The Effect of Infrastructure Development on Urban-Rural Price Differences in China

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October 18, 2020

Abstract

Market liberalization reforms in China have given rise to greater domestic market integration. However, large urban-rural price differences indicate that the segregation of the urban and rural markets still exists in China. We study evolution of price differences between urban and rural areas across 25 Chinese provinces over the period of 1985 and 2018. First, we show that 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 still remains large and persists over time. Second, we find that the urban-rural price gap has shrunk after 2000, when China adopted the Price Law resulted in liberalization of prices. This is suggestive of deeper urban-rural integration associated with policy changes. In addition, we record notable differences in urban-rural price gaps between provinces, however, using the log-t test we find an evidence of regional convergence of these price gaps. Finally, we investigate the effect of transport infrastructure development on the urban-rural price differences. The regression results show that highway- and railway-related variables have 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. Therefore, further improvement of infrastructure can promote the process of urban-rural economic integration within Chinese provinces, and this could became a main focus of the China's rural revitalization strategy introduced in 2018.

Keywords: Price level, Convergence, Urban area, Rural area, Infrastructure.

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 and Zhang (2004)).

China's urban-rural duality is deeply rooted in its early centrally planned strategies that favored heavy industry development over agriculture (Yang, 1999). The government controlled agricultural production and prices in the sector while also restricting migration from 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 1978 (before the beginning of liberalization reforms). This policy caused large imbalanced 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 lead to a noticeable urban-rural income inequality (e.g. Yang (1999), Eastwood and Lipton (2004), and Park (2008)). The literature document 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)).

This paper intends to address the urban-rural divide from the perspective of the urban-rural differences in cost of living observed across provinces in China. A very limited number of papers explored this topic. For instance, Gong and Meng (2007) studied the regional price differences only in urban China; Brandt and Holz (2005) estimated 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 strong evidence of an overall convergence of prices across Chinese cities (Lan and 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 and 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 for the majority of regions price gaps converge over time.

Finally, we try to understand importance of various factors in narrowing urban-rural price gap in China. Using provincial income and urban-rural expenditure inequality, we examine whether poorer provinces tend to exhibit lower income inequality between the urban and rural areas and therefore enjoy smaller price gap as suggested by the Balassa-Samuelson hypothesis. Using transport infrastructure variables, we study if provinces with better access to transport infrastructure and higher productivity of its utilization 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 and Demir (2015), and Donaldson (2018)), improve productivity (Fan and Zhang (2004), and Teruel and Kuroda (2005)), stimulate the formation of urban agglomerations and through spillover effects enhance regional integration (e.g., McCann and Shefer (2004), Song et al. (2012), Börjesson et al. (2019), and Zhang et al. (2020)).

Our findings show that provinces with better transport infrastructure exhibit smaller urban-rural price divide with highway construction playing more important role in reducing urban-rural gap than railway construction. Nevertheless, when we consider efficiency of using the infrastructure for freight and passenger transportation, we find that efficient utilization of railways for both passenger transportation and freight contributes more to the reduction of price differences than usage of highways. Overall, increasing passenger turnover and freight turnover by both highway and railway play important role in removing urban-rural price differences.

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 of 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 became a main focus of the 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 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 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 courses, 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 and Holz (2005). First, for the purpose of this paper we calculate intra-provincial urban and rural price differences, 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 and 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 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 and Holz (2005) suggestion, Tibet and Hainan

[1] Following Brandt and 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`.

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 highway mileage 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 highway and railway in order to capture effect of transport usage productivity on price divide. Among other control variables we use urban-rural expenditure inequality[3] and provincial GDP per capita.

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[4], 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

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

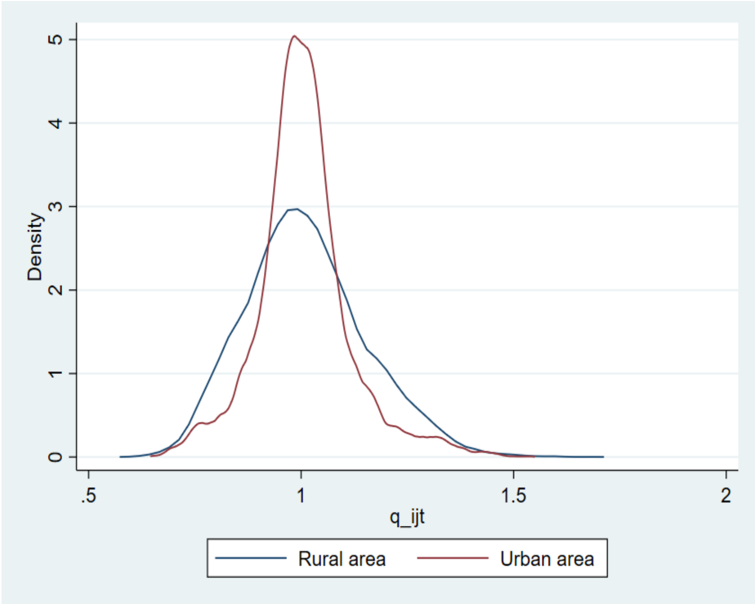
where P_{it}^{k} is the price of a fixed basket of goods in the area k (either urban area or rural area) of province i at a specific time t. This measure is informative about the relative cost of living across various provinces in China, and the degree of their price integration. Convergence in cost 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 estimation of the urban-rural price gap calculated as

