The Law of One Price in Chinese factor markets

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Abstract

This paper investigates whether Chinese factor markets became more integrated in the period around WTO accession. This would have required reductions in factor price dispersion. However, prices for 18 agricultural factors between 1998 and 2001 and for 118 industrial factors between 1999 and 2002 varied significantly across 36 cities. Variation declined temporarily for industrial factors, perhaps to facilitate WTO accession, but not for agricultural factors. Sixteen factors had especially high frequencies of city-specific price components, suggesting that they may have been subject to domestic trade restrictions. Idiosyncratic prices for agricultural factors were concentrated in two cities. However, most cities had idiosyncratic prices for at least some industrial factors.

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The efficiency of Chinese internal markets has been of concern since the start of reform. World Bank (1994) summarizes the advantages of integrated internal markets, progress toward inter-regional integration through early reforms and outstanding challenges. World Bank (2003, chapter 3) recapitulates the arguments in favor of integration and emphasizes continuing impediments to the flow of goods and factors of production across regions. This emphasis has renewed, if not heightened urgency, because integrated internal markets have become legal obligations associated with membership in the World Trade Organization, or WTO (World Bank, 2003, pg. 24), as well as imperatives of economic efficiency.

This paper provides new evidence regarding the performance of Chinese internal markets. It reconsiders the inferences that can be drawn regarding efficiency from comparisons of factor movements and factor prices. It then pursues these inferences through new empirical investigations of inter-city dispersion in prices for agricultural and industrial factors of production.

Section I of this paper discusses the importance of integrated internal markets, particularly in the case of China. Section II summarizes existing evidence regarding barriers to internal Chinese trade. Section III discusses the effects of economic integration on prices and especially those for factors of production. Section IV introduces data reporting the prices of agricultural and industrial factors in China and examines descriptive evidence of factor price dispersion. Sections V and VI test hypotheses about this dispersion. Section VII concludes.

I. The importance of integration in China

Baldwin and Venables (1995) provide a general treatment of the aggregate efficiencies associated with integrated markets. They observe (pg. 1606) that the benefits of regional integration "may be many times larger if industries are imperfectly, rather than perfectly, competitive," a situation which may have been common in China during the period under study. Regardless, the aggregate efficiencies associated with internal integration would ordinarily be desirable in any context.[1]

Internal integration may also have important redistributive effects. The theoretical model in Martin (1999) predicts that reductions in the costs of inter-regional transactions reduce inter-regional income differences, as well as increase national growth rates. Empirically, Shankar and Shah (2003, Abstract) observe that "countries ... experiencing [inter-regional] convergence ... focus on promoting an economic union". In the Chinese context, interregional income disparities are of particular concern (World Bank, 2003, pgs. 13-15).

The relationship between internal integration and inter-regional inequality can be amplified when external trade barriers are dismantled. Behrens (2005, Abstract) demonstrates that, in theory, "trade liberalization in developing countries with poor infrastructure and mostly autarkic regions may exacerbate spatial inequalities". Hussain (2004, 306) predicts that "the impact on the Chinese economy of WTO accession will depend crucially on what happens to internal trade barriers in the years after accession." Fan and Wei (2006, 682) agree.

WTO membership requires China to remove impediments to internal trade. If such impediments did not exist, aggregate growth would be enhanced, inter-regional disparities would be reduced and the effects of liberalized trade would be distributed more equitably. For all of

[1] Parenthetically, Bolton and Roland (1997) assert that increased factor mobility across regions reduces separatist incentives.

these reasons, the extent of internal barriers to trade in China needs to be assessed.

II. The extent of local trade barriers

Local protectionism may appeal to sub-national governments in many circumstances. As examples, it is an equilibrium outcome in Cai and Treisman (2004) when central government enforcement mechanisms are weak. Li, Qiu and Sun (2003) predict that this is especially likely in the presence of fiscal decentralization and high external trade protection.[2]

These circumstances have certainly obtained in China. The literature on Chinese inter-regional trade is replete with anecdotes of substantial and even startling instances of local trade barriers. Zhou (2000), for example, provides an entertaining account of local government interference in the Chinese tobacco and cigarette industry.

More generally, Young (2000) describes a wide variety of protectionist policies, including regulatory, physical and judicial obstruction, tariffs and "wars" afflicting inter-regional trade in raw materials. Naughton (2003) refers to these wars as well. Moreover, "China has reserved the right ... to maintain some restrictions on transportation and distribution of goods inside China" in its accession negotiations with the WTO (Gertler, 2004, pg. 23). The question is whether these instances are representative of systematic barriers to inter-regional trade or isolated distortions in a generally integrated national economy.

There seems to be agreement that, at least during earlier periods of reform, national policies inadvertently encouraged local protectionism (Zhao and Zhang, 1999). Young (2000,

[2] Autarky can also be optimal in Kessler, Lulfesmann and Myers (2003), though this result requires equal per-capita capital stocks across regions.

pg. 1093) asserts that, as reform progressed, local governments in China became increasingly dependent on local industry for revenue. This was a consequence of the traditional decentralization of tax administration in China, coupled with declining transfers from the central to local governments and increasing decentralization of political authority.

In these circumstances, restrictions on flows of production factors with local origins or of final goods produced elsewhere redistributed rents to local industry. Local governments could then extract them. Zhou (2000), Naughton (2003), World Bank (2003, chapter 3) and Bai, et al. (2004) restate this argument with varying levels of detail.

This argument is consistent with observations from the early reform period. World Bank (1994, pg. 15) reports that inter-regional trade flows declined, relative to total output, during this time. World Bank (1994, pgs. 35-37) examines prices for eight consumer goods and five industrial factors of production. It concludes that "(o)n balance it is clear that regional price variations were still significant in 1991 and have not noticeably diminished since 1986."

Additional evidence indicates that local protectionism remains important. Poncet (2003, 2005) finds that interprovincial flows of goods declined, relative to international and intra-provincial trade, between 1987 and 1997. This suggests that barriers to international trade were abandoned more rapidly than those to inter-provincial trade. Young (2000) concludes that provinces continued to pursue autarkic policies because the composition of production converged across regions while prices diverged. Moreover, agricultural production factors were reallocated in contradiction to comparative advantages. Bai, et al. (2004) find modest tendencies towards reduced specialization across provinces in industries with larger appropriable surpluses.

However, this evidence has been challenged. Holz (2006) offers rebuttals to Young

(2000). Naughton (2003), preceding Poncet (2003,2005), asserts that inter-provincial flows of goods in China were too large in 1987 and 1992 to be subject to substantial internal barriers.

Additional evidence suggests that the Chinese internal economy is becoming more integrated. Poncet (2006) finds that labor became more mobile between 1985 and 1995 despite the *hukou* system of residential registration. In what may be the only available direct evidence, a survey of more than 3,000 enterprises reported reductions in internal barriers to trade since the early years of reform (Li, Liu and Chen, 2003).

Relatively unimpeded inter-provincial trade would also be consistent with many indirect results: the dependence of provincial inflation rates on differential productivity growth (Guillaumont Jeanneney and Hua, 2002), strong indications of increasing regional specialization (Bai, et al., 2004; Dougherty, Herd and He, 2007), the dominance of sector-specific effects in long-term growth of real province- and industry-specific value-added (Xu, 2002) and weak evidence of inter-provincial correlations in provincial business cycles (Tang, 1998). Based on the accumulated evidence, the OECD (2005, pg. 38) concludes that "(c)onsiderable progress has been made on reducing trade and investment barriers between domestic regions."

III. The Law of One Price

The extent of inter-regional integration is difficult to assess. Much previous work regarding China attempts to measure it through quantities, such as disparities in industrial composition or volumes of inter-provincial trade flows. Naughton (2003) declares that the theoretical implications of inter-regional integration in these dimensions, as in many others, are obscure. Xu (2002, 119) concurs. For example, Ottaviano (1999) presents a model in which increasing inter-regional integration can lead to either greater or reduced specialization in production.[3]

Predictions regarding prices are clearer. In integrated markets, goods and services should flow away from locations in which they receive low prices and towards locations in which they receive high prices. These flows should enforce the Law of One Price: they should tend to equalize prices at all locations, at least within bounds set by transport costs.

