prices are more expensive than in other provinces while urban prices are cheaper as compared to other regions. This suggests that regional price differences for urban and rural markets of the same province may differ significantly.

The above results underline the importance of urban-rural integration for the domestic market convergence. While previous literature on domestic market integration in China focuses on regional urban price differences (e.g., Lan & Sylwester (2010) and Li et al.(2018)), it ignores existence of the intra-provincial price gap. In what follows, we will focus on the urban-rural price differences and the role of infrastructure development in narrowing this gap.

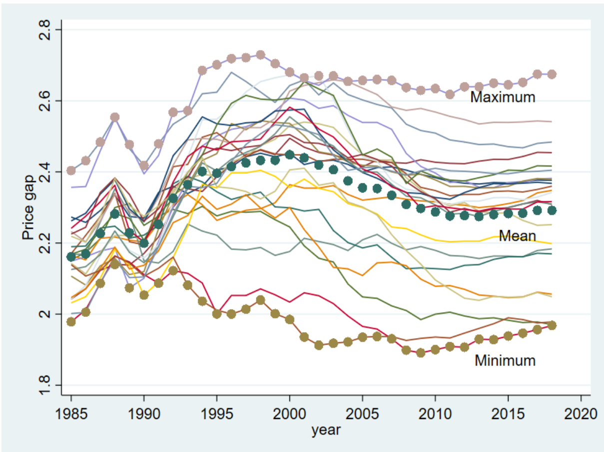
[5]For each province i we calculate average relative cost of living as $\overline{q}_{it}^{k} = \frac{1}{25}\sum_{j=1}^{25} q_{ijt}^{k}$.

3.2 Urban-rural price differences

3.2.1 Persistence of price gap

First, we explore the evolution of the urban-rural price gap and its persistence. Figure 2 plots the urban-rural price differences calculated as in equation (2) for each province over the period of 1985 and 2018. The average gap in 2018 is slightly higher than it was in 1985 (2.29 vs. 2.16, respectively). The gap has been increasing significantly between 1985 and the late 1990s. Interestingly, for the majority of provinces the gap started to shrank in the late 1990s, when China adopted the Price Law that resulted in the liberalization of prices.[6] This is signaling of the integration process between the rural and urban areas. Nevertheless, the process of urban-rural integration has slowed down after the Global Financial Crisis as evident from Figure 2 – the average urban-rural gap remains almost unchanged after 2010 at the level of 2.28.

Figure 2: **Evolution of Urban-Rural Price Differences by Province**



Looking at the above figure, one might be interested to know whether these urban-rural price differences are temporary or permanent, i.e. there is convergence between urban and rural price levels over time, or not. To answer this question we test whether the differences between urban and rural price levels are stable using Augmented Dickey-Fuller unit root tests. In other words, we assess convergence between urban and rural price levels by estimating the following

[6]The price liberalization process in China started from the late 1970s, however the most prominent step in this process is associated with the adoption of the Price Law in 1998, which formally stated the direction of price reform.

ADF-type equation:

$$\Delta q_{it} = k + \theta q_{it-1} + \sum_{l=1}^{L} \theta_l \Delta q_{it-l} + \epsilon_t, \quad (3)$$

where Δq_{it} is the first difference of the urban-rural price gap. If the null hypothesis $\theta = 0$ is accepted, the price gap is non-stationary, meaning that there is no urban-rural price convergence. In the case where the null is rejected, there is some evidence of convergence in price levels between urban and rural markets over time. If the null is rejected, we calculate the half-life of the gap $(ln(2)/ln(1+\theta))$ which estimates the speed of gap mean reversion.

Table 2: ADF unit root test results

Province	p-Value	Half-life	Province	p-Value	Half-life
Anhui	0.241		Jilin	0.241	
Fujian	0.001***	6	Liaoning	0.184	
Gansu	0.967		Neimenggu	0.447	
Guangdong	0.140		Ningxia	0.363	
Guangxi	0.030**	1	Qinghai	0.259	
Guizhou	0.710		Shaanxi	0.706	
Hebei	0.437		Shandong	0.323	
Heilongjiang	0.450		Shanxi	0.529	
Henan	0.079*	3	Sichuan	0.072*	3
Hubei	0.312		Xinjiang	0.938	
Hunan	0.767		Yunnan	0.457	
Jiangsu	0.248		Zhejiang	0.023**	5
Jiangxi	0.174		All (panel)	0.481	

Notes: Asterisks indicate a significance level of *1%, **5%, and ***10% at which the null of unit root is rejected.