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

[3]Urban-rural expenditure inequality is calculated as ratio of urban annual household consumption expenditure to rural one.

[4]The Law of One Price states that a good must sell for the same price in all locations if there are no barrier 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.

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



We start our analysis by comparing difference in cost of living across Chinese provinces for urban area, q^U_{ijt}, and rural area, q^R_{ijt}. 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.[5]

Table 1 portrays information on average relative cost of living in the urban and rural areas[6] and the urban-rural price gap. As can be seen from Table 1, the inter-provincial price differences for both urban and rural area are not comparable with provincial urban-rural price differences. While 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), the size of the urban-rural price gap varies from 1.90 to 2.73. These numbers tell us that the maximum cross-provincial price difference for urban (rural) area is about 39% (44%), while the maximum

[5] 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 integration than rural markets.

[6] For each province i we calculate average relative cost of living as $q^k_{it} = \frac{1}{25}\sum q^k_{ijt}$.

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

Province	Urban price differences ($\overline{q}_{ijt}^{U}$)				Rural price differences ($\overline{q}_{ijt}^{R}$)				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

(average) urban-rural price gap within a province is 173% (133%). Therefore, while there is an evidence of regional convergence in cost of living for the same types of markets (either urban or rural), there is still huge price gap between the urban and rural area within Chinese provinces.

Table 1 further shows that for some provinces there are similar patterns in both urban and rural markets. For instance, Anhui, Hebei, Henan, Jiangxi, Neimenggu, and Shandong, are typically cheaper than other provinces in both urban and rural areas, while 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.

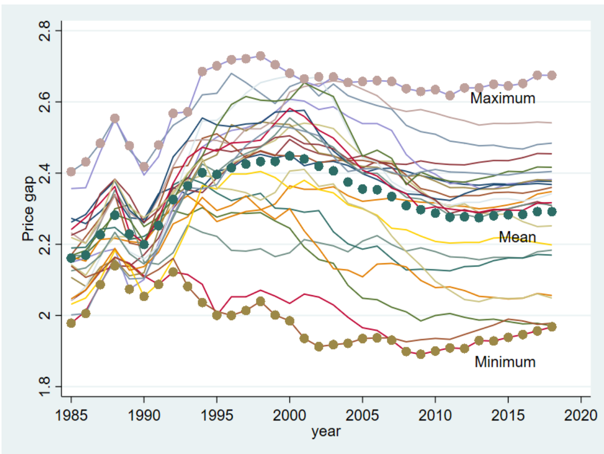
The above results underline the importance of urban-rural integration for the domestic market convergence. While previous literature on domestic market integration in China focuses on regional urban price differences (e.g.Lan and Sylwester (2010) and Li et al.(2018)), it ignores existence of the intra-provincial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

3.2 Urban-rural price differences

3.2.1 Persistence of price gap

First, we explore 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 liberalization of prices.[7] 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 whether these urban-rural price differences

[7]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.

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 ADF-type equation:

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

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 and 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 $q_{it+k}/q_{lt+k} \rightarrow 1$, as $k \rightarrow \infty$ 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[8] for $t = [rT], [rT]+1, ..., T$ with trimming percentage $r = 0.3$[9]. 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. 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

[8]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.

[9]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.