In China, this Law appears to hold for rice (Keller and Shiue, 2004), food and other consumer goods (Xu and Voon, 2003) and many perishable consumer goods (Fan and Wei, 2006). However, World Bank (1994, pgs. 35-37) found no evidence of price convergence. Fan and Wei (2006) find that the Law of One Price holds much less consistently for industrial materials, raw industrial materials, durable goods, nonperishable consumer goods and services. Moreover, Young (2000) reports no consistent trend in price dispersion for consumer goods, industrial materials and agricultural products.

The application of the Law of One Price to factor markets is interesting for three reasons. First, even if factor mobility is impeded, trade in goods should equalize factor prices (Samuelson, 1948).[4] Second, Shankar and Shah (2003, Abstract) identify the removal of barriers to factor mobility as an essential policy for promoting economic union and reducing regional disparities. These disparities are sensitive to labor mobility, at the very least (Cai, Wang and Du, 2002; Hu, 2002). Third, obvious distortions remain in the markets for at least two factors, land and labor (OECD, 2005, pgs. 111-114).

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[3] This is consistent with Kim (1995), who describes more than a century of alternating convergence and divergence in industrial structure across the states of the United States, despite constitutional prohibitions against local protectionism.

[4] This is another reason why factor flows are an ambiguous indicator of efficiency.

This paper makes three contributions. It is the first to examine the prices of agricultural factors of production. The efficiency of agricultural factor markets is of special interest, given the challenges confronting farmers in the Chinese economy (World Bank, 2003, pgs. 53-57).

Second, this paper examines the evolution of factor price dispersion during the period of Chinese accession to the WTO. China's WTO obligations require it to promote internal market integration: "China's commitments under its Protocol of Accession specifically require that it maintain a uniform system of administration. Furthermore the central government is required to establish a mechanism whereby those concerned about problems of regional protection can bring their concerns to its attention." (Luo and Findlay, 2004, 147).

Third, the empirical techniques employed here identify cities in which many factors have idiosyncratic prices relative to those in the city with the most liberal trade regime. They also identify factors which exhibit extreme degrees of price dispersion relative to those which are least afflicted with obstructions to trade. These may be cities that are especially prone to protectionism and factors that are particularly subject to internal trade barriers.

IV. Descriptive evidence of convergence in factor prices

The analysis in this paper is based upon annual average prices in 36 cities for up to 30 agricultural factors of production in the years 1998 through 2001, and for up to 139 industrial factors of production in the years 1999 through 2002.[5] The level of aggregation in these data is minimal. Each of the factors is a specific input which could presumably be purchased on the

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[5] The analyses here exclude another industrial factor which is included in the original sources, home-made 70g. offset paper, because reported prices are suspect.

basis of its description.[6]

The Price Yearbooks of China for 1999 (table 5-25), 2000 (tables 5-23 and 5-26), 2001 (table 5-33), 2002 (tables 5-31, 5-32 and 5-34) and 2003 (table 5-17) report average prices by city for agricultural factors of production. They report 551 prices for 1998, 787 for 1999, 565 for 2000 and 769 for 2001. The Price Yearbooks of China for 2000 (table 5-23), 2002 (tables 5-31 and 32) and 2003 (table 5-17) report average prices by city for industrial factors of production. These sources report 3,559 prices for 1999, 4,374 for 2000, 3,684 for 2001 and 3,702 for 2002.

These years immediately precede 11 December 2001, the date of Chinese accession to the WTO (Gertler, 2004, 21), and, in the case of industrial factors, continue one year beyond it. China had strong incentives to eradicate most barriers to internal trade during this period because their removal was a condition of membership. If it responded to those incentives, price dispersion should have declined.

Within-year standard deviations of prices for each factor provide a simple characterization of this dispersion. However, these standard deviations would probably not be zero even with complete integration,. Economies of scale in production would typically imply that factors are not produced at all locations where they are employed. With transportation costs that depend on distance, factor prices at points of employment would therefore vary to some extent. The implications for market integration of these standard deviations, themselves, are therefore uncertain.

However, changes in these standard deviations over time imply unambiguous conclusions

[6] Appendix tables 1 and 2 provide these descriptions. The authors can provide all data and computer programs upon request.

Table 1

Changes in standard deviations for factor prices

Change from first year to second year	Change from second year to third year	Change from third year to fourth year	Number of agricultural factors	Number of industrial factors
Decrease	Decrease	Decrease	1	9
Decrease	Decrease	Increase	0	26
Decrease	Increase	Decrease	7	20
Decrease	Increase	Increase	1	25
Increase	Decrease	Decrease	4	5
Increase	Decrease	Increase	4	14
Increase	Increase	Decrease	0	5
Increase	Increase	Increase	1	14

Note: "First year to second year", "second year to third year" and "third year to fourth year" represents 1998 to 1999, 1999 to 2000 and 2000 to 2001 for agricultural factors; 1999 to 2000, 2000 to 2001 and 2001 to 2002 for industrial factors. Standard deviations which remain the same across two years appear here as "decreases".

regarding changes in market integration. The claim that regional markets were becoming more integrated would require, at a minimum, that these standard deviations decline. Any other pattern would suggest that progress towards integration was, at the very least, not continuous.

Table 1 summarizes trends in the standard deviations of prices for agricultural and industrial factors of production over the sample years. The standard deviations for each factor are are calculated for the subset of cities which report prices in every sample year. This subset differs across factors. The median number of cities in the sample for each agricultural factor is 21.5.[7] The median number of cities in the sample for each industrial factor is 28.

Table 1 categorizes the patterns of changes in these standard deviations. Only one

[7] Lasa does not report prices for any agricultural factor in every year. Prices are not reported in one of more years for 12 agricultural factors and 22 industrial factors.

agricultural and nine industrial factors of production display reductions in standard deviations in each of the sampled years. These are the only factors which demonstrate unambiguous price convergence. By this measure, more factors demonstrated unambiguous price divergence. Standard deviations of prices for one agricultural and fourteen industrial factors actually increased in each successive sample year.

Changes in standard deviations from the beginnings to the ends of the studied periods, disregarding the intervening years, were also inconsistent with the requirements of increased integration. Of the 22 agricultural factors with reported prices in 1998 and 2001, standard deviations were smaller in 2001 than in 1998 for only nine, or 40.9%. Of the eight factors with one or no reported prices 1998, standard deviations were lower in 2001 than in 1999 for four and higher for four.[8]

Similarly, only 52 of the 118 industrial factors, or 44.1%, experienced reductions in the standard deviations of their prices between 1999 and 2002. Of the 21 industrial factors excluded from table 1 with incomplete price records, only two have price reports that are more than one year apart.[9] The standard deviation of prices for the Jiefang CA1092 truck increased in each of the years from 1999 through 2001. That of prices for the Jiangling NHR54ELW passenger/goods

[8] Standard deviations calculated with all valid prices for agricultural factors exhibit fewer tendencies toward price homogeneity. The 2001 standard deviations of all reported prices were higher for 17 factors than the 1998 standard deviations and lower for only five. For the eight factors without usable 1998 prices, the 2001 standard deviations of all reported prices were higher than the 1999 standard deviations for five and lower for three. Details for these and all other results are available from the authors.

[9] Price reports are available in one year for 15 industrial factors and in two adjacent years for four.

dual vehicle increased from 1999 to 2001 and again from 2001 to 2002.[10]

The standard deviations in table 1 are unscaled. Arguably, if two factors have prices with the same standard deviations but different averages, they might be construed as demonstrating different degrees of price homogeneity. The same degree of variation might be less important for the factor with the higher average price. Table 2 addresses this issue. It categorizes annual changes in the coefficients of variation for the prices of agricultural and industrial factors, as an alternative measure of dispersion.[11]

Table 2 contains even less evidence of increasing price homogeneity among agricultural factors than does table 1. None exhibits coefficients of variation which decrease consistently. The coefficients of variation for two increase consistently throughout the period. For the 22 factors with coefficients of variation for prices in 1998, only four exhibited lower values in 2001 than in 1998. Of the remaining eight factors, four exhibited lower values and four exhibited higher values in 2001 than in 1999.[12]

In terms of the coefficient of variation, the same number of industrial factors experienced

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[10] Results based on standard deviations calculated with all available industrial factor prices are virtually identical. The 2002 standard deviations for all reported prices were lower than the 1999 standard deviations for only 54, or 45.8% of the industrial factors reporting prices in all four survey years. The standard deviations of prices for the Jiefang CA1092 truck were identical in 1999 and 2002. Those for the Jiangling NHR54ELW passenger/goods dual vehicle declined between 1999 and 2001.