We test for urban-rural price convergence in each province separately. The results presented in Table 2 show that the unit root null cannot be rejected for the majority of provinces except for Fujian, Guangxi, Henan, Sichuan, and Zhejiang. This suggests that the price gap between the urban and rural area in China is permanent, and there is no evidence of convergence between urban and rural price levels for 20 out of 25 provinces under study.

3.2.2 Regional convergence of price gaps

Next, we examine whether the size and dynamics of the urban-rural price gaps are common for all regions in China. We test whether there is an evidence of the price gap convergence across provinces using the nonlinear time-varying heterogeneous factor model proposed by Phillips & Sul (2009). The methodology refers to the concept of "relative" convergence, which means that two series share the same stochastic or deterministic trend elements in the long run, so that their ratio eventually converges to unity. Relative urban-rural gap convergence is defined as $q_{it+k}/q_{lt+k} \to 1$, as $k \to \infty$ for any pair of provinces $i \neq l$. To test the convergence hypothesis we first estimate the following auxiliary least-squares regression:

$$\log\left(\frac{D_1}{D_t}\right) - 2\log\log t = \alpha_0 + \alpha_1 \log t + \epsilon_t, \tag{4}$$

where $D_t = \frac{1}{25}\sum_{i=1}^{25}(h_{it} - 1)^2$ is the sample transition distance, and $h_{it} = q_{it}/\frac{1}{25}\sum_{i=1}^{25} q_{it}$ is the relative transition curve[7] for $t = [rT], [rT] + 1, ..., T$ with trimming percentage $r = 0.3$[8]. The null of overall convergence $H_o : \alpha_1 \geq 0$ versus $H_1 : \alpha_1 < 0$ is tested using one-sided t-test.

If the null of overall convergence is rejected, we can further use log t-test to check for the regional convergence within some clubs of provinces. According to the previous literature (e.g. Glushenkova et al. (2018)) price convergence process is non-linear, and lack of overall convergence may be associated with existence of local convergence clubs arising due to factors associated with regional factors rather than to nationwide characteristics. To test for the regional convergence, we employ the above test sequentially in subgroups of provinces. The club convergence test include the following steps: (1) sort all observations from the latest to the earliest time period; (2) apply the log t-test to choose a primary convergence club against which other provinces will be compared; (3) sieve through provinces one at a time to check for possible membership of the primary convergence club using the log t regression; (4) repeat steps 2 and 3 and, if no further convergence clubs emerge, classify the remaining observations as displaying divergent behavior.

We first apply the log t-test to our data and find that the null of convergence is rejected at 1% level of significance, suggesting that there is no evidence of urban-rural gap convergence at the national level across all provinces. Then, we follow the club convergence testing procedure and document evidence for regional convergence. Table 3 presents results for the club convergence test. The first row of Table 3 shows the national convergence coefficient for the whole

[7]Before applying the log t-test, we remove the business cycle component from our price gap variable, q_{it}, using the Hodrick-Prescott smoothing filter.

[8]This trimming percentage is suggested by Phillips and Sul (2007) for samples smaller than 50 time-series observations.

Table 3: Log t-test results

	α_1	t-stat	Average Gap	Converging Provinces
Overall	-0.979*	-13.716	2.323	-
Club 1	-0.243	-0.352	2.556	Jiangxi, Sichuan
Club 2	-0.195	-0.980	2.338	Anhui, Fujian, Guangdong, Guangxi, Hebei, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Jilin, Liaoning, Neimenggu, Ningxia, Qinghai, Shandong, Shanxi, Yunnan, Zhejiang
Club 3	1.028	6.360	2.139	Gansu, Guizhou, Shaanxi, Xinjiang

Notes: Asterisk indicate a significance level of *1% at which the null of convergence, $H_o : \alpha_1 \geq 0$ is rejected.