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 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: **Transition path for clubs**

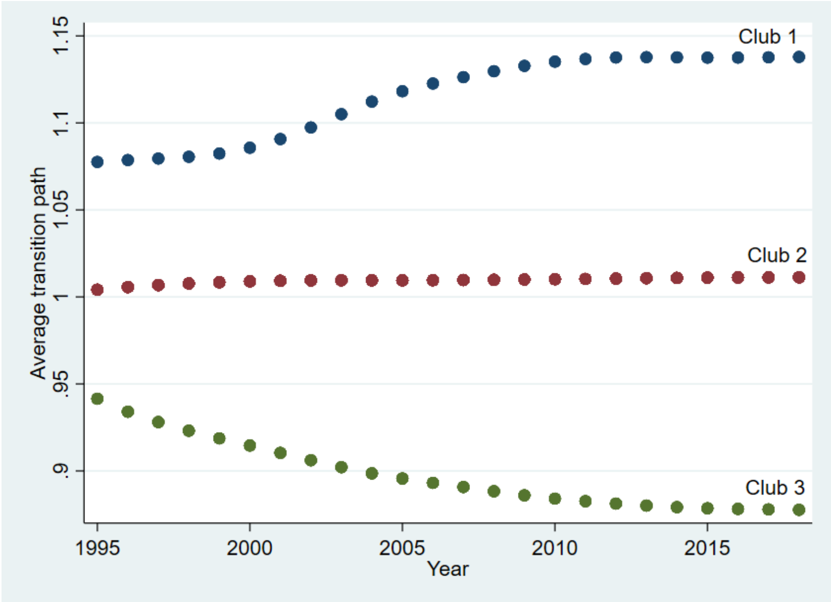


Figure 4 presents the average transition curve across the provinces forming each club over the period 1995-2018[10]. Figure 4 shows that the first (third) club includes provinces with price gaps higher (lower) than national average, while the second club is characterised by the urban-rural price differences 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.

[10]The average transition curve for each club k is calculated as $\overline{h}_{kt} = N_k^{-1} \sum_{i=1}^{N_i} h_i t$, 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.

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 used for construction of the basket are same for urban and rural area while the weights differ significantly across two areas[11]. 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_{it}^k, 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

$$P_{it}^k = (1-\alpha_i^k)P_{TRit}^k + \alpha_i^k P_{NTRit}^k, \tag{5}$$

where α_{it}^k is the share of non-traded goods in living expenditures in area k (either urban or rural) in province i; P_{TRit}^k and P_{NTRit}^k 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 $p_{TRit} = P_{TRit}^U / P_{TRit}^R$ and $p_{NTRit} = P_{NTRit}^U / P_{NTRit}^R$ 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

[11] 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`

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 and Lipsey (1988), who showed that real income per capita is the predominant factor determining differences in price levels. Similarly, Brandt and Holz (2005) showed 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. Using consumer expenditure difference between urban and rural area in each province and provincial GDP per capita, we examine whether poorer provinces tend to exhibit lower expenditure inequality between the urban and rural areas and therefore enjoy smaller price gap as suggested by the Balassa-Samuelson hypothesis. Also, special attention is paid to the role of transport infrastructure in explaining domestic price difference, as transport infrastructure development may affect both traded goods and non-traded goods. First, improvement of transport network provides easier and, in some cases, cheaper access to trade, which helps provinces to better exploit arbitrage opportunities. At the same time, existence of more developed and faster transportation modes may increase mobility of workers and stimulate domestic migration, which leads to convergence of productivity and incomes across provinces. Our baseline model is given as follows

$$q_{it} = \beta_0 + \beta_1 EI_{UR,it} + \beta_2 GDP_{it} + \beta_3 T_{it} + \beta_4 D_{2000} + \varepsilon_{it} \qquad (7)$$

where $EI_{UR,it}$ is expenditure inequality between urban and rural area in province i at time t, T_{it} is the proxy for transport infrastructure development in the province, GDP_{it} is logarithm of GDP per capita in province i at time t, and D_{2000} is a dummy that takes the value 1 if the year is 2000 and onward. Estimation results are presented in Table 4.

The results show that coefficient on intra-provincial urban-rural expenditure inequality is positive and vary between 0.081 in column (1) and 0.140 in column (2) suggesting that expenditure differences between urban and rural area can explain a large share of the urban-rural price differences. Moreover, given that coefficient on the GDP per capita is positive, rich provinces tend to exhibit larger urban-rural price divide than poor provinces. This could be explained by the fact that in rich provinces prices tend to grow faster in urban area than in rural area due to the increasing productivity gap, which results in widening urban-rural price differences.