[11] Holz (2006, 13) prefers the coefficient of variation for the purpose here.

[12] Coefficients of variation calculated with all available agricultural factor prices again exhibit fewer tendencies toward price homogeneity. The 2001 coefficients of variation for all reported prices were higher for 19 factors than the 1998 coefficients of variation and lower for only three. For the eight factors without usable 1998 prices, the 2001 coefficients of variation for all reported prices were higher for five and lower for three. Disregarding the prices for 1998, patterns are again similar.

Table 2

Changes in coefficients of variation for factor prices

Change from first year to second year	Change from second year to third year	Change from third year to fourth year	Number of agricultural factors	Number of industrial factors
Decrease	Decrease	Decrease	0	11
Decrease	Decrease	Increase	0	29
Decrease	Increase	Decrease	7	21
Decrease	Increase	Increase	1	24
Increase	Decrease	Decrease	2	6
Increase	Decrease	Increase	3	12
Increase	Increase	Decrease	3	4
Increase	Increase	Increase	2	11

Note: "First year to second year", "second year to third year" and "third year to fourth year" represents 1998 to 1999, 1999 to 2000 and 2000 to 2001 for agricultural factors; 1999 to 2000, 2000 to 2001 and 2001 to 2002 for industrial factors. Coefficients of variation which remain the same across two years appear here as "decreases".

continual reductions in price dispersion as experienced continual increases, 11. Nevertheless, the overall pattern is similar to that of table 1: fluctuations in price dispersion with no general trend. Only 53 of the 118 factors, or 44.9%, experienced reductions in the coefficients of variations of their prices between 1999 through 2002, ignoring the intervening years. The coefficient of variation of prices for the Jiangling NHR54ELW passenger/goods dual vehicle decreased from 1999 to 2002. However, that for the Jiefang CA1092 truck increased in each of the years from 1999 through 2001.[13]

[13] Coefficients of variation calculated with all available industrial factor prices yield similarly meager evidence of trends toward price homogeneity. The 2002 coefficients of variation for all reported prices were lower than the 1999 coefficients of variation for only 54, or 45.8% of the industrial factors reporting prices in all four survey years. The coefficients of variation of prices for the Jiangling NHR54ELW passenger/goods dual vehicle again decreased from 1999 to 2002, while those for the Jiefang CA1092 truck increased between 1999 and 2001.

V. Decompositions of price dispersion

The evidence in the previous section is suggestive, but informal. Tables 3 through 6 present a formalization whose purpose is to determine whether the standard deviations and coefficients of variation from the previous section embody statistically significant trends in the extent of price homogeneity. Each column in each table presents results from regressions of the form

$$\textit{Price variation}_{factor,year} = \beta_0 + \beta_{year}{}'\mathbf{Y} + \beta_{factor}{}'\mathbf{F} + \varepsilon_{factor,year}. \qquad \textbf{(1)}$$

Y represents a 3×1 column vector whose elements are dummy variables for the three later years of the agricultural and industrial factor price samples. β_{year} is a 3×1 column vector whose elements are the coefficients for each included year. These coefficients provide the tests for whether prices converged over the periods studied here. With the first year in each sample as the reference year, convergence requires that the coefficient for each successive year should be negative and larger in absolute value than that for the previous year.

F is a column vector whose elements are dummy variables for all but one of the factors included in the analysis. β_{factor} is a column vector of the same dimensions as **F**, whose elements are the coefficients for each included factor.[14]

The sample for table 3 consists of 72 factor-year observations for the eighteen agricultural factors with price reports in all four sample years. In this case, **F** contains dummy variables for 17 of these factors. The omitted factor is home-made urea with 46% nitrogen. This serves as the reference factor because it is widely available, easily fabricated, and therefore unlikely to be

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[14] Young (2000, Section III.B) employs the same specification of explanatory variables. His dependent variable is the natural log of the standard deviation of the natural log of prices.

Table 3

Regression estimates of trends in city-specific agricultural factor prices

	Dependent variables:	
	Standard deviation for for factor prices	Coefficient of variation for factor prices
Year 1999 coefficient	−.445	−.689
p-value	.399	.582
Year 2000 coefficient	−.00452	1.05
p-value	.993	.402
Year 2001 coefficient	.0375	1.37
p-value	.943	.274
F-statistic for H_0: the coefficients for 1999, 2000 and 2001 are jointly zero	.385	1.17
p-value	.766	.330
F-statistic for H_0: the coefficients for all explanatory variables are jointly zero	28.7	5.94
p-value	<.0001	<.0001
R^2	.918	.700
Adjusted R^2	.886	.582

Note: The sample consists of 72 observations. Each observation represents one of the four years for each of 18 factors. These observations are aggregated from 1,432 city-, year- and factor-specific price reports.

subject to effective internal trade barriers.

The dependent variable for the regression in the first column of table 3 is the year-specific, factor-specific, standard deviation of nominal agricultural factor prices, as tabulated in table 1. This regression attains a very high level of explanatory power: The R^2 is .918 and the adjusted R^2 is .886. F-statistics reject the null hypotheses that all explanatory variables are insignificant at better than .01%.[15]

However, as demonstrated in the first three rows of the first column of table 3, agricultural factor prices did not become more homogeneous over the years 1998 through 2001. The estimated effects for the last three years of this period, given in the first three rows of the table, are all statistically insignificant. The F-statistic in the fourth row fails to reject the null hypothesis that all three are jointly zero with a prob-value of .766. In other words, there was no trend over this period in the standard deviations of factor-specific prices.

The second column of table 3 presents an analogous regression. The dependent variable here is the factor-specific, year-specific coefficient of variation for prices, tabulated in table 2. The results of this regression are very similar to that for the standard deviation of factor prices. Once again, the regression as a whole has high explanatory power and all explanatory variables are jointly significant.

Moreover, the coefficients for 1999, 2000 and 2001 are again individually and jointly insignificant. As with the standard deviations for factor prices, there is no evidence that the coefficients of variation for factor prices varied across the years under study. In other words, there is no evidence that factor prices moved in the direction of homogeneity during this period, either absolutely or relative to their average levels.

The sample for the regressions of table 3 uses only factor prices from cities which report in all four survey years. This ensures that changes in factor-specific measures of price dispersion

[15] As reported in section IV, the number of year-specific, city-specific price observations varies across factors. This raises the possibility that the dependent variables in the regressions of table 3 are heteroskedastic. However, the test of the null hypothesis of homoskedasticity fails to reject that hypothesis for the standard deviations and coefficients of variation with prob-values of .506 and .697, respectively. Consequently, all statistical tests are OLS calculations.

Table 4

Tests for H_0: coefficients for 1999, 2000 and 2001 are
jointly zero in expanded samples of agricultural factor prices

	Dependent variables:	
	Standard deviation for factor prices	Coefficient of variation for factor prices
Consistent cities for each factor: 105 factor-year observations derived from 2,051 factor-, city- and year-specific price reports		
F-statistic	.45	1.02
p-value	.719	.388
All prices: 105 factor-year observations derived from 2,667 factor-, city- and year-specific price reports		
F-statistic	1.15	4.85
p-value	.336	.0040

are attributable to actual changes in prices, rather than changes in the samples from which the samples are drawn. It also ensures that each of the included factors exhibits a pattern of changes in price dispersion over the full four years of the sample.

At the same time, this sample ignores many available price observations. Table 4 reports results of the test for changes in price dispersion in the fourth row of table 3, derived from the estimation of equation 1 on two expanded samples. Both include measures of price dispersion for the twelve agricultural factors omitted from the sample for the regressions of table 3.

In the first expanded sample, consistent sets of cities provides these measures. These sets consist of all cities reporting prices for each additional factor in any year for which prices for that factor are available. Changes in price dispersion for these factors are therefore again attributable only to changes in city-specific prices across years. However, these changes are not observable across the entire sample period. Prices are available for nine of these factors in three years, and for the remaining three factors in only two years. Consequently, this sample has 33 additional factor-year observations.

The second expanded sample incorporates all price reports for all factors. This sample includes all available information. However, it yields measures of price dispersion which can vary both because of changes across years in city- and factor-specific prices and changes in the composition of cities reporting these prices.