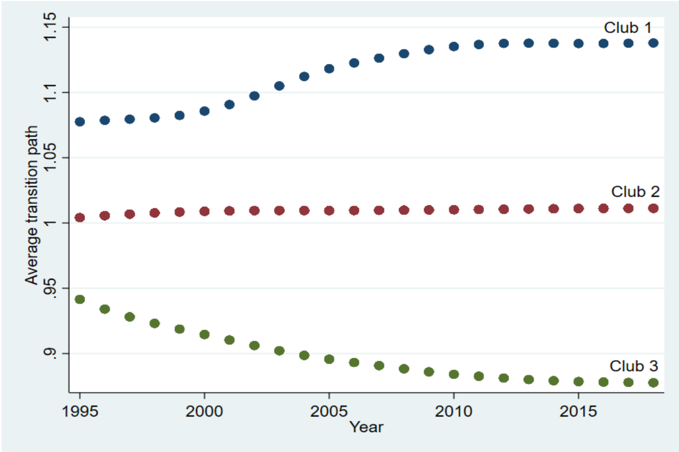
sample of provinces. In the next three rows, results of the regional convergence coefficients are recorded. The convergence procedure identifies existence of three clubs with different number of provinces forming each of them. Figure 3 presents on a map the set of provinces that form each convergence club.

Figure 3: **Convergence clubs**

As could be seen from Figure 3 there are three clubs: club 1 (marked by blue color) consisting of only two provinces, Jiangxi and Sichuan; club 2 (marked by orange color) which is the largest club consisting of 19 provinces; and club 3 (marked by red color) of relatively small size of 4 provinces (Gansu, Guizhou, Shaanxi, and Xinjiang).

Figure 4 presents the average transition curve across the provinces forming each club over

Figure 4: **Transition path for clubs**



the period 1995-2018[9]. Figure 4 shows that the first (third) club includes provinces with price gaps higher (lower) than national average, while the second club is characterised by the urban-rural price differences close to the national mean. Average price gaps for each club are presented in column 3 of Table 3. There is an apparent divergent path for the three clubs, but interestingly, average transition path for club 2 is stable and almost does not change over time. The results suggest that while there is no overall convergence for all provinces in China, there is a large club formed by majority of provinces (19 out of 25 provinces) and transition paths for these provinces converge over time. We are inclined to interpret this as a signal that urban-rural price gap is a nationwide phenomenon and these regional gaps are changing in the same direction for the majority of provinces. Therefore, in what follows we focus on the overall sample of provinces and do not further investigate formation of clubs.

Next, we investigate the factors that affect urban-rural price differences and may lead to price convergence.

4 Effect of infrastructure on urban-rural price divide

The living expenditure basket consists of a set of products (goods and services) and their weights calculated based on the quantities purchased in the base-year. The product categories

[9]The average transition curve for each club k is calculated as $\overline{h}_{kt} = N_k^{-1} \sum_{i=1}^{N_i} h_{it}$, where h_{it} is relative transition curve, $h_{it} = q_{it} / \frac{1}{25} \sum_{i=1}^{25} q_{it}$. Note that t starts from 1995 as 30% trimming percentage has been applied to the data.

used for construction of the basket are same for urban and rural area while the weights differ significantly across two areas[10]. We can group all goods included in the basket in two generalized categories - traded products and non-traded products (services). So the price of the basket, P^k_{it}, could be presented as the cost of traded goods and their share as well as the cost of non-traded goods with their share in living expenditures

$$P^k_{it} = (1 - \alpha^k_i)P^k_{TRit} + \alpha^k_i P^k_{NTRit}, \tag{5}$$

where α^k_i is the share of non-traded goods in living expenditures in area k (either urban or rural) in province i; P^k_{TRit} and P^k_{NTRit} are expenditures on traded and non-traded goods, respectively. Using equation (5) and assuming that the structure of living expenditures does not vary across provinces, we can present the urban-rural price differences as

$$q_{it} = \alpha p_{TRit} + \gamma p_{NTRit}, \tag{6}$$

where $p_{TRit} = P^U_{TRit}/P^R_{TRit}$ and $p_{NTRit} = P^U_{NTRit}/P^R_{NTRit}$ are relative prices of traded and non-traded goods in province i, respectively; α and γ are relative shares of traded and non-traded goods, respectively.