Next, we examine effect of transport infrastructure development on urban-rural price gap. For this purpose we use different proxies for highway and railway infrastructure in each province i, such as a) density of the highway/railway in operation, b) log of passenger turnover by highway/railway, and c) log turnover volume of freight by highway/railway.[12]

Table 4: Determinants of urban-rural price differences

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Expenditure inequality	0.081***	0.140***	0.110***	0.116***	0.114***	0.129***
	(0.008)	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)
GDP	0.108***	0.051***	0.082***	0.046***	0.058***	0.060***
	(0.007)	(0.008)	(0.009)	(0.006)	(0.007)	(0.006)
Highway						
Density	-0.210***					
	(0.014)					
Passenger turnover		-0.040***				
		(0.013)				
Freight turnover			-0.051***			
			(0.008)			
Railway						
Density				-0.071***		
				(0.020)		
Passenger turnover					-0.067***	
					(0.015)	
Freight turnover						-0.106***
						(0.014)
Dummy After2000	-0.028**	-0.094***	-0.100***	-0.085***	-0.080***	-0.076***
	(0.013)	(0.015)	(0.014)	(0.015)	(0.015)	(0.014)
Constant	1.091***	1.840***	1.746***	1.426***	1.980***	2.239***
	(0.070)	(0.060)	(0.057)	(0.115)	(0.072)	(0.084)
Observations	840	839	840	840	839	840
R-squared	0.777	0.717	0.729	0.720	0.721	0.740

Note: All models include province fixed effects. Robust standard errors presented in parenthesis. Asterisks indicate a significance level of the coefficients ***1%, **5%, and *10%.

As shown in Table 4, both highway and railway development significantly contribute to the

[12]For the robustness check we also use length of the highway/railway in operation and length of the highway/railway per capita. The effects of these variables are very close to the effects of transport network density and passenger turnover on price gap, respectively. The results are not shown in the paper but available on request.

narrowing the intra-provincial price gap. Due to high correlation of highway and railway variables, we include one transport proxy in the regression at a time. First, coefficient for all proxies of infrastructure development are negative and significant, suggesting that provinces with better transport infrastructure exhibit smaller urban-rural price divide. Second, highway development plays more important role in reducing urban-rural gap than railway construction. Coefficient on highway density is three times higher than coefficient on railway density, -0.210 and -0.071 as shown in column (1) and (4), respectively. This difference may arise due to the different pace of building railways and roads. To be more specific, a pace of highway construction is much higher than railway construction, and so there are more changes in the construction of new highways in China over time than railways. This may explain why effect of highway is larger than that of railway.

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. Therefore, one might be interested in looking at the intensity (productivity) of using transport infrastructure for passenger transportation and freight. In column (2) and (5) we show the estimated effect of passenger turnover by highway and by railway on price differences, which equals -0.040 and -0.067, respectively. The numbers indicate that passenger turnover by railway plays bigger role in explaining price difference than passenger turnover by highway. Same goes for freight - the coefficient on freight turnover by highway equals -0.051, while coefficient on freight turnover by railway is twice larger, -0.106. The results suggest that effective usage of railways for both passenger transportation and freight contributes more to the reduction of price differences than usage of highways. Moreover, transport infrastructure plays an important role in reducing price differences for both traded and non-traded goods, with larger importance of infrastructure for traded inputs than for non-traded inputs[13].

We also include dummy for the post-2000 period. The regression results show that coefficient on post-2000 dummy varies between -0.028 and -0.100 in columns (1) and (3), respectively,

[13]The coefficient on freight turnover is significantly larger than coefficient on passenger turnover for both highway and railway indicating larger importance of trade-related usage of infrastructure than its migration-related usage for price convergence.

implying that price gap became smaller after the adoption of the price law. This is suggestive of deeper urban-rural integration associated with price reform and price liberalization process in China.

5 Conclusion

We have investigated 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 effect transport infrastructure development on this process.

First, we show that while there is an evidence of regional convergence in cost of living 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 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 show that urban-rural price differences for Chinese provinces can be significantly affected by urban-rural expenditure inequality, by income and by transport infrastructure development. Provinces characterised by lower expenditure inequality between the urban and rural areas tend to exhibit smaller price gaps. Furthermore, urban-rural price divide is larger in richer provinces than in poorer provinces due to increasing productivity gap between the markets.

Finally, we document an important role of infrastructure development and productivity of its utilization in domestic market integration. The results suggest that effective usage of railways for both passenger transportation and freight contributes more to the reduction of price differences than usage of highways. Moreover, we find that the transport infrastructure affects prices mainly via trade-related channel (due to arbitrage), which implies a key role for transportation costs in determining price gap between urban and rural area in China. Further improvement of infrastructure can promote the process of urban-rural economic integration within Chinese provinces, thus this could become a main focus of the China's rural revitalization strategy.

Acknowledgement

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

CRediT authorship contribution statement

Marina Glushenkova: Conceptualization, Software, Visualization, Writing- Original Draft, Reviewing and Editing, Funding acquisition. **Yingying Shi**: Data curation, Investigation, Validation, Writing- Original Draft.

Declaration of competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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