The failure of factor-specific prices to converge across cities is apparent, regardless of sample design. The first row of table 4 demonstrates that the null hypothesis of constant price dispersion over time cannot be rejected for the first expanded sample, regardless of whether price dispersion is measured by the standard deviation or the coefficient of variation.[16]

The second row of table 4 demonstrates the same result for price dispersion measured by the standard deviation for prices in the sample based on all reported prices. In contrast, the coefficients of variation for prices in this sample varied significantly across sample years. However, all three coefficients in β_{year} are positive, and those for 1999 and 2001 are individually significant. In this sample, price dispersion was arguably greater in 2001 than in 1998.

Tables 5 and 6 reproduce the analyses of tables 3 and 4 for industrial production factors. In table 5, **F** is a 117x1 column vector whose elements are dummy variables for 117 of the 118 industrial factors with valid price reports from a consistent set of cities in all four sample years.

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[16] As in footnote 15, the null hypothesis of homoskedasticity cannot be rejected for any of the four regressions summarized in table 4. The prob-values for this test for the regressions with, respectively, the standard deviation and the coefficient of variation for prices as dependent variables, are 1.00 and .754 for the first expanded sample. They are 1.00 and .655 for the second expanded sample. Consequently, table 4 presents results based on OLS estimates.

Table 5

Regression estimates of trends in city-specific industrial factor prices

	Dependent variables:	
	Standard deviation for for factor prices	Coefficient of variation for factor prices
Year 2000coefficient	−25.9	−1.97
p-value	.202	.0005
Year 2001 coefficient	−25.1	−1.81
p-value	.217	.0012
Year 2002 coefficient	55.2	−.555
p-value	.0067	.319
F-statistic for H_0: the coefficients for 2000, 2001 and 2002 are jointly zero	7.07	5.97
p-value	.0001	.0006
F-statistic for H_0: the coefficients for all explanatory variables are jointly zero	51.8	20.4
p-value	<.0001	<.0001
R^2	.947	.875
Adjusted R^2	.928	.832

Note: The sample consists of 472 observations. Each observation represents one of the four years for each of 118 factors. These observations are aggregated from 12,608 city-, year- and factor-specific price reports.

Here, the Shanghai Santana 2000 GSI automobile is the reference factor omitted from **F**. This product is likely to be relatively free of protectionism because it also has a national market as an important final consumer good. Local protectionism would be counter-productive because the scale of automobile manufacture ensures that local production levels would overwhelm local demand. In addition, consumer goods are somewhat less likely to be subject to government price controls than are producer goods (National Development and Reform Commission, 2005).

As in table 3, the regression for the standard deviations of industrial factor prices attains a very high level of explanatory power. The R^2 and adjusted R^2 values both exceed .92. All explanatory variables are jointly significant at better than .01%.[17]

As demonstrated in the first three rows of the first column of table 5, there is no evidence that industrial factor prices became more homogeneous between 1999 and 2002. Although the estimated effects for 2000 and 2001 are negative, neither differs significantly from zero. In addition, the estimated effect for 2002 is large, highly significant and positive. This implies that standard deviations for industrial factor prices in 2002 were systematically higher than in 1999.[18]

As in table 3, the second column of table 5 reproduces the regression of the first column, but with factor- and year-specific coefficients of variation as the measure of price dispersion. This regression again attains very high explanatory power. However, in contrast to the regression for standard deviations, this regression implies at least temporary movements in the direction of price convergence.

The estimates of β_{2000} and β_{2001} in this regression suggest that price dispersion was significantly and substantially lower during the intervening years of the period from 1999

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[17] The null hypothesis of homoskedasticity cannot be rejected for any of the six regressions summarized in tables 5 and 6. The prob-values for this test for the regressions with, respectively, the standard deviation and the coefficient of variation for prices as dependent variables, are 1.00 and .772 for the sample of table 5, .997 and .664 for the first expanded sample of table 6 and .999 and .636 for the second expanded sample of table 6. Consequently, tables 5 and 6 present results based on OLS estimates.

[18] The F-statistic for the null hypothesis that all three year effects are jointly zero rejects this hypothesis at .01% significance. However, it is evident that this rejection relies heavily on the individual significance of the estimate for β_{2002}.

Table 6

Tests for H_0: coefficients for 2000, 2001 and 2002 are jointly zero in expanded samples of industrial factor prices

	Dependent variables: Standard deviation for factor prices	Dependent variables: Coefficient of variation for factor prices
Consistent sets of cities for each factor: 486 factor-year observations derived from 12,954 factor-, city- and year-specific price reports.		
F-statistic	7.05	6.14
p-value	.0001	.0004
All prices: 501 factor-year observations derived from 15,319 factor-, city- and year-specific price reports.		
F-statistic	2.68	4.39
p-value	.0469	.0047

through 2002. However, the estimate of β_{2002} in this regression is small and statistically insignificant. Even with price dispersion measured by the coefficient of variation, industrial factor price dispersion at the end of the period was no less than that at the beginning.[19]

As in table 4, table 6 reproduces the tests for trends in table 5 in expanded samples of industrial factor prices. The first expanded sample includes fourteen additional factor-year observations: three years of price observations from consistent sets of cities for two additional factors and two years of price observations from consistent sets of cities for four additional factors. The second expanded sample includes all price reports from all cities in all years. This

[19] Regressions available from the authors demonstrate that the apparent inconsistencies between these results and those of the regression for the standard deviations of industrial factor prices are attributable to average industrial factor prices, which were significantly higher in both 2000 and 2001 than in 1999, but insignificantly different in 2002 from those in 1999.

inclusion adds fifteen factor-year observations for factors with only one year of price reports.[20]

As in table 5, the regressions for the standard deviations and coefficients of variation of industrial factor prices in table 6 all reject the null hypothesis that factor price dispersion was the same in all four sample years. However, the signs, magnitudes and significance patterns for the individual year effects in these regressions are all similar to those in the regressions of table 5.

Consequently, the null hypothesis is rejected for the same reasons, regardless of sample. Industrial factor price dispersion, as measured by the standard deviation for prices, remained the same in 2000 and in 2001 as in 1999, before increasing significantly in 2002. As measured by the coefficient of variation for prices, price dispersion declined significantly in 2000 and remained at this lower in 2001, but then returned to the 1999 level in 2002.

The results of tables 3 through 6 are very similar to those of Young (2000, figure V), for periods ranging from the mid-1980s through the 1990s. Young finds no evidence of price convergence for agricultural goods or industrial materials, and some evidence of price divergence for retail goods. According to tables 3 through 6, the absence of price convergence apparently continued into the first years of the 21st century for factors of production.

VI. Decompositions of prices

The regressions of tables 3 through 6 aggregate the original year-, factor- and city-specific price data into year- and factor-specific summary statistics to assess whether trends occur in the extent of factor price homogeneity. Tables 7 and 10 return to the original data to address the underlying issue of efficiency in factor markets from a different perspective. They explore whether inter-city

[20] The regressions for this sample do not include fixed effects for these fifteen factors.

variations in the prices of individual factors are statistically significant, using the regression

$$\begin{aligned} Price_{city,factor,year} = {} & \beta_0 + \beta_{year}{}'\mathbf{Y} + \beta_{factor}{}'\mathbf{F} + \beta_{city}{}'\mathbf{C} \\ & + \beta_{factor,year}\mathbf{F}\otimes\mathbf{Y} + \beta_{city,year}\mathbf{C}\otimes\mathbf{Y} + \beta_{city,factor}\mathbf{C}\otimes\mathbf{F} \\ & + \varepsilon_{city,factor,year}\,. \end{aligned} \qquad \textbf{(2)}$$

Equation 2 presents an analysis-of-variance which decomposes these original year-, factor- and city-specific prices into β_0, a constant that is embedded in prices for all factors in all cities and all years, and six additional components. **Y** and **F** are as defined in equation 2 as in equation 1. As there, the omitted element in **Y** establishes the first year in each sample as the temporal reference. For each sample, the reference factor omitted from **F** is that which is most likely to be traded freely.

C represents a column vector consisting of 35 dummy variables. They identify all but one of the cities, with Shenzhen as the reference. Shenzhen's internal trade regime is arguably the most liberal. Systematic deviations from prices in Shenzhen might therefore be attributable to local protectionist policies.[21]

The three main effects serve as controls. β_{factor} is a column vector comprised of coefficients for all but the omitted factor. Each coefficient represents an effect that is common to the price of the associated factor in all cities and all years.