According to the Law of one price, the price of traded goods should not vary significantly across locations because of the arbitrage opportunities. Therefore, one set of factors explaining price differences is associated with transportation cost and opportunities to trade. At the same time, non-traded goods (services) are delivered locally, and their prices are determined by the local production cost (e.g. wages and rent) and local productivity, suggesting that the price differences for non-traded goods should be closely associated with income differences across locations, with richer regions characterised by higher prices. This explanation of price differences refers to the Balassa-Samuelson hypothesis (Balassa 1964; Samuelson 1964) proposing that consumer prices tend to be higher in more developed regions than in less developed regions due to the variation in productivity. Empirical evidence of this effect was recorded by Kravis & Lipsey (1988), who show that real income per capita is the predominant factor

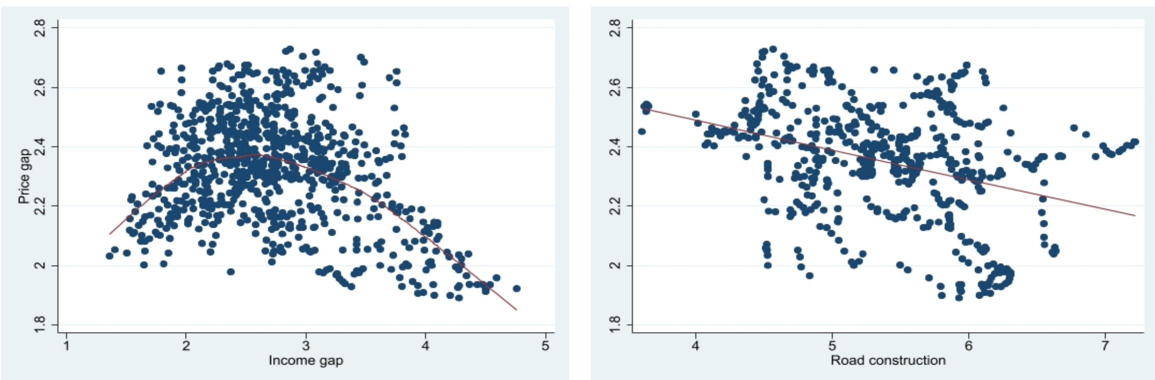
[10]Detailed description of the basket construction is available in the online Appendix B of Brandt and Holz (2005) at `http://carstenholz.people.ust.hk/SpatialDeflators.html`

determining differences in price levels. Similarly, Brandt & Holz (2005) show that cost of non-tradeable goods is the main reason of price differences across Chinese provinces, associated with the inter provincial differences in the labor cost.

Next, we consider various variables influencing the traded and non-traded components of the CPI that can potentially explain urban-rural price differences. First, using income difference between urban and rural area in each province, we examine whether income convergence between urban and rural area is conducive to price convergence. We plot the relationship between urban-rural income differences and price differences in Figure 5a. Interestingly, we find nonlinear effect of income gap on price gap. One explanation of such a phenomenon could be associated with the Kuznets hypothesis and findings of Bosworth & Venhorst (2018) who showed that economic growth in the rural region and its convergence towards urban economy depends on integration of commuters into the rural economy. According to Kuznets, the process of economic development first increases income inequality as rural workers tend to migrate to urban area and work there. If they tend to spend most of their income in urban communities this will increase the demand in urban market and thus push urban prices up resulting in enlarging urban-rural price gap. However, at some point when the urban-rural income gap reaches a critical point making cost of living too high, rural-urban migrants will start spending more of their earnings in their residence place (i.e. rural region) which will induce convergence of the urban and rural cost of living.

Figure 5: **Relationship between urban-rural price gap and explanatory variables**

(a) Price differences vs. Income differences (b) Price differences vs. Road construction



We also investigate the role of transport infrastructure in explaining urban-rural price difference, which may affect prices through both trade-related channel and non-traded channel. First, improvement of transport network provides easier and, in some cases, cheaper access to trade, which helps provinces to better exploit arbitrage opportunities. This way, infrastructure development may promote trade between regions and lead to price convergence. At the same time, existence of more developed and faster transportation modes may increase mobility of workers as more rural residents tend to commute to urban area attracted by a higher level of wages there. Thus, investment in infrastructure development may stimulate rural-urban migration. As shown in previous studies (see, e.g., Huang et al.(2020) and Ma & Tang (2020)) rural-urban migration in China contributes to income inequality and thus can aggravate the urban-rural price gap. To distinguish between these two channels, we include migration and cargo flow by different transport modes in our model. Figure 5b provides intuitive evidence on the relationship between the road construction and the price gap. The negative slope of the fitted curve implies that the road construction is conducive to price convergence. In what follows, we investigate this relationship more formally.

Similar to Huang et al. (2020), we control for other explanatory variables that may affect the cost of living in urban and rural area, such as industrial structure of province and openness. More details about the explanatory variables are presented in Table 4.

Table 4: List of variables

Variable	Description
Income gap (I_{it})	The ratio of urban to rural per capita disposable income
Openness ($Open_{it}$)	The degree of openness of the province calculated as the sum of total import and export to regional GDP
Industrial structure (IS_{it})	The ratio of the output of the tertiary industry to the output of the secondary industry
Migration (M_{it}^m)	The ratio of province level passenger turnover by transport mode m, i.e. road (hw) and railroad (rw), to national passenger turnover
Cargo ($Cargo_{it}^m$)	Per capita freight turnover by transport mode m, i.e. road (hw) and railroad (rw), in each province
Construction ($Constr_{it}^m$)	Per capita road (railroad) mileage in each province.

Our baseline model is given as follows

$$q_{it} = \beta_0 + \beta_1 I_{it} + \beta_2 I_{it}^2 + \beta_3 Open_{it} + \beta_4 IS_{it} + \beta_5 Constr_{it}^m + \beta_6 Cargo_{it}^m + \beta_7 M_{it}^m + \varepsilon_{it}. \quad (7)$$

Table 5 shows the correlation coefficients for the variables included in the model. Due to high correlation of road and railway variables, we estimate the impact of road and railway construction separately.

Table 5: **Correlation coefficients**

	I_{it}	$Open_{it}$	IS_{it}	M_{it}^{hw}	$Cargo_{it}^{hw}$	$Constr_{it}^{hw}$	M_{it}^{rw}	$Cargo_{it}^{rw}$	$Constr_{it}^{rw}$
I_{it}	1								
$Open_{it}$	-0.226	1							
IS_{it}	0.056	-0.036	1						
M_{it}^{hw}	-0.298	0.639	-0.051	1					
$Cargo_{it}^{hw}$	-0.131	-0.138	0.129	-0.073	1				
$Constr_{it}^{hw}$	0.279	-0.212	0.302	-0.396	0.527	1			
M_{it}^{rw}	-0.550	0.443	-0.142	0.511	-0.092	0.364	1		
$Cargo_{it}^{rw}$	0.103	-0.353	-0.102	-0.457	0.540	0.501	-0.189	1	
$Constr_{it}^{rw}$	0.119	-0.480	0.168	-0.729	0.376	0.691	-0.309	0.675	1

According to the previous literature, road construction, income gap and thus price gap are likely to be affected by spatial correlation. Therefore, we first test whether there is spatial correlation in the model. Table 6 shows the results of the Moran's and Geary's tests[11]. The tests report that we can reject the null that errors are i.i.d., therefore, the spatial econometric models should be used to estimate our model.