β_{year} is a column vector containing three coefficients. Each represents an individual year effect that is common to the prices of all factors in the associated year. These elements capture

[21] Xu (2002) observes that the interpretations of effects estimated by specifications such as equations 1 and 2 depend heavily on the choice of reference.

generalized trends in the prices of all factors.

The third main effect, β_{city}, is a column vector comprised of 35 coefficients. Collectively, they estimate variation in aggregate factor price levels across cities. Individually, they represent city-specific aggregate price indices for factors of production.

Controls also include two interaction effects. The factor-year interaction coefficients contained in $\beta_{factor,year}$ allow for the possibility that time trends in prices differ across factors. The city-year interaction coefficients in $\beta_{city,year}$ allow for the possibility that time trends for aggregate producer price indices differ across cities.

The sixth component is $\beta_{city,factor}$, the vector of city-factor interactions. The coefficients in this interaction term test for market efficiency. If their contribution to the explanation of factor prices is statistically significant, then prices for individual factors vary significantly across cities, even after controlling for price variations across factors, variations across cities and time in aggregate price levels, and variations in the evolution of factor-specific prices and city-specific factor price indices. This result would suggest that neither factor nor goods mobility in China was sufficient to ensure efficient production.

This design is identical to that employed by Xu and Voon (2003) for the purpose of explaining changes in retail price indices. However, they interpret large values for the elements of β_{factor} compared to those of β_{city} and $\beta_{city,factor}$ as evidence of "long-run integration", that factor-specific components are the most important elements of actual prices.[22] While this interpretation

[22] Xu and Voon (2003) impose an analogous short-run interpretation on the comparison between $\beta_{factor,year}$, β_{year} and $\beta_{city,year}$. Xu (2002) regresses changes in real value added by sector and province on fixed effects for sector and year and interactions for provinces by year, sector by year and province by sector. Interpretation is unclear because provincial fixed effects are omitted.

is of interest, the presence of significant elements in $\beta_{city,factor}$ would still be a clear violation of the Law of One Price. Therefore, $\beta_{city,factor}$ is the focus here.

Equation 2 differs importantly from the estimating equations of Fan and Wei (2006). They adopt time-series techniques which emphasize the properties of the sequence of prices for a single good.[23] These techniques are not practicable here because the time dimension in the data is too short.

Moreover, the regression of equation 2 and its implementation here have advantages in comparison to the techniques of Fan and Wei (2006). Their techniques do not contain any analogue to β_{city} or $\beta_{city,year}$. Consequently, they cannot identify cities where aggregate factor costs are high or low, nor cities in which these costs are changing. While each of the equations for their unit panel root tests estimates one element of $\beta_{city,factor}$, they do not test for the collective significance of these elements. Lastly, the interpretations of these elements below identify specific cities which may be inclined towards protectionist policies and specific factors which may be subject to them.

Table 7 summarizes the results from the application of equation 2 to the sample of agricultural factor prices upon which tables 1, 2 and 3 are based. First, the main effects for factors are significant at better than .01%. This indicates, not surprisingly, that different factors have consistently different prices.

The evolution of price levels differs across factors as well. The interaction between years

[23] These techniques, based on unit root tests, have identified strong evidence of price convergence in a number of contexts (Parsley and Wei, 1996; Goldberg and Verboven, 2005; Crucini and Shintani, 2006). Analyses using other estimation techniques seem to find more persistent evidence of price divergence (Alessandria and Kaboski, 2005; Haskel and Wolf, 2001).

Table 7

Analysis of variance for agricultural factor prices

Source	Degrees of Freedom	Sum of squares	Mean square	F-Value	prob-value
Error	918	5,484.	5.974		
Model	513	560,953.	1093.	183.	<.0001
Factors	17	503,865.	29,639.	4,961.	<.0001
Factors by years	51	1,187.	23.28	3.90	<.0001
Years	3	4.014	1.338	.22	.880
Cities	34	3,659.	107.6	18.01	<.0001
Cities by years	102	568.6	5.575	.93	.665
Cities by factors	306	21,359.	69.80	11.68	<.0001

Note: The R^2 value for this regression is .990. The sample contains 1,432 observations, each representing the price for one factor in one city during one year.

and factors tests the null hypothesis that prices for different factors jointly exhibited the same time trends. This hypothesis is rejected at better than .01% significance. Most of the variation in factor-specific price trends appears to be attributable to price changes over time for five of the eighteen included factors.[24]

The remaining explanatory variables address issues upon which previous tables have been silent. The fifth row of table 7 demonstrates that the year effects make no significant collective contribution to the explanation of agricultural factor prices. In other words, aggregate trends in price levels are absent, as well as, from table 3, aggregate trends in their dispersion.

[24] Discussions of individual coefficients here acknowledge statistical significance at the 10% significance level or better. This standard is less rigorous than that for tests of collective significance because the data are unavoidably less informative about the former. The maximum number of price observations for any factor is 136. With city, factor and year main effects removed, interaction terms are identified only by whatever variation remains.

The sixth, seventh and eighth rows of table 7 present evidence regarding the nature of this dispersion. Collectively, they represent all possible sources of systematic price variation across cities. They demonstrate that almost all of the substantive variation is factor-specific, which is suggestive of market inefficiency.

The sixth row reports that the city effects achieve collective significance at the .01% level. This implies that different cities have different aggregate agricultural factor price indices. However, only the city of Xining has a statistically significant individual effect, indicating substantially higher agricultural producer costs than in Shenzhen. Apart from this effect, these data do not conclusively distinguish between high- and low-cost cities for agriculture.

The seventh row reports that the city-year effects are collectively insignificant. This demonstrates that, in general, city-specific aggregate agricultural factor price indices do not exhibit city-specific time trends. Individual city-year effects indicate significant changes in price levels over time in only two cities, downward in Shijazhuang and upward in Shanghai.

Consequently, the final row in table 7 demonstrates that the only substantively important source of inter-city dispersion in agricultural factor prices is variations across cities in the prices of individual factors. This row reports that the contribution of the interaction of cities by factors to the variation in factor prices is statistically significant at better than .01%. This test rejects the null hypothesis implied by factor market efficiency.

In other words, variations across cities in prices for the same agricultural factor contribute significantly to the overall variation in factor prices. The same factor may have significantly different prices in different cities. Moreover, these differences comprise an important part of the overall variation in all factor prices. This conclusion differs substantially from those in Xu and Voon (2003) and Fan and Wei (2006).[25]

Individual city-factor effects are much more likely to achieve statistical significance than any of the other interaction effects in equation 2.[26] The analysis of variance in table 7 estimates 306 individual city-factor effects. Of them, 35 are significant at better than 1%, nine at better than 5% and three at better than 10%. These effects, summarized in table 8, identify the factors whose prices are most reliably different in different cities.[27]

According to table 8, eleven of the eighteen factors have prices which differ significantly in at least one city from their reference prices. The prices for five differ in only one city, suggesting that their prices generally adhere to the Law of One Price. The same is true, although with more exceptions, for the four factors whose prices differ from the reference prices in a quarter or fewer of all reporting cities.

However, the prices for sumi-alpha 5% emulsion vary from its reference price in half of reporting cities. Those for deltamethrin 40% emulsion vary from its reference price in eighteen out of 21 cities, or 85.7%. Ubiquitous deviations such as this would be difficult to maintain if these factors were traded freely. Consequently, the implication must be that they are not. Whether

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[25] The regression of equation 2, applied to the second expanded sample of table 4, yields the same levels of statistical significance as in table 7 for all classes of effects. Effects that are statistically significant in the sample of table 7 are also significant in the first expanded sample of table 4. In the latter sample, the year effects are also jointly statistically significant at better than 5%. These effects indicate that agricultural factor prices were higher in 2002 than in 1999.

[26] Significant city−factor effects are especially noteworthy because, with city, factor and year main effects removed, these terms are identified only by whatever variation remains in the prices for a particular factor in a particular city over the four sample years.

[27] For the first and second expanded samples of table 4, respectively, 90 of 522 and 140 of 821 individual city-factor effects are statistically significant at 10% or better.