Table 6: **Spatial correlation tests**

	Coefficient	P-value	E(I)	Variance	Z-value
Moran's I	0.161	0.000	-0.002	0.014	7.238
Geary's C	0.781	0.000	1.000	0.020	-7.837

Table 7 show the regression results for the effect of transport infrastructure estimated using OLS model, SDM (Spatial Durbin Model), SAR (Spatial Autoregressive Model), and SEM (Spatial Error Model). The estimation results do not vary much across the models. Based on the Akaike information criterion, we consider SDM as the most suitable model for the analysis. Similar conclusion is made based on the Lagrange multiplier and Robust Lagrange multiplier tests.

First, the results support our finding that the effect of income gap on urban-rural price differences is inverted U-shaped. Initially, the process of economic development increases income inequality as rural workers tend to migrate to urban area and work there. This increase in

[11] Before performing the tests, we construct the spatial distance weight matrix using inverse geographical distance calculated from the coordinate variables.

Table 7: Determinants of urban-rural price differences

VARIABLES	(1) OLS	(2) SDM	(3) SAR	(4) SEM	(5) OLS	(6) SDM	(7) SAR	(8) SEM
Inc. gap	0.101**	0.128***	0.136***	0.147***	0.254***	0.371***	0.273***	0.357***
	(0.043)	(0.044)	(0.041)	(0.042)	(0.047)	(0.046)	(0.040)	(0.046)
Inc. gap^2	-0.019***	-0.021***	-0.023***	-0.025***	-0.040***	-0.053***	-0.042***	-0.052***
	(0.007)	(0.007)	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.007)
Openess	-0.004	0.021	-0.022	0.007	-0.051**	-0.045**	-0.059***	-0.053**
	(0.026)	(0.023)	(0.025)	(0.023)	(0.026)	(0.022)	(0.022)	(0.022)
Ind. structure	-0.018	-0.053***	-0.023*	-0.049***	-0.006	-0.040***	-0.013	-0.039***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.015)	(0.013)	(0.013)	(0.013)
Road	-0.081***	-0.132***	-0.053***	-0.116***				
	(0.007)	(0.011)	(0.008)	(0.010)				
Migration^{hw}	0.015	-0.106	-0.075	0.076				
	(0.233)	(0.208)	(0.219)	(0.195)				
Cargo^{hw}	-0.086***	-0.088***	-0.048***	-0.066***				
	(0.015)	(0.017)	(0.015)	(0.016)				
Railway					-0.110***	-0.060***	-0.032***	-0.074***
					(0.012)	(0.016)	(0.012)	(0.015)
Migration^{rw}					2.144***	1.692***	1.878***	2.057***
					(0.262)	(0.254)	(0.224)	(0.235)
Cargo^{rw}					-0.350***	-0.202***	-0.259***	-0.268***
					(0.027)	(0.027)	(0.024)	(0.026)
ρ		0.239***	0.184***	0.305***		0.218***	0.262***	0.304***
		(0.027)	(0.027)	(0.018)		(0.028)	(0.020)	(0.018)
AIC		-1959.27	-1854.68	-1937.94		-1804.68	-1767.86	-1762.43
Observations	624	624	624	624	552	552	552	552
R-squared	0.544	0.597	0.496	0.536	0.527	0.596	0.527	0.478
Number of regions	24	24	24	24	24	24	24	24
Periods	26	26	26	26	23	23	23	23

Note: Asterisks indicate a significance level ***1%, **5%, and *10%. Province fixed effects are included in all models based on the results of the Hausman test. The models (1)-(4) cover the period 1993-2018 as for the earlier years the data for cargo and migration are missing. In the models (5)-(8) we further exclude the years 1998-2000 due to the limited data availability on migration by railway. Finally, Sichuan province is excluded from the analysis as it has a lot of missing observations.

income gap will also be accompanied by increase in price differences as rural commuters will spend their income in urban area and thus stimulate the demand in urban market pushing prices up. However, at some point when the urban-rural income gap reaches a critical point, the urban migrants will tend to spend more of their earnings in their residence place (i.e. rural region) which will lead to convergence of the urban and rural cost of living.

Next, we examine effect of transport infrastructure development on urban-rural price gap. For this purpose we use two types of transport infrastructure, i.e., roads and railways. As shown in Table 7, both road and railway construction significantly contribute to the narrowing of the intra-provincial price gap. The regression coefficients of highway construction and railway construction are significantly negative, suggesting that provinces with better transport infrastructure exhibit smaller urban-rural price divide.

As we discussed above, the infrastructure development may affect both traded and non-traded components of prices by providing easier and cheaper access to trade and by increasing mobility of workers, respectively. Therefore, we are interested in estimating the effect of migration and freight transportation by various transport mode on price differences. The estimated effect of migration by road is insignificant in all the models, while migration by railway has significant positive effect on price gap, implying that increasing passenger turnover by railway widens price gap. One possible explanation of this effect is that migration from rural to urban area increases income gap between the places[12] and thus contributes to larger differences in the cost of living via Balassa-Samuelson channel.

Importantly, the effect of freight turnover is negative and significant for both types of transportation, suggesting that increasing flow of goods contributes to trade and thus helps to narrow the urban-rural gap via the trade channel. Similarly, models (5) - (8) show that the estimated effect of openness is negative, i.e., increasing openness of the region stimulates trade and triggers price convergence within province. Finally, we find that industrial structure has negative effect on price differences. As discussed by Huang et al. (2020), majority of the tertiary industries are located in urban areas and therefore contribute to the welfare of urban residents enlarging the urban-rural income gap, which in turn increases the differences in the cost of services between urban and rural areas and thus widens the urban-rural price gap.

5 Conclusion

We have investigated the evolution of the urban-rural price differences in China over the period of 1985 and 2018. This has informed us about the changing degree of market integration of urban and rural areas across Chinese provinces and the effect of transport infrastructure development on this process.

First, we show that while there is an evidence of regional convergence in the cost of living

[12]The positive effect of migration on urban-rural income inequality in China was recorded by several researchers, e.g., Huang et al. (2020) and Ma and Tang (2020).

separately for urban and rural markets, there is still a huge intra-provincial price gap between urban and rural area, which has not been properly studied in the existing literature. This gap has been increasing significantly between 1985 and the late 1990s, while for the majority of provinces the gap started to shrank in the late 1990s after adoption of the Price Law, which lead to further liberalization of prices. Nevertheless, using unit-root test we show that the price gap in China is persistent, and there is no evidence of price convergence between urban and rural markets for the majority of provinces. We also document that the size of urban-rural price differences vary significantly across provinces, but 19 out of 25 provinces form a convergence club meaning that these provinces are characterized by similar dynamics of the urban-rural price gaps.

Next, we find that urban-rural price differences for Chinese provinces can be significantly affected by urban-rural income inequality. Interestingly, we record an inverted U-shape relationship between urban-rural income gap and the cost-of-living gap, suggesting that the increasing income inequality first widens the price gap, while after reaching a critical point further increase of income gap leads to a smaller differences in the cost of living.

Finally, we document an important role of infrastructure development and resource flow in domestic market integration. The results suggest that road and railroad construction significantly contribute to the narrowing of the intra-provincial price gap, suggesting that provinces with better transport infrastructure exhibit smaller urban-rural price divide. The development of transport infrastructure helps to narrow price gap mainly via the trade-related channel, i.e. due to the increasing flow of goods and reduction in the cost of trade. Although railway construction is conducive to price convergence, it may also contribute to the urban-rural price divide by stimulating migration which in turn widens the price gap through the income-related channel, i.e. by contributing to the urban-rural income inequalities.

Our results are informative for economic theory and policy makers. For instance, our findings suggest that there is the inverted U-shaped relationship between urban-rural cost-of-living gap and the intra-provincial income gap. To our best knowledge, this has not been discussed in the literature before and is worth further investigation. Existing literature explains the effect of income inequalities on prices differences using Balassa-Samuelson hypothesis, which is designed for the explanation of the international price differences rather than regional (or even intra-regional) price gaps. Thus, regional economic models would benefit from exploring inverted U-shaped phenomenon. Such theoretical models would be able to better explain the relationship between income inequalities and price gaps at the intra-regional level. Finally, our results highlight the importance of further improvement of infrastructure to promote the process of urban-rural economic integration within Chinese provinces that takes place mainly via trade, thus this could become a focus of the China's rural revitalization strategy.

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