Table 8

Agricultural factors ranked by percent of significant city-specific effects

Factor name	Number of cities: reporting prices	with significant effects	percent significant effects
Deltamethrin 40% emulsion	21	18	85.7%
Sumi-alpha 5% emulsion	12	6	50.0%
Ordram 76% emulsion	8	2	25.0%
Potassium methylamine 50% emulsion	24	5	20.8%
DDVP 80%	30	6	20.0%
Rogor oxide 40% emulsion	30	5	16.7%
Benomyl 50% powder	14	1	7.14%
Ammonium citrate hydrocarbons	21	1	4.76%
Potassium chloride 50%-60% potassium oxide	22	1	4.55%
Three-way compound fertilizer, home-made	23	1	4.35%
High-pressure polythene mulch film	24	1	4.17%

Note: The reference factor is home-made urea with 46% nitrogen.

domestic trade impediments are economic in origin, as, for example, driven by transportation costs, or attributable to policies such as trade barriers, is worth exploring.[28]

Statistically significant city-factor effects also distinguish cities where prices for agricultural factors vary from reference levels. As summarized in table 9, eight cities have no significant city-factor prices. In other words, in each of these cities the vector of observed factor prices is not distinguishable from the Shenzhen reference. If Shenzhen allows unimpeded trade

[28] The expanded samples of table 4 add twelve agricultural factors to the analysis. In the first of these samples, these additions do not change the overall pattern of factor-specific price variations for the eighteen factors in the analysis of table 7. Seven of the twelve additional factors have significant city-specific price effects, two in ten cities or more. The same is true for the second expanded sample of table 4. In this sample, deltamethrin 40% emulsion and sumi-alpha 5% emulsion have significant city-specific price effects in almost all cities.

Table 9

Cities with significant agricultural factor-specific effects

City	Number of factors: reporting prices	Number of factors: with significant effects	percent significant effects	City	Number of factors: reporting prices	Number of factors: with significant effects	percent significant effects
Chengdu	11	10	90.9%	Taiyuan	11	1	9.09%
Wulumuqi	2	1	50.0%	Nanning	12	1	8.33%
Huhehaote	6	2	33.3%	Dalian	13	1	7.69%
Guiyang	3	1	33.3%	Xi'an	13	1	7.69%
Nanjing	13	3	23.1%	Ningbo	14	1	7.14%
Shanghai	9	2	22.2%	Fuzhou	15	1	6.67%
Beijing	15	3	20.0%	Hangzhou	15	1	6.67%
Lanzhou	10	2	20.0%	Shenyang	16	1	6.25%
Xiamen	10	2	20.0%	Wuhan	16	1	6.25%
Haikou	5	1	20.0%	Zhengzhou	15	0	0.0%
Yinchuan	16	3	18.8%	Changsha	10	0	0.0%
Kunming	11	2	18.2%	Shijazhuang	10	0	0.0%
Qingdao	15	2	13.3%	Chongqing	8	0	0.0%
Guangzhou	9	1	11.1%	Changchun	7	0	0.0%
Hefei	10	1	10.0%	Tianjin	7	0	0.0%
Jinan	10	1	10.0%	Nanchang	6	0	0.0%
Ha'erbin	11	1	9.09%	Xining	2	0	0.0%

Note: Shenzhen is the reference city. Lasa contributes no price reports to this sample.

in these factors, then it must be concluded that these cities do, as well. The same is probably true for the 13 cities in which only one factor price differs from that in Shenzhen.

However, prices for at least one-fifth of reported factors vary significantly from reference levels in ten cities. This degree of variation may suggest city-specific trade practices which are at least partially inhibitory.

In particular, table 9 suggests that trade policies in Chengdu may interfere with the

Table 10

Analysis of variance for industrial factor prices

Source	Degrees of Freedom	Sum of squares	Mean square	F-Value	prob-value
Error	8,997	2,007,899,662.	223,174.		
Model	3,610	530,755,938,962.	147,023,805	658.8	<.0001
Years	3	109,069,752.	36,356,584.	162.9	<.0001
Factors	117	523,614,964,602.	4,475,341,578.	20,053	<.0001
Factors by years	351	1,017,330,098.	2,898,376	12.99	<.0001
Cities	35	230,935,762.	6,598,165.	29.57	<.0001
Cities by years	105	105,600,382.	1,005,718	4.51	<.0001
Cities by factors	2,999	3,194,649,659.	1,065,238	4.77	<.0001

Note: The R^2 value for this regression is .996. The sample contains 12,608 observations, each representing the average price for one factor in one city during one year.

unimpeded movement of agricultural factors. This is the only city in which more than one-third of the factors for which prices are available in all four sample years demonstrate significant variations from reference levels. In fact, these variations appear for ten of the eleven factors for which Chengdu provides complete price information.[29]

Table 10 demonstrates that equation 2 explains even more of the variation in the sample of industrial factor prices represented in tables 1, 2 and 4 than in agricultural factor prices. Each of the effects tabulated in table 10 make contributions to this explanatory power that are statistically significant.

Year effects are jointly statistically significant. Individual coefficients demonstrate that

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[29] The additional significant city-factor effects in the first expanded sample of table 4 do not substantially change the overall pattern of factor-specific price variations across cities. However, in the second expanded sample of table 4, almost all cities exhibit at least three unique factor prices, and prices in Chengdu are less distinct than in the smaller samples.

the aggregate industrial factor price level was significantly higher in 2002 than in 1999. Prices for industrial factors varied significantly across factors. In addition, 46 of the 117 factors have at least one statistically significant year effect, indicating that their prices deviated from the aggregate trend in at least one year.

Although city effects are jointly significant, all individual city effects are insignificant. Consequently, equation 2 does not provide a clear ranking of aggregate industrial factor price indicies across cities in the reference year of 1999. However, the subsequent evolution of these indicies is unambiguous: all but Changchun and Guiyang had significantly and substantially lower industrial factor prices in 2002 than did Shenzhen. With an average of 3,593 yuan across all reported factor prices, the 2002 discount relative to the aggregate factor price index in Shenzhen varied from a modest 187 yuan in Shijazhuang to a substantial 874 yuan in Taiyuan.[30]

Lastly, regression 2 reveals substantial inter-city variation in the prices of individual industrial factors, far in excess of the inter-city variation in agricultural factor prices. Prices for 64 industrial factors have no significant city-specific components. However, of the 2,999 estimated city−factor effects, 1,364, or 45.5%, are statistically significant. Table 11 identifies the 54 factors with significant effects.

For 22 of these factors, 10% or fewer of city-factor effects are significant. If these factors

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[30] The regression of equation 2, applied to the two expanded samples of table 6, yields the same levels of statistical significance as in table 10 for all classes of effects. Both expanded samples estimate that average industrial factor prices increased in 2002. Forty-eight of 124 factors in the first expanded sample and 50 of 139 factors in the second exhibit significant factor-specific price changes over time. All city-specific effects are individually insignificant in both expanded samples. All cities with the exceptions of Changchun and Guiyang have lower aggregate industrial factor prices in 2002 than Shenzhen in the first expanded sample. The same is true for all cities with the exceptions of Beijing, Shijazhuang, Changchun and Guiyang in the second expanded sample.

Table 11

Industrial factors ranked by percent of significant city−factor effects

	Number of cities				Number of cities		
Factor	reporting prices	with significant effects	percent significant effects	Factor	reporting prices	with significant effects	percent significant effects
50	12	12	100.%	90	13	2	15.4%
56	19	19	100.%	39	27	4	14.8%
120	15	15	100.%	54	14	2	14.3%
47	26	25	96.2%	31	32	4	12.5%
119	18	17	94.4%	40	27	3	11.1%
118	17	14	82.4%	44	30	3	10.0%
45	22	18	81.8%	73	22	2	9.09%
35	31	25	80.7%	72	23	2	8.70%
36	32	25	78.1%	29	14	1	7.14%
64	29	20	69.9%	87	14	1	7.14%
24	27	18	66.7%	74	15	1	6.67%
21	32	18	56.3%	62	19	1	5.26%
42	23	12	52.2%	69	22	1	4.55%
49	16	8	50.0%	19	23	1	4.35%
48	23	11	47.8%	55	27	1	3.70%
78	8	3	37.5%	58	28	1	3.57%
79	8	3	37.5%	52	30	1	3.33%
63	30	11	36.7%	16	31	1	3.23%
30	32	10	31.3%	41	31	1	3.23%
46	26	8	30.8%	23	32	1	3.13%
32	24	7	29.2%	8	33	1	3.03%
22	18	5	27.8%	3	34	1	2.94%
34	29	7	24.1%	5	34	1	2.94%
33	32	7	21.9%	17	34	1	2.94%
20	32	6	18.8%	18	34	1	2.94%
38	30	5	16.7%	13	35	1	2.86%
51	24	4	16.7%	14	35	1	2.86%

Note: The Shanghai Santana 2000 GSI car is the reference factor.

are subject to any trade restrictions at all, they must be relatively mild. At the same time, eleven factors have prices which embody significant city−specific components in at least two−thirds of the cities for which prices are available. Prices for these factors are so idiosyncratic as to suggest that they could be subject to non-market forces.[31]

Table 12 retabulates the city−factor effects of table 11 by city. It ranks 35 cities according to the percentage of factors exhibiting city−specific prices that differ significantly from those in Shenzhen. If Shenzhen is relatively free of local protectionism, then the evidence of table 12 suggests that a number of other cities are probably similarly open. Ten cities have statistically significant effects for fewer than 10% of the factors for which they report prices.

In contrast, Lasa and Qingdao have statistically significant city−specific effects for at least 20% of the industrial factors for which they report prices. In other words, controlling for the aggregate level and trends in the aggregate level of producer prices in each city, the prices of industrial factors of production in these cities are still so idiosyncratic as to raise the suspicion that local protectionism may be active.[32]

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[31] In the first expanded sample of table 6, equation 2 estimates that 379 of 3,146 city-factor effects are significant. It estimates that 612 of 4,473 city-factor effects are significant in the second expanded sample. The proportions of estimated effects which are significant for each factor in the first expanded sample are similar to those in table 11. In the comparison between table 11 and the second expanded sample, these proportions increase from 4.35% to 11.8% for factor 19, 3.13% to 65.7% for factor 23, 0.0% to 11.8% for factor 43, 37.5% to 100% for factor 78 and from 37.5% to 95.2% for factor 79. They decline from 27.8% to 15.6% for factor 22, 29.2% to 3.23% for factor 32, 80.7% to 31.4% for factor 35, 100% to 35.3% for factor 56, 82.4% to 41.4% for factor 118, 94.4% to 61.3% for factor 119 and 100% to 64.29% for factor 120.

[32] The proportions of city-factor effects that are statistically significant for each city in the first expanded sample of table 6 are similar to those in table 12. The proportions of significant effects in the second expanded sample increase to 12.0% in Haikou, 17.9% in Wulumqi, 18.6% in Beijing, 24.1% in Xiamen and decline to 23.0% in Lasa.

Table 12

Cities ranked by percent of significant city−factor effects

City	Number of factors reporting prices	Number of factors with significant effects	percent significant effects	City	Number of factors reporting prices	Number of factors with significant effects	percent significant effects
Lasa	28	9	32.1%	Taiyuan	69	8	11.6%
Qingdao	108	22	20.4%	Zhengzhou	99	11	11.1%
Xiamen	66	13	19.7%	Xi'an	73	8	11.0%
Kunming	80	15	18.8%	Shenyang	112	12	10.7%
Fuzhou	100	17	17.0%	Huhehaote	103	11	10.7%
Changchun	86	14	16.3%	Harerbin	98	10	10.2%
Hangzhou	113	18	15.9%	Shanghai	89	9	10.1%
Nanchang	89	14	15.7%	Guiyang	81	8	9.88%
Nanjing	105	16	15.2%	Nanning	105	10	9.52%
Guangzhou	86	12	14.0%	Chongqing	76	7	9.21%
Hefei	110	15	13.6%	Tianjin	101	9	8.91%
Lanzhou	92	12	13.0%	Jinan	81	6	7.41%
Chengdu	85	11	12.9%	Dalian	88	6	6.82%
Ningbo	111	14	12.6%	Xinning	63	4	6.35%
Shijazhuang	88	11	12.5%	Wulumuqi	32	2	6.25%
Wuhan	97	12	12.4%	Yinchuan	66	4	6.06%
Changsha	98	12	12.2%	Haikou	22	0	0.00%
Beijing	99	12	12.1%				

Note: Shenzhen is the reference city.

VII. Conclusion

The evidence in this paper demonstrates that dispersion in agricultural factor prices did not diminish in the years prior to WTO accession. Dispersion in industrial factor prices did diminish, at least as measured by the coefficient of variation. However measured, though, dispersion in industrial factor prices increased after WTO accession.

This raises the possibility that the reduced or at least restrained dispersion in industrial factor prices prior to WTO accession was a tactic to ensure WTO membership. If, as seems likely, the Chinese industrial sector was of greater interest to international investors than was the Chinese agricultural sector, unobstructed markets in domestic factors of industrial production would have been of greater interest to the arbiters of Chinese WTO accession. Chinese policy may therefore have been designed to provide temporary evidence of increasing domestic integration in these markets.

Similar proportions of agricultural and industrial factors of production exhibit symptoms consistent with the presence of protectionist policies. Two of eighteen agricultural factors and fourteen of 118 industrial factors had prices which differed significantly from their respective reference prices in at least half of all cities with complete price data for each factor.

The distributions of city-specific factor prices differ substantially across cities for agricultural and industrial factors. For agricultural factors, more than half of all cities have idiosyncratic prices for 10% or fewer of agricultural factors with complete price records. However, two cities exhibit such prices for half or more of agricultural factors.

In contrast, no city has idiosyncratic prices for even half of all industrial factor prices with complete price records. At the same time, more than two thirds of all cities exhibit such prices for at least 10% of industrial factors.

Violations of the Law of One Price are so pervasive for some agricultural and industrial factors as to suggest that city-specific markets for these factors are highly insulated. They are sufficiently widespread as to suggest that many cities may indulge in protectionist policies for some factors. Only five cities – Chongqing, Tianjin, Dalian, Jinan and Xining – have significant factor-specific prices for 10% or less of both agricultural and industrial factors.

Increased integration could yield previously unexploited efficiencies. Inefficiencies, to the extent that they are deliberate, generally represent attempts by local governments to induce and then extract economic rents. World Bank (2003) discuss policies that may discourage such attempts. Explicit prohibitions against local protectionism are an obvious, though hitherto ineffective strategy. More general reforms that increase competition and reduce local government demand for rents may also have promise.

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Appendix

Appendix Table 1

Agricultural factors of production

Factor 1:	Ammonium citrate hydrocarbons, nitrogen>17%, water?3.5?
Factor 2:	Urea with 46% nitrogen, home-made
Factor 3:	Urea with 46% nitrogen, imported
Factor 4:	Diammonium phosphate, home-made
Factor 5:	Diammonium phosphate, imported
Factor 6:	Potassium chloride 50%-60% potassium oxide
Factor 7:	Three-way compound fertilizer, home-made with P.N.K. at 5% respectively
Factor 8:	Three-way compound fertilizer, imported with P.N.K. at 5% respectively
Factor 9:	High-pressure polythene film with folded diameter=1m thick, 0.10mm±0.02
Factor 10:	High-pressure polythene film with folded diameter=3.5-5m thick, 0.10mm±0.02
Factor 11:	High-pressure polythene mulch film, thickness 0.014mm ±0.002
Factor 12:	Dipterex 90% crystal
Factor 13:	DDVP 80%
Factor 14:	1605 ethyl 50%
Factor 15:	1605 methyl 50%
Factor 16:	Rogor 40% emulsion
Factor 17:	Rogor oxide 40% emulsion
Factor 18:	Potassium methylamine 50% emulsion
Factor 19:	Fenvalevate 10%
Factor 20:	Deltamethrin 40% emulsion
Factor 21:	Furadan 3%
Factor 22:	Sumi-alpha 5% emulsion
Factor 23:	Iprobenfos 40% emulsion
Factor 24:	Benomyl 50% powder
Factor 25:	Ordram 76% emulsion
Factor 26:	Diesel 0# for agricultural use
Factor 27:	Diesel -20# for agricultural use
Factor 28:	Agricultural-use tractor 12-15 horsepower, 4-wheel; mainly local sale, 10,000 yuan
Factor 29:	Dregs of beans, home-made
Factor 30:	Wheat bran, home-made

Appendix Table 2

Industrial factors of production

Factor 1: I-steel 16, Q235 Yuan/ton
Factor 2: I-steel 30, Q235 Yuan/ton
Factor 3: U-steel 20, Q235 Yuan/ton
Factor 4: U-steel 30, Q235 Yuan/ton
Factor 5: L-steel 40x40, Q235 Yuan/ton
Factor 6: Round steel 12, Q235 Yuan/ton
Factor 7: Round steel 16, Q235 Yuan/ton
Factor 8: Flat steel 4x30, Q235 Yuan/ton
Factor 9: Spiral steel 18, Q235 Yuan/ton
Factor 10: Spiral steel 22, Q235 Yuan/ton
Factor 11: Wire rod, common 6.5, Q215A Yuan/ton
Factor 12: Wire rod, common 6.5, Q235A Yuan/ton
Factor 13: Hot-rolled middle and thick plate 6, Q235A carbon Yuan/ton
Factor 14: Hot-rolled middle and thick plate 10, Q235A carbon Yuan/ton
Factor 15: Hot-rolled thin plate 0.5, Q235A Yuan/ton
Factor 16: Hot-rolled thin plate 1, Q235A Yuan/ton
Factor 17: Cold-rolled thin plate 0.5, Q195-Q235 Yuan/ton
Factor 18: Cold-rolled thin plate 1, Q195-Q235 Yuan/ton
Factor 19: Tinplate 0.25, E2
Factor 20: Galvanized plate 0.5, 200g Yuan/ton
Factor 21: Galvanized plate 0.75, 200g Yuan/ton
Factor 22: Sand steel plate 0.5, DW470-50 Yuan/ton
Factor 23: Galvanized pipe 15, Q235BF, 200g Yuan/ton
Factor 24: Stainless steel 1.2x1000x2000 Yuan/ton
Factor 25: Carbon synthetic steel 25, 45# Yuan/ton
Factor 26: Pig iron for casting 18 Yuan/ton
Factor 27: Iron for steelmaking 10 Yuan/ton
Factor 28: Billet killed steel 95-105 Yuan/ton
Factor 29: Ferrosilicon with 75% silicon Yuan/ton
Factor 30: Electrolytic copper 1# Yuan/ton
Factor 31: Aluminium A00 Yuan/ton
Factor 32: Aluminium A0 Yuan/ton
Factor 33: Lead 1# Yuan/ton
Factor 34: Zinc 0# Yuan/ton
Factor 35: Zinc 1# Yuan/ton
Factor 36: Tin 1# Yuan/ton

Appendix Table 2, continued

Factor 37: Nickel 1# Yuan/ton
Factor 38: High-pressure polythene film 1F7B Yuan/ton
Factor 39: High-pressure polythene film Q200 Yuan/ton
Factor 40: High-pressure polythene injection moulding 112A Yuan/ton
Factor 41: Low-pressure polythene wiredrawing 5000S Yuan/ton
Factor 42: Low-pressure polythene film 7000P Yuan/ton
Factor 43: Low-pressure polythene injection moulding 7006A Yuan/ton
Factor 44: Polypropylene wiredrawing 2401 Yuan/ton
Factor 45: Polypropylene film 2400 Yuan/ton
Factor 46: Polypropylene injection moulding 1300, 1400 Yuan/ton
Factor 47: Polystyrene transparent 666D Yuan/ton
Factor 48: Polyvinyl chloride suspension Yuan/ton
Factor 49: Polyvinyl chloride emulsion Yuan/ton
Factor 50: Polyester section fibre Yuan/ton
Factor 51: Benzene petroleum Yuan/ton
Factor 52: Methylbenzene petroleum Yuan/ton
Factor 53: Xylene petroleum Yuan/ton
Factor 54: Calcium carbide Yuan/ton
Factor 55: Methanol Yuan/ton
Factor 56: Ethanol Yuan/ton
Factor 57: Sulphuric acid 98% acid Yuan/ton
Factor 58: Nitric acid Yuan/ton
Factor 59: Hydrochloric acid 30% acid Yuan/ton
Factor 60: Sodium carbonate with industrial alkali content?98.5% Yuan/ton
Factor 61: Caustic soda solid alkali (ion film) content ?98% Yuan/ton
Factor 62: Caustic soda liquid alkali (ion film) content ?30% Yuan/ton
Factor 63: Natural home-made rubber, 1# rubber Yuan/ton
Factor 64: Synthetic butadiene rubber Yuan/ton
Factor 65: Meridian tire (Santana) 185/70SR13 Yuan/pc
Factor 66: Korean pine log 4-6m long, diameter >30cm, first class, Yuan/cubic meter
Factor 67: Korean pine log 6m long, diameter >30cm, first class, Yuan/cubic meter
Factor 68: Larch log 4-6m long, diameter >30cm, first class, Yuan/cubic meter
Factor 69: Larch log 6m long, diameter >30cm, first class, Yuan/cubic meter
Factor 70: Fir log, mainly local sale, diameter=14cm-18cm Yuan/cubic meter
Factor 71: Northeast China ash log, 4m long, diameter>30cm, first class, Yuan/cubic meter
Factor 72: White pine thick board, 4m long and 6cm thick, first class
Factor 73: Larch thick board, 4m long and 6cm thick, first class Yuan/cubic meter
Factor 74: Assorted thick board, 4m long and 5cm thick, first class, Yuan/cubic meter

Appendix Table 2, continued

Factor 75: Home-made plywood, common 1.22x2.44x3 Yuan/pc
Factor 76: Imported plywood, common 1.22x2.44x3 Yuan/pc
Factor 77: Fibreboard 1x2 Yuan/pc
Factor 78: Paper pulp, bleached coniferous tree, imported kraft Yuan/ton
Factor 79: Paper pulp, bleached broadleaf tree, imported kraft Yuan/ton
Factor 80: Offset paper, home-made 70g, Yuan/ream
Factor 81: Bituminous coal, Grade 9 coking coal Yuan/ton
Factor 82: Bituminous coal, industrial boiler mixed coal<50mm Yuan/ton
Factor 83: Coke, smelter coke?40mm Yuan/ton
Factor 84: Diesel 0# (used for public transportation) Yuan/ton
Factor 85: Diesel -10# Yuan/ton
Factor 86: Diesel -20# Yuan/ton
Factor 87: Gasoline 90# lead-free Yuan/ton
Factor 88: Heavy oil pressure reduction (heavy oil for fuel) Yuan/oil
Factor 89: Common industrial use electricity, uniform price if voltage<315 voltage, Yuan/kilowatt-hour
Factor 90: Natural gas, natural gas for industirl use, Yuan/cubic meter
Factor 91: Coal gas, coal gas for industrial use, Yuan/cubic meter
Factor 92: Water for industrial use, tap water for industrial use, Yuan/ton
Factor 93: Common silicate cement 525# bag package Yuan/ton
Factor 94: Common silicate cement 425# bag package Yuan/ton
Factor 95: Slag silicate cement 525# bag package Yuan/ton
Factor 96: Slag silicate cement 425# bag package Yuan/ton
Factor 97: Common plate glass 3mm Yuan/cubic meter
Factor 98: Common plate glass 5mm Yuan/cubic meter
Factor 99: Float plate glass 3mm Yuan/cubic meter
Factor 100: Truck, Jiefang CA1092 Yuan/pc
Factor 101: Truck, Dongfeng EQ1092E Yuan/pc
Factor 102: Truck, Dongfeng EQ1092F2D Yuan/pc
Factor 103: Truck, Beijing BJ1041, Yuan/pc
Factor 104: Truck, Yuejin NJ1061A, Yuan/pc
Factor 105: Car, Shanghai Santana 2000 GSI Yuan/pc
Factor 106: Car, FA Red-flag Jixing CA7180AE Yuan/pc
Factor 107: Car, FA new Jetta GTX Yuan/pc
Factor 108: Car, Tianjin Xiali TJ7130UA, Yuan/pc
Factor 109: Car, SA Dragon Citroen 988 Yuan/pc
Factor 110: Light passenger car, Iveco A40-10-2Z, Yuan/pc
Factor 111: Passenger/goods dual vehicle, Jiangling NHR54ELW Yuan/pc

Appendix Table 2, continued

Factor 112: Off-road jeep, Beijing BJ2020S, Yuan/pc
Factor 113: Off-road jeep, Beijing Cherokee 7250, 4x2 Yuan/pc
Factor 114: Ginned cotton, Grade Three 27mm, Yuan/ton
Factor 115: Pure cotton yarn, 42 bobbin, Yuan/ton
Factor 116: Polycotton yarn, 65/35 combing, Yuan/ton
Factor 117: Pure cotton grey cloth 38"30x3672x69 fine cloth, Yuan/100m
Factor 118: Pure cotton grey cloth 50"30x3068x68 fine cloth, Yuan/100m